

FIRST FIELD ECOLOGY SYMPOSIUM, “FOREST ECOLOGY AND RESTORATION” 28TH – 30TH JANUARY 2005

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Little detailed knowledge is available on Indochina's biodiversity (plants, invertebrates, vertebrates, etc.) at the level that currently exists for the temperate zone and for some areas in the Neotropics and Africa (e.g., TERBORGH *ET AL.*, 1990; ROBINSON *ET AL.*, 2000 and cited there-in). This is particularly problematic for countries in Indochina, where large-scale deforestation (and other forms of habitat destruction) is occurring rapidly (FAO, 1997) and this biodiversity is being lost and biological communities are being significantly changed before they have been well documented. For example, less than 20% of Thailand remains forested compared with an estimate of 53% from the early 1960's (LEUNGARAMSRI & RAJESH, 1992). In conjunction with habitat loss and fragmentation, there is still intense exploitation of wildlife resources for food and for the national and regional wildlife trade (BENNETT & RAO, 2002).

Compounding these problems is a serious lack of human resources and expertise in all fields of ecology (SODHI & LIOW, 2000). Thailand, a country of over 65 million people, and now one of the most developed in the region, still ranks in the bottom 25% in the world in terms of the number of people involved in any form of research and development (WORLD BANK, 2002). Although Thailand has an equal or higher level of biological diversity of many groups of organisms and a larger area complex tropical ecosystems compared to the United States for example (ASEAN REGIONAL CENTRE FOR BIODIVERSITY CONSERVATION, 2003), our estimates suggest that it probably graduates < 5 Ph.D. ecologists per year (0.08 ecology graduates/ million people) compared to at least 40 times that rate from the United States (> 1000 Ph.D. ecologists per year). The situation is far worse for most of Thailand's immediate neighbors. Furthermore, while the situation is improving, there are still too few Thai or other South-east Asian researchers with sufficient training or experience to conduct scientifically-sound surveys of any form of biodiversity and even fewer with the capacity to analyze data and publish scientific papers in this scientific field (SODHI & LIOW, 2000).

However, anecdotal evidence suggests that a relatively large community of researchers is currently working in many different parts of the country covering many aspects of its biodiversity. Unfortunately, this research tends to be isolated and/or fragmented, leading to reduced impact and lower international output.

In order to gather researchers (Thai and foreigner) who are presently conducting research in Thailand related to forest ecology and forest restoration we decided to organize and host a symposium on “forest ecology and restoration” which we hope will be the beginning of a long-term series of symposia on field ecology to be organized on a bi-annual

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basis, and perhaps on an annual basis depending on the level of interest. The meeting atmosphere allowed researchers and students to exchange ideas for enhancing the quality of their work and establishing future cooperation.

The symposium focused on a range of researchers—from senior professors to graduate students. Our first goal was to have senior researchers, with international standing, share their knowledge among the participant in a series of plenary talks covering many different aspects of forest ecology. The second goal was for graduate students to have the opportunity to present their work in an atmosphere similar to an international meeting and receive constructive scientific feedback from a scientific audience. The symposium, sponsored by Biodiversity Research Training (BRT), PTT-EP, King Mongkut's University of Technology Thonburi (KMUTT) and Wildlife Conservation Society (WCS), was attended by approximately 90 researchers from Thailand and other countries. Here follows the abstracts from 37 oral presentations and 10 posters that were presented during the three days of the symposium.

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ABSTRACTS OF ORAL PRESENTATIONS**Current Policies Regarding Conducting Research in Thailand's Protected Areas**

Chaweewan Hutacharern

After Bureaucratic restructuring in 2002, the Department of National Parks, Wildlife and Plant Conservation (DNP) was formed as a separate agency from the existing Royal Forest Department (RFD). The DNP was established to oversee selected categories of protected areas (national parks, wildlife sanctuaries and head watershed areas) where relatively fragile environments require special protection and maintenance to preserve their biological diversity. Forest reserves and forest parks, however, remain under the jurisdiction of the Royal Forest Department.

Management of these protected areas requires baseline information on their physical and biological aspects. This information is obtained through field surveys and by monitoring environmental changes, and the DNP must ensure that these actions are sufficient to inform environmental management. In addition to providing valuable ecosystem services, Thailand's protected areas serve a number of other functions, including biological and environmental study. The DNP and the RFD have therefore implemented policies that support all research in these protected lands. Data from this extramural research contribute to the monitoring goals of the DNP and RFD without expending their resources. All research must be carried out in accordance with Thailand's pertinent laws, regulations and procedures.

The Director-General of Department of National Parks, Wildlife and Plant Conservation is authorized to grant permits to those conducting research in protected areas under the jurisdiction of the DNP. Permission is granted in accordance with the recommendations of a technical consulting committee and after being endorsed by the Minister of Natural Resources and Environment. Processing time for a research permit application is usually less than 60 days. Any projects involving foreign researchers must be approved by the National Research Council of Thailand before the application is submitted to the DNP. Applications for research to be conducted on lands under the jurisdiction of the RFD are handled in a similar manner. While this two-step procedure allows for more thorough review of the requests, it has also become rather time-consuming. Nevertheless, the process was established to better meet Thailand's obligations as a Contracting Party to the Convention on Biological Diversity, balancing the need to protect the country's interests while granting access to its biological and genetic diversity for the greater global good.

Conducting a Successful Long-term Wildlife Research in Thailand: Strategy and Funding

Pilai Poonswad

It is very difficult to provide a typical model strategy in order to keep a long-term wildlife research running, particularly in a developing country such as Thailand where wildlife is much considered for its economical value, but with little care for its ecological value. The research itself basically requires a long duration, a lot of manpower and great amount of funding. It also involves a number of influential unexpected factors. To be successful and achieving goals such project has to be recognized by agencies of authority, public and private sectors. To achieve the goals, from my perspective, I propose the following strategies: Firstly, it directly involves the researcher; the personal discipline, including inspiration, curiosity and passion, setting goals, honesty and determination. Secondly, the researcher must have a scientific thinking process; comprising interrelated thinking from data emission, consistency and ethics, interpretation and evaluation of results, dissemination of results and implementation. Thirdly, social and psychological skill; it involves attracting public attention, arousing and convincing awareness, appreciation, creating trust and inviting participation. These would render both moral and financial support which perpetuate the research and create pride among the public. The discussion is based on first hand experience.

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The Plant Community and its Diversity at the Tumpang Archeological Site, Walailak University

Chatchai Ngarmriabsakul and Maruay Mekanawakul

Plant species at the Tumpang Archaeological site, Walailak University, Nakhon Si Thammarat, were numerated. There are in total 189 species in 144 genera and 75 families. Families represented by the greatest number of species were the Rubiaceae (15 spp.), Euphorbiaceae (10 spp.), Myrtaceae (9 spp.), Anacardiaceae (7 spp.), Moraceae (7 spp.) and the Palmae (6 spp.). The top seven species in terms of an importance value index (IVI) were *Hevea brasiliensis* 53.29, *Dipterocarpus alatus* 40.38, *Microcos tomentosa* 16.20, *Chaetocarpus castanocarpus* 14.22, *Vitex pinnata* 13.99, *Syzygium gratum* 12.84 and *Licuala spinosa* 11.46. This information on plant community suggested human activities in the area before closed conservation both in terms of archeological and biological value. The area is a lowland and flooded for a short period of time every year as suggested by the indicator species such as *Syzygium gratum*, *Syzygium oblata*, *Fragraea racemosa*. High IVI values for *Microcos tomentosa*, *Chaetocarpus castanocarpus* and *Vitex pinnata* indicate that these species are pioneers and fast growing. Plant community structure of the Tum-Pang Archaeological site is a monocrown and densely covered on top. The undershading species include *Licuala spinosa*, rattans and seedlings. The present data can be used for future comparative studies and

monitoring changes in the plant community.

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Using Lichens for Long-term Monitoring of Climate Change

Kansri Boonpragob

Global warming caused by anthropogenic emission of greenhouse gases into the atmosphere may cause severe damage to ecosystems and human societies. Adaptations to minimize the impacts require understanding of future changes that may occur. Lichens are epiphytes, which directly depend on the atmosphere for growth resources. Species composition in various ecosystems are different, and can be used as indicators of environmental quality, forest type and air pollution. It is expected that species migration to higher elevations will occur under global warming. However, the long life span of the dominant vegetation may result in delayed responses and thus precautionary measures to minimize the impacts and adaptation strategies to conserve biodiversity under climate change could be undetermined. The objectives of this study are to explore biodiversity of lichens in various ecosystems together with monitoring microclimates of their habitats in order to use lichens as bioindicators of global warming. The study was conducted at Khao Yai National Park, where forest ecosystems span from 200–1300 meters elevation. This study found that lichens in lower montane forest, tropical rain forest, dry evergreen forest, mixed deciduous forest, dry dipterocarp forest, secondary forest and tree plantations contained 215, 298, 224, 80, 60, 184 and 67 species, respectively. Seven species were found in all ecosystems. These species appear to have a wide range of environmental tolerance. It was also found that 28, 27, 10, 3, 2, 17 and 3 species respectively, were found to be unique to the above forest types. These species may require specific habitats and climatic conditions, and therefore used as bioindicators of climate change as well as forest type. They may also be sensitive to environmental change, and are thus threatened with extinction. However, long-term monitoring is necessary to accurately assess these changes.

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The Use of the Mo Singto Forest Dynamics Plot for Study of Forest Community Ecology and Regeneration in Khao Yai Park: A Unique Research Resource

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The Mo Singto Forest Dynamics Plot was initiated in 1994 and underwent a complete tree census in 2000–2001 (10 cm dbh) and again in 2003–2004 (1 cm dbh). It is about

30 ha in area and was originally located to contain the home range of a habituated gibbon study group. Nearly all the mammals resident in the park occur on the plot and about 130 species of birds are breeding residents in the plot or surrounding forest. The flora includes 200 species of trees 10 cm in dbh and about 150 species of vines and lianas. This plot, which took about 6 years to establish and requires constant work to maintain, provides unique opportunities for the study of population dynamics, plant-animal relations, and forest regeneration. On-going studies of resident birds are establishing precise densities and breeding habits. Gibbon studies are focusing on ranging paths, diet, and the relation between fruit source distribution, range use, and defended territory. The use of the tagged trees in studying gibbon behavior and travel, combined with the tree census database, allows the mapping of ranging paths and home range with a precision never before achieved in primate study. Examples of plotted ranging paths and home ranges are given, with objectives and plans for future research.

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Using Science-based and Innovative Techniques to Reduce Human-Elephant Conflict at Kaeng Krachan National Park

Puntipa Pattanakaew¹ and Simon Hedges²

Human-elephant conflict (HEC) has increasingly become a major problem in many areas in Africa and Asia where humans live in or next to elephant habitat. The commonest form of HEC is crop raiding by elephants. Such problems have an impact on both local economics and conservation because HEC can lead to bad feelings towards protected areas and can lead to farmers poisoning or otherwise killing elephants. Kaeng Krachan National Park (KKNP) is Thailand's largest national park and listed among seven protected areas facing the most serious HEC problem. The park with support from NGOs has experimented with several mitigation methods but none have achieved long-term effectiveness. Wildlife Conservation Society (WCS) has developed a project which aims to reduce HEC by using science-based, innovative techniques. Distribution of natural water sources and saltlicks has been mapped. The level of HEC around the park is being assessed using standardized methods. The data on the spatial and temporal distribution of crop-raiding by elephants will help us to design and implement an appropriate low-tech conflict reduction strategy. Novel methods to be tested include the use of extremely powerful chilies as an elephant deterrent. Experiments in Zimbabwe have shown that elephants are effectively deterred from entering crops if ropes coated in chili-laden grease are strung around the perimeter of the fields. In addition, burning dry cow dung mixed with chilies has been shown to produce an acrid smoke that helps keep elephants away from crops. A trip-wire alarm system, sirens, spotlights, fire-crackers already employed by local people will be promoted to use in a coordinated manner

to frighten away elephants when they try to enter. The lessons learnt from this work in KKNP will assist farmers reduce HEC effectively elsewhere in Thailand and more widely in Asia and Africa.

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An Assessment of Presence/Absence of Carnivore Species Using Indirect Monitoring Methods at Khao Yai National Park

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Monitoring the status, distribution, and threats to biological diversity is a critical element of protected area management; however, even in Thailand's most studied protected area, Khao Yai National Park, only limited scientific knowledge is available on the status and ecology of species such as the tiger and clouded leopard. Consequently, protected area staff lack adequate information on which to base management decisions regarding carnivore communities. To address these deficiencies, the Smithsonian Institution, WildAid, and Khao Yai National Park jointly initiated a carnivore monitoring project at Khao Yai. Surveys were carried out following a zone-based approach. Between 11 October 2003 and 27 August 2004, 14 of the 22 park management zones were surveyed. Two survey teams were sent out to separate zones each month. During the survey, three methods were used for recording wildlife presence: recce surveys following a line of least resistance, 200m straight line transects oriented on a north-south axis at each camera location, and camera traps. Camera traps were deployed for a minimum of 21 days. Through the combined survey methods, 27 mammal and 4 bird species were identified, including: Tiger, Dhole, Jackal, Malayan Sun Bear, and Asiatic Black Bear. A total of 385 signs were encountered during recce surveys. The highest percentage of signs was close to park headquarters. Tiger signs were recorded in two separate park zones, KY16 and KY21. A total of 27.65 km of line transect were walked separate from the recce surveys, and also resulted in the encounter of tiger signs. Cameras placed at 76 distinct locations totaled 2465 camera trap-nights. The camera traps resulted in a total of 270 animal captures on film, with ten carnivore species being filmed. Our results showed carnivore signs from all three survey methods; however, target carnivores such as tiger and clouded leopard were not detected through camera trapping. These are especially elusive species, so it will be interesting to resurvey areas where tracks were found with a focus on obtaining a tiger or leopard photograph.

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Field Studies in Gallo-pheasant of Thailand

Wina Meckvicha

Six out of ten species of gallo-pheasant in Thailand are threatened by habitat loss and over-hunting for meat, feathers and eggs from the forests. Moreover, habitat fragmentation also affects long-termed genetic diversity. There is an urgent need to study and establish management guidelines for conservation of these endangered species before the situation becomes worse and irreversible. The following topics will be addressed in the symposium on Ecology and Restoration: which of the threatened species should have research priority; where are the most suitable study sites; when is the appropriate time for field-surveys, and what are the most suitable methods and conservation strategies for each species.

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Forest Restoration Science: Recent Advances and Future Challenges

Stephen Elliott and David Blakesley

This paper reviews the current state of forest restoration science and its application to accelerate biodiversity recovery in deforested or degraded land in the tropics. Progress in addressing recommendations made at two landmark international symposia on the subject is reviewed (“Accelerating Native Forest Regeneration on Degraded Tropical Lands”, Washington DC, 1996 & “Forest Restoration for Wildlife Conservation”, Chiang Mai, 2000), with particular reference to the progress that has been achieved in developing successful techniques to restore evergreen tropical forest to degraded sites in upland areas of northern Thailand.

Chiang Mai University’s Forest Restoration Research Unit (FORRU) has been able to achieve closed canopy, evergreen forest on abandoned agricultural land, at 1,300 m elevation, within 3–4 years after planting 20–30 so called “framework” tree species, which perform well, shade out weeds and attract seed-dispersing wildlife, thus facilitating recruitment of forest tree species and biodiversity recovery. This success was accomplished by focusing on three main research areas: i) development of criteria and quantifiable standards for the selection of framework tree species from amongst the indigenous forest tree flora; ii) development of nursery techniques to grow vigorous planting stock and iii) development of effective post-planting silvicultural treatments.

Whilst recovery of forest ecosystem structure and function has been rapid, biodiversity recovery has been more equivocal. Therefore, mechanisms of biodiversity recovery and their enhancement require further research. Research on the following topics is particularly recommended: i) the ecology and behavior of bird/mammal species, most likely to disperse seeds from intact forest to restoration sites (particularly less studied groups such as bats); ii) how plantation design (size, positioning, species mix, addition of artificial structures such as nesting/roosting boxes etc.) can be modified to attract wildlife (particularly seed dispersers).

There is also an urgent need for research to adapt the framework species approach to restore other forest ecosystem types (particularly deciduous forests). Further testing and adaptation of the principles of the technique in other Indochinese countries, with a similar seasonally dry climate, are recommended.

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Distribution of Forest Gaps on the Mo Singto Biodiversity Research Plot

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The study of gap dynamics and their species composition leads to greater understanding of tropical forest dynamics. A gap is defined as a hole or space in the forest that is caused by falling trees or snapped branches. The disturbance damage can be created by abiotic, e.g. wind, or biotic factors, e.g. fungi, insects, etc. The shape of the forest opening is usually irregular and its size depends on the extent of the catastrophe. The border of gaps may be defined as the innermost points reached by canopy foliage. Gaps and disturbed areas play an important role in forest dynamics. They affect the regeneration and species composition of the forest ecosystem. Gap environments differ from closed canopy including: higher light intensity, soil nutrients and moisture. These available resources offer advantages to many kinds of plant species, especially pioneer species.

In 2003, we started mapping gaps in the Mo Singto biodiversity research plot, Khao Yai National Park. We defined a gap as above but included only those where most of the seedlings and saplings were no higher than 5 m. A total of 84 gaps were mapped and their sizes were calculated using GIS. The total area of gaps was 2.75% of the total plot area and the size of gaps ranged between 5 m² and 941 m², with modal size approximately 25 to 50 m². We found that 20, 20, and 44 gaps were created in 2003, 2002, and before 2002, respectively. Surprisingly, gaps formed in 2003 comprised most of the total gap area (44.5%), and were caused by catastrophic wind-storms in the late summer season. Studies of gap species composition, niche partitioning, and seedling recruitment are currently being undertaken.

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**Seedling Establishment of Climax Species
under the Eucalyptus Plantation and Open Site at Wang Nam Khiew
Forestry Student Training Station, Amphoe Wang Nam Khiew,
Changwat Nakhon Ratchasima**

Weerasak Niamrat and Dokrak Marod

Reforestation is a valuable method for sere shortening and rehabilitation in disturbed forest areas. Fast growing pioneer species are commonly recommended at the first stage of the plantation process; however, the final aim is a mixed community of native climax species. To support this process, studies were conducted in disturbed dry evergreen forest at the Forestry Training Station, Amphoe Wang Nam Khiew, Changwat Nakhon Ratchasima. Seeds of 14 native tree species as *Dipterocarpus intricatus*, *D. alatus*, *Shorea siamensis*, *S. floribunda*, *S. henryana*, *Pterocarpus marcrocarpus*, *Xylia xylocarpa*, *Azzeria xylocarpa*, *Hopea odorata*, *Suregada multiflorum*, *Clausena guillauminii*, *Dialium cochinese*, *Peltophorum dasyrachis* and *Walsura trichostemon* from the nearby forest were collected to study seed germination and seedling survival. The seedlings were tested by planting in three different habitats: gaps in 4 and 20-year old *Eucalyptus* plantations and open areas. Two replications were set in each habitat with approximately 50 seedlings of each species used per treatment. Some environmental factors including physical and chemical soil characteristics and climate data were collected and analyzed.

The results showed that the soil properties showed minor variation among the three sites but the top layer in the 20-year old *Eucalyptus* plantation had much higher soil moisture nearly all year round. There was no difference in soil moisture content among the middle soil layers. The level of light through the canopy (standard sky overcast) was low in the 20-year old plantation but high in the 4-year old plantation and the open site. Percent germination of seeds in the 20-year old plantation was high for every species but low in the 4-year old plantation and the open site with only 5 and 2 species, respectively. The seedlings of the dominant tree species in the dry evergreen forest survived well under the 20-year old plantation while the seedlings from dominant trees in the dry dipterocarp and the mixed deciduous forests had high survival rate and growth under the 4-year old plantation and the open sites. The ratio of root and stem biomass of seedlings indicated that seedlings of the trees in the dry evergreen forest were around 1 while the seedlings from the trees in the other two forest types had value over 1. The results suggest that suitable seedlings for rehabilitation in old plantations such as the 20-year old *Eucalyptus* plantation include *Hopea odorata*, *Shorea henryana*, *S. floribunda*, *Dipterocarpus alatus* and *Dialium cochinese* and for young plantations and recently disturbed sites *S. floribunda*, *S. siamensis*, *Pterocarpus marcrocarpus*, *Xylia xylocarpa*, *Peltophorum dasyrachis* and greater than 1-year old seedlings of *H. odorata*.

Rapid Streamside Revegetation: Development of Collection, Propagation and Planting Techniques for Trees of the Lowland Rivers and Streams in Northern Thailand

Ricky Ward

Between May 2000 and August 2003 small scale trials of planting trees on abandoned, low elevation land has produced information for developing revegetation techniques applicable in most northern Thai villages.

Agricultural and urban development has caused the near total disappearance of the original riparian trees in the plains and lower valleys of northern Thailand. In many places the exotic *Samanea saman* now dominates. These changes, selective logging and the transformation of forests by fire have resulted in a tragic loss of biodiversity and of a local appreciation of what once grew by the streams.

To remedy this loss of knowledge, a study of CMU Herbarium floristic specimen reports from two national parks in Chiang Mai and Chiang Rai together with visits to extremely rare streamside remnant vegetation communities from Nan to Mae Hong Sawn has resulted in a list of 80 indigenous tree species from 37 families as suitable for planting. Observations and experimental results relating to 21 of these species are presented.

In January 2004, following extensive destruction by the government of vegetation along the Ping River in urban Chiang Mai, a trial began to produce a diversity of trees and plant them in numbers sufficient to demonstrate effective rapid revegetation of streamside land.

This project has been done by a small group of retirees using a makeshift stick and shade cloth nursery on wasteland in urban Chiang Mai with plantings on 5 sites in 4 districts in Chiang Mai and Nan provinces.

These plantings are producing promising results for rapid revegetation with *Salix tetrasperma*, *Eugenia formosa*, *Dipterocarpus turbinatus*, *Celtis tetrandra.*, *Holoptelea integrifolia*, *Anogeissus accuminata*, *Azelia xylocarpa*, *Alstonia scholaris*, *Adenanthera microsperma*, *Bombax cebia*, *Oroxylum indicum* and *Butea monosperma*.

Were rural high school science teachers to emulate this project with their communities we might see an end to the fruitless concretization of the streams of Thailand.

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Sowing the Seeds of Forest Restoration Education: State of the Art

Kunakorn Boonsai, Sudarat Zangkum, Narisa Pongsopa and Susan Doust

With many years' experience in researching forest restoration in northern Thailand, the staff of Chiang Mai University's Forest Restoration Research Unit (FORRU) recognized a growing need for an education program based on the unit's research findings to successfully restore and maintain the country's watershed forests in a sustainable way. Rather than merely publishing results in journals that gather dust on library shelves, research results should be

evaluated and practically used to encourage successful forest conservation projects. Although FORRU had been running a few ad hoc education events before, financial support from the UK's Darwin Initiative enabled employment of a full-time team of Darwin Education Officers (DEO) in 2002 to implement a comprehensive program of forest restoration education events. The DEO team has adopted a participatory approach of working with different target groups, ranging from young school children up to university students, as well as government officers and community leaders. The team members come from a variety of backgrounds, i.e. biology, agriculture, forestry, education, psychology, and art, and have various skills which have allowed them to integrate different techniques to modify the information from FORRU's research to suit each target group. Under the participatory approach, activities are carried out by "learning together", sharing experiences and exchanging knowledge.

Two and a half years into the project, the DEO team has carried out more than 15 technical workshops, 130 events for school children (both in classrooms and in the field) and many extension events at local communities. We have also hosted several groups of international visitors. The project has expanded to other areas of Thailand, as news of the work has spread. Future plans include development of a wider range of practical teaching aids, outreach programs, backed up with small grants to enable communities to establish their own tree nurseries and a program targeting trainers who will train others to adopt these successful techniques of forest restoration. The DEO team believes that, by encouraging greater care and appreciation of forests, the task of increasing local participation in forest restoration programs can be accomplished easily.

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The Effects of Forest rRestoration on the Species Diversity and Composition of a Bird Community in Doi Suthep-Pui National Park, Thailand

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This research involved bird surveys in framework species plantations of The Forest Restoration Research Unit (FORRU) at Ban Mae Sa Mai in Suthep-Pui National Park. Framework tree species should be attractive to wildlife such as birds or bats for feeding and nesting. Birds were used as indicators for monitoring forest recovery. The research objectives were to determine the species richness and composition of bird communities in experimental framework species plots of different ages, as well as the relative attractiveness of the various framework tree species planted to seed-dispersing bird species. Ecological relationships between the planted tree species and the birds attracted to them were elucidated. The results of this research should enable refinements of the framework species method of reforestation to be made, by determining which species are most likely to accelerate the biodiversity recovery and initiate improvements in plantation design to maximize the attractiveness of the

planted areas to seed dispersers. Point counts and the Mackinnon method were used in plots planted in 1998, 2000, 2002 and in non-planted control plots (three replications for each treatment year). The survey was carried out over 1 year from June 2002 to June 2003. In addition, observations of bird behavior in planted trees were carried out and the trees which birds used were identified by using FORRU planting data. Basic vegetation surveys were conducted on each plot twice during the dry season and at beginning of the rainy season. Measurements focused on the percentage of ground vegetation cover, canopy cover, and tree density. Preliminary results show that different framework species within the plots attract different birds when they produce resources such as nectar and fruit. The planted plots attracted birds that are characteristic of evergreen forest such as Hill blue Flycatcher (*Cyornis banyumas*), Scarlet Minivet (*Pericrocotus flammeus*) and White-rumped Shama (*Copsychus malabaricus*), more than open degraded areas.

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Effect of Local and the Landscape Environment on Seed Dispersal by Birds in Regenerating Forest

Puntipa Pattanakaew¹ and George A. Gale²

Knowledge of the relationships between seed dispersal, bird seed dispersers and vegetation structure inside and surrounding regenerating forest can be used to facilitate forest restoration and reduce the cost. The objective of this study was to determine which environmental factors most influence the density and species richness of birds and the seeds that they disperse into regenerating forest sites. This study was established on 8 plots in two study sites (Ban Pah Dang [PD] and Ban Mae Sa Mai [BMSM]) in northern Thailand. Five plots were located on naturally regenerating sites and three plots were located on tree plantation sites. All plots contained seed traps beneath artificial bird perches and at control points (sites without perches). We surveyed birds and collected seeds that came into the experimental plots, measured vegetation structure and used IRS satellite images and geographic information system (GIS) to study the land cover within a 5 km radius of the plots. We found that the abundance and species richness of birds per hour of observation at PD (4.7 and 2.4) was higher than at BMSM (3.9 and 1.7). Also, the abundance and species richness of seeds per month per plot at PD was 97.7 and 2.5 while BMSM was 45.6 and 1.9. Satellite images showed that PD had a higher area of forest (79.2%) than BMSM (60.5%), and the plots at PD were closer to forest than the plots at the BMSM site. The number of observations of frugivorous birds was significantly different among plots, and was positively correlated with both the number of trees and number of fruiting plants on the plots. The results indicated that degraded and regenerating sites with a high percentage of forest in their surroundings, and a shorter distance to forest had a higher density and species richness of birds and seed input. Herbaceous weeds were less attractive to frugivorous birds but seed

input into forest regenerating plots could be increased by putting up artificial bird perches, however for plots with a high percentage of canopy cover, artificial perches are less useful because birds prefer to use natural vegetation.

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The Past and the Future of Eld's deer (*Cervus eldi*) in the Wild for Thailand

Naris Bhumpakphan

Eld's deer or Brow-antlered deer (*Cervus eldi*) was commonly found in Thailand 50 years ago. Two subspecies were found within the country: the Siamese subspecies (*Cervus eldi siamensis*) was found in the Central, North, North-eastern Thailand and the Burmese subspecies or Thamin (*Cervus eldi thamin*) was found in the West. Eld's deer have been protected by Thai wildlife law as a nationally protected species since 1960. Losing their potential habitats (dry dipterocarp forest and wetlands) and hunting pressure in the past doomed the Eld's deer to extirpation from the country. The last sighting of Eld's deer was in Huai Kha Khaeng Wildlife Sanctuary, Uthai Thani Province in 1984.

Ex situ conservation programs managed by government zoos and wildlife propagation stations, and private zoos potentially maintain both Thamin and Siamese subspecies. There are 15 Siamese Eld's deer in 2 captive areas and more than 600 Thamin kept in 20 captive sites. The lessons learned from the reintroduction of Eld's deer to Phu Khiew WS in 1997 are interesting. The released deer adapted well and produced offspring. Recently, two workshops held by the Zoological Park Organization, Smithsonian Institute, and Wildlife Conservation Society at Khao Khiew Open Zoo regarding conservation and reintroduction programs for Eld's deer indicated the possibility of reintroducing Thamin to the Western Forest complex—Huai Kha Khaeng Wildlife Sanctuary (HKWS) by 2009. In addition, the Siamese Eld's deer will require more time—perhaps ten more years—to increase their population. Strategic planning for restoration of these deer has already been discussed. The Zoological Park Organization is preparing the initial population while Thung Fag Wildlife Propagation Station in HKWS has planned for a “soft” release of the animals, while the Faculty of Forestry plans to support monitoring of the released population.

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Status of Forest Birds and Habitats in Montane Evergreen Forest Patches in the Western Forest Complex

Anak Pattanavibool¹, Youngyut trisurat² and Jutamart Tifong³

Montane evergreen forest supports various resident and migratory forest bird species, many of which are endangered or threatened. Unfortunately it is one of the most threatened habitats in Thailand due largely to habitat destruction and fragmentation. Its abundance in the north has been severely reduced causing extinction of many species such as great hornbills, rufous-necked hornbills, gray peacock pheasant, and rufous-throated partridge. The mountain areas in the west are believed to be the last stronghold for many of such species. They have experienced disturbances including encroachment, fires, and hunting. This study is to document bird diversity and abundances in 3 montane forest patches located in Umpang (UP), Huai Kha Khaeng (HKK), and Thung Yai (TY). The results from Landsat TM image interpretation showed that the sites differ in size; UP 130 km², HKK 350 km², TY 705 km²; and disturbance. In each patch, we used 15–20 line transects each with 200 m in length to survey birds and they were distributed along the slope at 1,100–1,800 m in elevation. In 2003–4 we have walked the transect lines and recorded species, number of individuals, and perpendicular distance from the line. Data from line transects were augmented by observation data along the trails for bird diversity comparisons. The preliminary results on bird diversity and abundance are as follows. UM, the smallest and most disturbed, was walked 4 times and 90 species found. HKK, medium sized and disturbed, was surveyed 5 times and 133 species found. TY, the largest and least disturbed, was walked one time and 84 species found. Large and high elevation birds such as rufous-necked hornbills were most abundant in TY and HKK patches but rare in UP. The UP patch still harbored good populations of chestnut-capped fulvetta and long-tailed wren-babbler, newly recorded species for Thailand. More field surveys are planned for another year before conclusions can be drawn.

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Effects of Roads on Carnivore Abundance in Kaeng Krachan National Park

Dusit Ngoprasert¹, George A. Gale¹ and Antony J. Lynam²

Roads and human traffic can negatively impact the survival and behavior of a variety of mammals. In this study, camera-trapping techniques and capture-recapture estimation models were used to determine the effects of roads and human presence on Asiatic leopard relative abundance in a 104-km² section of Kaeng Krachan National Park, Thailand.

Density estimates for leopards were 4.78 ± 2.42 individuals per 100 km², or a minimum of 4 males and 2 females known alive in the study area. The road was not shown to be a

barrier for leopards, but their appearance to be effects related to human activity along the road. A logistic regression model suggested that the probability of the presence of leopards was significantly lower near the road ($p < 0.05$) that bisected the study area. Human presence in the forest appeared to influence leopard activity patterns, suggesting that their activity was less diurnal in areas more heavily used by people than in areas less used (Mann-Whitney U, $p = 0.004$). However, hunting in the study area is still the biggest threat to leopards and other wildlife. Finally, in addition to more effort to reduce poaching, more research is needed to determine the demographic implications of road avoidance for such species, and what if any mitigation strategies are required.

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Ecological Influences on Reproductive Performances in White-handed Gibbons (*Hylobates lar*) at Khao Yai National Park

Tommaso Savini

An ecological study on the home range quality of 7 well-habituated gibbon groups has been conducted for 3 years at Khao Yai National Park. The study combined long-term demographic data of a decade or longer with detailed ecological quality variation measurements for each home range. Home range quality was measured in terms of forest productivity by applying a *food abundance index* (F.A.I.) which combined the spatio-temporal distribution of important gibbon food resources. Spatial distribution of resources was defined for 20% of each home range, while temporal reproductive status of trees was defined for species comprising 80% of the monthly gibbon diet. The F.A.I. was combined with a biomass coefficient quantifying fruit production on a kg per ha basis. Overall, a marked seasonal variation in productivity was found with higher food availability in the dry and rainy seasons than during transitional seasons. Moreover, significant variation in productivity also occurred among home ranges, resulting in differences in overall home range quality.

Corresponding to the seasonal fluctuation in the variation of ecological quality a significant seasonality in reproductive events was found, with conception concentrated during months of higher quality. No significant correlation was found between ecological quality and birth season. This result could be explained by the higher energetic requirements during conception compared to birth, which may push females to synchronize conception, rather than birth, during the highest productivity months available for their home ranges. Furthermore, when testing the hypothesis that a home range with higher quality will lead to a higher reproductive output of the occupying female, no significant correlation was found. This could indicate that the overall capacity of reproduction may not be directly dependent on home range quality because groups may be able to compensate for an initial low quality area by increasing overall range size.

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How Forest Ecology Can Impact the Behavior and Reproduction of Primates

Carola Borries and Andreas Koenig

Seasonal changes in mating behavior as well as resulting conceptions and births are often seen as consequences of ecological conditions during peak lactation. Many Asian primates, however, seem to contradict this suggestion, because often the season of high food availability is timed to a period when conceptions take place. To explain such a pattern, we suggest the following. In the course of a year, plant productivity in a given forest will for instance vary according to length and strength of wet and dry seasons. With productivity, the number and diversity of food items available to the forest animals also varies. Strong shortfalls in resource availability which occur regularly in areas further away from the equator may produce energetic bottlenecks affecting female nutritional condition. If bottlenecks become very severe, nutritional condition may drop to a point where females no longer produce enough reproductive hormones to conceive. As a consequence, instead of nutrition at peak lactation female reproduction may be constrained by seasonal shortfalls of resources influencing the ability to ovulate and conceive. We will demonstrate the consistency of this suggestion with examples from a data set collected over 7 years in a dry evergreen, highly seasonal Sal forest near Ramnagar (southern Nepal) where we investigated how fluctuating food availability may influence energy intake and reproductive performance in Hanuman langur females (*Semnopithecus entellus*). Data on weather conditions, phenology, food and energy intake as well as energy expenditure of monkeys are combined with studies of mating behavior, hormonal status and timing of births. We have begun collecting similar data on Phayre's leaf monkeys (*Trachypithecus phayrei*) at Phu Khieo Wildlife Sanctuary (Thailand). We will present first results on the weather, timing of matings and births, and monkey activity, ranging and feeding behavior including nutrient content. With this project we hope to identify energetic bottlenecks that might lead to the seasonal clustering of births from November through April. (This work is supported by the National Science Foundation, BCS-0215542.)

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Pigtail Macaque (*Macaca nemestrina*) Ranging, Forest Use and Feeding Ecology: A Case for the Study of Interactions between Human and Primate Populations

Marie-Claude Huynen

Expanding human incursions into previously wild, untouched areas pushes wildlife into sharing more and more human habitat. Within non-human primates, this is the case of most macaque species. The pigtail macaque, *Macaca nemestrina*, well represented in the Thai forests, would be a good candidate in which to study the patterns and consequences of

human/non-human primate interactions.

It is generally recognized that contact between human and wildlife habitats have altogether a direct impact on human activities (for instance hunting and defense against crop raiding) but it has also an indirect effect by altering the ecosystem equilibrium. For instance, human exploitation often results in the progressive fragmentation of forest, particularly a growing proportion of edge areas, where human-developed and natural environments come into contact. Particular disturbances occurring in these areas have been identified as the so-called "edge effect". For instance, sunlight and wind penetrate to a greater extent, drying the edge of the forest and favoring the growth of opportunistic plant species. But the growing proportion of edge areas also favors the incursion of some primary forest dwellers into disturbed or edge areas, bringing the new phenomenon of predation and competition with already fragile species. This might be the case of some primates living in the primary forest, such as the pigtail macaque, for which the proximity of human settlements most likely represents a valuable resource to exploit. This new motivation leads them to cross the edge zone and exploit resources present in the secondary forest and open areas on their way to human resources. In addition to impacts of macaques on other wild species, the access to human resources is likely to modify substantially their ecology and behavior.

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Primate Diversity and Density of Phu Khieo Wildlife Sanctuary, Chaiyaphum Province

Andreas Koenig¹, Eileen Larney², Kitti Kreetiyutanon³ and Carola Borries¹

The assessment of diversity and density of primate communities is an important task, because it helps us understand the evolution of primate communities and to set conservation priorities. Asian primate communities have been considered odd, because of unusual relationships of primate diversity to mammalian diversity, rainfall, and latitude. Here we report group and population densities of a primate community inhabiting a dry evergreen forest at Phu Khieo Wildlife Sanctuary and compare it to data for other Asian communities. A 4-km transect was walked on four consecutive days in the middle of each month resulting in more than 400 km of transect walks (12/2000–08/2003). We encountered 6 diurnal species. Phayre's leaf monkeys (*Trachypitecus phayrei*) were most abundant, white-handed gibbons (*Hylobates lar*) and Assamese macaques (*Macaca assamensis*) were the second most common species. Other macaques (*M. mulatta*, *M. nemestrina*, *M. arctoides*) occur at low densities. Circumstantial evidence indicates the presence of nocturnal slow loris (*Nycticebus coucang*). We did not encounter silvered langurs (*T. cristatus*) reported for other parts of the sanctuary. Cumulative density calculations indicate robust values for Phayre's leaf monkeys, gibbons, and Assamese macaques. Although densities are moderate to low compared to most other sites, the primate species richness is considerably higher than expected based on latitude and rainfall. This high biodiversity supports the idea of Pleistocene refugia during glacial aridity. It suggests that future analyses of Asian primate communities should include more Indochinese mainland communities. More importantly, these and other results strongly

indicate that the Western Border Forest Complex and the Western Isaan Forest Complex represent phylogenetic hotspots. Given their diversity and their evolutionary importance these areas are unique in Southeast Asia. (This work is supported by National Science Foundation (BCS-0215542), National Geographic Society (7246-02), L.S.B. Leakey Foundation, and Stony Brook University.)

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Agonistic Behavior and Dominance Relationships in Female Phayre's Leaf Monkeys (*Trachypithecus phayrei*) in Phu Khieo Wildlife Sanctuary, Northeast Thailand

Eileen Larney¹, Amy Lu¹, Carola Borries² and Andreas Koenig²

Socioecological theory suggests that the strength of competition for food and safety, affects rates of agonism, structure of dominance hierarchies, and dispersal amongst group-living female primates. We have begun to investigate this proposed link in wild Phayre's leaf monkeys (*Trachypithecus phayrei*), a species in which females routinely disperse from their natal group. Here we present preliminary data on agonistic behavior and dominance relationships. Behavioral observations were conducted on two groups (four adult females; five adult females plus two juvenile females) at Phu Khieo Wildlife Sanctuary, Northeast Thailand. Rates of agonistic behavior were analyzed from focal continuous recording, while dominance hierarchies were constructed from all agonistic behaviors (focal and ad libitum sampling). Overall, female-female agonistic behaviors (aggression, submission, displacements) occurred at a low rate of less than 0.25 interactions per hour, although agonistic rates increased with group size. Moreover, agonistic interactions occurred more frequently over food than expected based on feeding time. Females in both groups exhibited linear dominance hierarchies with some reversals and possibly an age-inversed hierarchical structure in the larger group, i.e., younger adult females out-rank both older adult females and juvenile females. These data support previous observations that female leaf monkeys may experience feeding competition. The results fit well to previous results for leaf monkeys regarding a low frequency of interactions, displacements predominating agonistic behavior, and the possibility of an age-inversed hierarchy. However, the results contradict the suggested link between linearity of hierarchies and female philopatry. Future studies need to consider the notion that female dispersal may coexist with linear dominance hierarchies. (This research is supported by the National Science Foundation (BCS-0215542) and Research Awards of the Interdepartmental Doctoral Program in Anthropological Sciences.)

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Dugong Conservation Status and Developing a National Dugong Action Plan for Thailand

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The dugong (*Dugong dugon*) is the only representative of the Order Sirenia occurring in Indo-Pacific waters and it is listed by the IUCN as Vulnerable to extinction. Research on dugongs in Thailand has been conducted primarily by the Phuket Marine Biological Center (PMBC), Department of Marine and Coastal Resources (DMCR), and the Department of National Park, Wildlife and Plant Conservation (DNP), with contributions from foreign researchers. The species was once common along the coasts of the Andaman Sea and the Gulf of Thailand, but it is now revealed that dugongs are largely confined to coastal waters surrounding islands in the Andaman Sea and scattered elsewhere along the coasts. Due to their low reproductive rates, long generation times, and high parental investment, dugongs are particularly vulnerable to even small declines in adult survivorship. These life history traits, combined with the anthropogenic impacts affecting coastal environments in Thailand, explain their diminished population size and limited areas of occurrence. Although little quantitative data are available for assessing threats, accidental killings in gillnets and fish traps are believed to be the greatest source of human-caused mortality for dugongs in Thailand. The loss of seagrass habitat due to the destructive effects of push-netting and sedimentation from coastal development also threaten the viability of the Thai dugong's population. In March 2004, an expert roundtable meeting was held in Bangkok by DMCR and Wildlife Conservation Society (WCS) to develop a Dugong Action Plan for Thailand. Conservation strategies were identified including a set of recommendations on research priorities. The second public meeting held in June 2004 at Trang gathered more input from local communities. Four key conservation measures were determined, including integrated research, capacity development for stakeholders, law enforcement and policies, and community participation. DNP has also initiated a site-based pilot project to conserve dugong through community participation at Hat Chaomai National Park and nearby areas. Recommendations gathered from the field and other stakeholders provided a strong foundation for developing a detailed action plan. Lead by the DMCR, the plan is being developed simultaneously with the National Seagrass Action Plan and is expected to be completed in 2005.

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Natural Pollination Biology: A Case Study of Selected Bat-pollinated Species of Peninsular Thailand

Sara Bamrungsri and Kitichate Sridith

The study of natural pollination biology plays an important role in answering various questions in field biology. Specifically, it would give rise to better understanding of gene

flow in a given plant species population. Moreover, pollination biology concerns animal-plant co-evolution, which reflects their morphological characteristics and animal behavior in particular. A case study has been conducted on the (fruit) bat-pollinated species: *Parkia speciosa* Hassk. and *Parkia timoriana* Merr., in Peninsular Thailand. Preliminary results suggest that the floral biology of these species demonstrates their specific requirements for mobile, nocturnal pollinators, and that fruit bats are the major pollinators of these plants.

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Avian Frugivory at at Mo-Singto Long-term Biodiversity Research Plot, Khao Yai National Park

Wangworn Sankamethawee, Andrew J. Pierce and Somchai Nimnuan

Animal dispersers play a significant role in the maintenance of plant diversity of tropical forests. The study on avian abundance and diversity in Khao Yai National Park indicates that frugivores or frugivore-omnivores contributed three of the five most abundant bird species in the Mo-Singto permanent plot. Furthermore, most woody plant species in tropical Asia rely on birds to disperse their seeds. Between January 2003 and November 2004, 292 fecal samples containing seeds were collected from 21 bird species. The seeds came from 88 plant species (71 known, 8 unidentified) of which at least ten species were *Ficus* (Moraceae). Seeds were extracted from fecal samples collected during mist-netting operations and from direct observation of defecating perched birds. Most of the seeds came from the highly frugivorous bulbuls: Puff-throated Bulbul (*Alophoixus pallidus*) 69 samples with 46 plant species; Grey-eyed Bulbul (*Iole propinqua*), 98 samples with 34 seed species and Black-crested Bulbul (*Pycnonotus melanicterus*), 62 samples with 32 seed species. The seeds of the woody climber *Dissochaeta divaricata* (Melastomataceae) were found in the feces of nine bird species. Moreover, direct observations found some frugivory by predominantly insectivorous birds. During the course of observing nests, several seeds were also detected in the feces of nestlings, suggesting that fruit maybe a more important component nestling diets than previously assumed. Other supplementary studies to understand more about the ecological roles of these seed dispersers have been carried out including food availability based on phenological data and observations of birds visiting fruiting trees.

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Factors Influencing Food Selection among Four Sympatric Species of Hornbill at Khao Yai National Park, Thailand

Chution Kanwatanakid Savini^{1,2} and Pilai Poonswad²

Asian hornbills are frugivorous for most of the year, but change to a more omnivorous diet during the breeding season. Due to the high proportion of fruit in their diet they are assumed to play an important role as seed dispersers in the ecology of their forest habitat.

Preliminary results from an ongoing study of the feeding ecology of four sympatric species: Great hornbill (*Bucero bicornis*), Wreathed hornbill (*Aceros undulates*), Oriental Pied hornbill (*Anthracoceros albirostris*) and Brown hornbill (*Ptilolaemus tickelli*), at Khao Yai National Park are presented. The feeding habits and diet of each species have been monitored since January 2004 and will continue to be until December 2005. This will include two breeding seasons, January–June, and two non-breeding seasons, or flocking seasons, from July to December. The objectives of this study were: (1) to define which factors influence food selection specifically spatial-temporal availability, chemical and morphological variation of the chosen food items; (2) to define feeding overlap among the four sympatric species and how this influences their breeding biology; and (3) define breeding success among the different species in relation to food availability and quality. During the breeding season data on diet and feeding behavior were collected by direct observation at 6 nests of each species (with the exception of brown hornbill where only 4 nests could be observed). Fruits consumed were categorized as either fig or non-fig, the latter classified into species and differentiated by morphology. The diet during the flocking season was identified by collecting seed in traps set under roosting trees. Food selection of hornbills was measured by comparing food consumption with food availability. Food availability was defined monthly with phenological observations, based on percentage of canopy coverage, along line transects within the study area. Feeding bouts on fruiting trees and nutritional analysis of selected fruits were studied in both breeding and non-breeding season. In addition, we investigated other ecological factors that may influence food selection in the four observed species, such as height of nest, number of offspring etc.

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Do Male and Female Black-naped Monarch (*Hypothymis azurea*) Contribute Equally to Raise a Brood?

Kihoko Tokue, Andrew J. Pierce, Korakock Pobprasert, and George A. Gale

There are few detailed studies on parental care by tropical forest birds. At the Mo-ingto Plot in Khao Yai National Park, Black-naped Monarch (*Hypothymis azurea*) is a relatively common species. It is sexually dichromatic and both males and females engage in incubation and brooding tasks which makes it ideal for study of avian parental care. We compared

female and male parental care by testing two hypotheses: H1: females spend more time incubating and brooding than do males, and H2: males and females contribute equally to incubation and brooding. In addition, under either hypothesis, we expect that feeding visitation rates should gradually increase with nestling growth. We predicted that the second hypotheses would be supported because the closely related Hawaiian "Elepaio" shows a similar pattern of parental care. Preliminary results do suggest that males and females contribute equally to incubation and brooding, and that feeding rates increase as nestlings grow.

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Measuring Nest Success in Birds Using Mayfield Estimates

Andrew J. Pierce

Basic demographic data is essential in order to understand the requirements of a species and therefore protect or restore its habitat. This is especially important for tropical forest species due to the rapid rate of deforestation in the region. Annual reproductive output of birds is a significant part of their life history but is difficult to measure, and many studies use nest success as a parameter to assess breeding success. To make comparisons among species, populations and studies, it is important that data collection is standardized. The use of the Mayfield method to assess nesting success is a relatively simple technique that avoids the bias caused by variable nest detection. This method is based on the number of days a nest is observed to be active (or exposure-days). Mayfield estimates can also incorporate data from nests of unknown outcome which is especially important where there is limited data available for analysis.

The data required for measuring nest success are: the number of nests that are active for more than one day; the number of exposure-days; the number of nests that fail; and the number of days in each stage measured (e.g. incubation, nestling). A simple "Mayfield calculator" has been developed to allow a quick calculation of nest success and a standard error.

During 2004 we collected data on the nesting of Abbott's Babbler, *Malacocincla abbotti*, a small understory passerine, at Khao Yai National Park. The Mayfield estimate for nest success of 26 nests was 24.9% (± 8.5) whereas absolute nest success was 34.6%. The higher value for absolute nest success is caused because many nests that fail in their early stages are not detected while nests found in their later stages are more likely to succeed. This emphasizes the importance of how data is collected and interpreted.

The results show that breeding success of Abbott's Babbler is quite low, but comparable to other studies in the tropics and unlike many temperate passerines which generally have higher nesting success. Higher nest failure in the tropics is generally attributed to higher predation pressures but overall populations may be maintained by longer breeding periods and survival rates.

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Nesting Habitat Selection by Abbott's Babbler (*Malacocincla abbotti*), Mo Singto, Khao Yai National Park

Korakoch Pobprasert

Detailed habitat requirements and reproductive biology are largely unknown for many forest birds of South-east Asia. In Thailand, Abbott's Babbler (*Malacocincla abbotti*) is found in broadleaf evergreen forest and secondary growth from the west and north-east through the southern peninsula. I studied nest site selection of Abbott's Babbler in the Mo Singto Biodiversity Research Plot, Khao Yai National Park, Nakhon Ratchasima Province, during 2003–2004. Mated pairs have a year-round territory with an average size of approximately 1.75 ha ($n = 11$). The breeding season starts in the middle of January and finishes at the end of July. Females lay 2 or 3 eggs (usually 3) which are incubated only by the female for 14–15 days. Nestlings remain in the nest for 11–13 days. A total of 54 nests were found during the study. They were cup-shaped and built with fine roots, fibers and dry leaves. Forty seven were placed in rattans (*Daemonorops jenkinsiana* or *Calamus* spp.), 2 nests were in palms (*Areca* spp.) and one each in *Strobilanthes* sp., *Polyalthia* aff. *evecta*, *Uvaria hirsuta*, *Memecylon edule* and *Knema elegans*. The average nest height was 1.0 m ($SD = 0.47$, $n = 54$), the highest nest was 2.45 m, and the lowest 0.39 m. Preliminary analysis of nest-site micro habitat in 2003 suggests that Abbott's Babblers prefer sites with a high density of rattans and herbaceous vegetation < 2 m. tall.

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The Habitat Requirement and Breeding Success of the Malaysian Plover in the Gulf of Thailand

Mai Yasue

The Malaysian plover breeds on coastal beaches and wetlands in the Gulf of Thailand. Although these habitats are being altered by tourism development and the encroachment of shrimp ponds and pastureland, there has been virtually no research conducted on this near-threatened species. We monitored 60 pairs of Malaysian plovers in Prachuap Khiri Khan and Petchburi Provinces to determine the key micro- and mesosite characteristics influencing habitat selection and breeding success. At the microsite scale Malaysian plovers selected nest sites with low distance to vegetation, and a high percentage of ground debris, located near the center of the width of the beach. At the mesosite scale plovers selected wide beaches with low human disturbance that were far from trees. Mortality was roughly equal at the egg and chick stages and the mean number of chicks fledged per nest was 0.71 (± 0.11). Fledgling success was greater in sites with a higher percentage of 0.5–4 m tall vegetation cover. During 77 hours of diurnal behavioral observations I observed no predation events. However, plovers were frequently disturbed by neighboring conspecifics attacking chicks, or people walking or motorcycling along the beach. Our study indicated that human disturbance, reduction of beach

width due to the planting of *Casuarina* trees, and beach erosion may reduce nest habitat quality.

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Preliminary Estimates of Densities of Large Raptorial Birds across Bala Forest, Southern Thailand

Alan Kemp, Meg Kemp, and Siriporn Thong-aree
(presenter: *Sukanda Jotikapukkana*)

Large raptors share the top of the predatory food chain in tropical forests, but estimates of their densities are difficult to obtain despite their importance in assessments of forest ecology and quality. The 12.5 km of tar road that crosses the Bala section of Halabala Wildlife Sanctuary provided an opportunity for an east-west transect with various observation points over forest habitats at altitudes of 100–600 m a.s.l. We recorded the location of all raptors seen or heard along this road throughout 2004, from observation points, general travel and, at night, by call-up with tape recordings. Wherever possible, we recorded the movements and behavior of raptors under observation.

We plotted the records, movements, conflicts and breeding behavior of Bat Hawk, Oriental Honey-buzzard, Black Eagle, Crested Serpent Eagle, Blythe's Hawk Eagle, Rufous-bellied Eagle, Barred Eagle Owl and Brown Wood Owl. We based our estimates of densities on nearest-neighbor distances of nests and/or core areas and on records per unit area under observation from lookouts. Estimated densities along the road ranged from 1 pair (Bat Hawk, Black Eagle, Rufous-bellied Eagle) to 7 pairs (Crested Serpent Eagle, Barred Eagle Owl). Spacing between pairs and records per unit area under observation allow extrapolation to provide preliminary estimates of the population sizes of all species in the 111.5-km² Bala Sanctuary.

Few data exist on densities of large raptors in rain forest, and none we know of for Asia. Densities of the commonest species are similar to those in deciduous woodlands, but most species are specialists that occur, as might be expected from their niche requirements, at low densities. Comparative estimates for other forests and other species are needed to understand those derived from Bala further.

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Integration of Genetic, Species, Population, and Landscape Information for Conservation of Hornbills in Thailand: A Research Project Introduction

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Research and conservation of hornbills in Thailand have been globally recognized under the Hornbill Research Project for more than 20 years. Most studies have emphasized breeding biology and ecology and have been limited to Khao Yai National Park and Huai Kha Khaeng Wildlife Sanctuary. In 2003, the project launched a country-wide study on the distribution and the population status of hornbills in remaining pristine forests in Thailand. The overall objective is to understand genetic characteristics in relation to distribution, status of populations and habitats, and threats. This is an effort to assist responsible/relevant authorities to implement an effective conservation scheme for hornbills and their habitats. Aspects covered under the overall objective include the following. For genetic studies, the team uses either blood, feather, or tarsal scale samples to build a phylogenetic tree for Thai hornbills. For population genetics, the method is designed to determine genetic diversity among populations of the great hornbill, a widely distributed species from 3 priority forest landscapes of different size and degree of disturbance: the Western Forest Complex, Khao Yai National Park, and Budo-Sungai Padi National Park. For comparing population status, density estimates for hornbills is being obtained from point-transects in relation to habitat structure of the evergreen forests of those 3 priority sites. For distribution records, the recce technique is used to record species occurrences in other protected forests. Radio telemetry is also used to study ranging patterns of rare and little-understood species, particularly rufous-necked hornbill and plain-pouched hornbill. For habitat status, forest structure and composition is recorded within 40 x 50m plots. After 5 years, besides establishing a complete database, we expect to have a much greater understanding of hornbill ecology, genetics, and population status. The data will then be used to predict the future survival of Thai hornbills and recommend proper actions for the conservation and management of hornbills and their habitats.

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Database and Geographic Information System—GIS Development on Biodiversity in the Hala Bala Forests in Southern Thailand

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The project was set up by two offices: the National Center for Genetic Engineering and Biotechnology and the Royal Forest Department, in order to compile information on biodiversity in protected areas of the Hala-Bala forests. These areas consist of moist evergreen and tropical rain forests at elevations of 100–1,466 m m.s.l. Data show greatly varied communities of vegetation and wildlife at different elevations. These areas are very difficult to access and surveys are time-consuming. As a result, there has been scant data collection and little information to support planning and management. Some of the data are still not arranged systematically and are recorded in incompatible systems. However, GIS and GPS techniques can efficiently facilitate geo-referencing, especially by researchers and foresters.

This project will collect information on biodiversity in a relational database system. The database will serve researchers, foresters and students, and will also provide information for tourists who visit the Hala-Bala forest for eco-tourism. The database will also provide all kinds of knowledge on biodiversity for nearby communities, encouraging villagers to participate in natural resource conservation and support their community development.

GIS and database development can be divided in two parts: Part 1: (a) *Physical data*: contour lines, slope, drainage patterns, etc.; (b) *Biological data*: precise locations of various tree and wildlife species. Such data can be recorded and displayed via Arcview GIS version 3.2 as digital maps in a geographic information system (GIS). Part 2: (a) *Descriptive data*: nomenclature, tree classification, morphology, habitat, phynology, references, etc. References are programmed by Microsoft Access. Both sections of the database can be linked together and effectively developed in an applied program. The data can be displayed, queried, retrieved and analyzed.

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Distribution and Habitat Use Patterns of Hume's Pheasant in Northern Thailand

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Hume's Pheasant, *Syrmaticus humiae*, is currently categorized as Vulnerable, but there has been no quantitative study of the species in its native habitat in the country. The study assessed the habitat requirements of the bird in northern Thailand based on surveys in 5 protected areas with known historical records and one site outside the protected area system. The birds were found between 1233–1655 m elevation, and most of the observations were in

evergreen forest, often associated with oak and pine. Twenty-three habitat variables were measured at 35 focal (use) points and at 105 non-use points. The occupancy rate (proportion of sites occupied) within the study area was 0.69 ± 0.2 , and the detection probability was 0.16. The results from a multiple analysis of variance including the presence of hunting as a co-factor showed that the species prefers areas with a higher basal area of pine, taller trees, and more grass species richness, while avoiding areas with dense ground vegetation above 100 cm in height. The significant interaction between site occupation and hunting pressure indicated that when there is hunting, the birds may select areas with less pine and a lower canopy. By comparing all possible logistic regression models using the above four independent variables, the best model consisted of tree height, density of ground vegetation over 100 cm, and grass species richness.

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ABSTRACTS OF POSTERS

Species Diversity of Bird Food Plants in Deciduous Dipterocarp Forest: Khao Noi – Napang Community Forest, Phu Wiang, Khon Kaen

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This study identified bird food plants in dry dipterocarp forest at Khao Noi – Napang Community Forest, Khon Kaen Province. Birds feeding in the community forest were observed from June 15 to August 31, 2004. Ten belt transects 10 m in width, and 100 m apart, were surveyed. Seventy-one plant species (in 36 families, with many species in the Dipterocarpaceae) were recorded, of which 28 species were identified as bird food plants. Seven species were observed fruiting during the study season and being used by frugivorous birds. These bird-food plants included *Flacourtia indica* (Burm.f.) Merr, *Casearia grewiaefolia* Ven., *Antidesma sootepense* Craib, *Irvingia malayana* Oliv. ex. A. Benn, *Ficus* sp, *Memecylon edule* Roxb, and *Ellipanthus tomentosus* Kurz. *Eucalyptus* spp. and *Oroxylum indicum* (L.) Kurz were observed being used by nectarivorous birds, while *Rothmania wittii* (Craib) Bremek was observed being used by both fruit eating and nectarivorous birds. Thirty bird species were recorded, 12 being identified as plant feeders. Six species were observed eating fruit: Hill Myna, Eurasian Jay, Stripe-throated Bulbul, Large-billed Crow, Streak-eared Bulbul, and Green-eared Barbet. Four species were observed eating nectar: Olive-backed Sunbird, Grey-breasted Prinia, Common Tailorbird, Dark-necked Tailorbird, and two species were observed eating both fruit and nectar: Scarlet-backed Flowerpecker and Black-crested Bulbul.

Fuelwood Plants in Ban Non Chad Community Forest, Tambon Dongkeng, Nongsonghong District, Khon Kaen Province

Wanpen Soonprakhon and Adcharaporn Pagdee

This survey-based study investigates fuelwood collection and consumption at Non Chad village, Dongkeng, Nongsonghong, Khon Kaen. Seventy-nine face-to-face questionnaires were distributed to Non Chad villagers. Twenty-one quadrats were also conducted to analyze Non Chad community forest structure. Forty-one species in a dry dipterocarp forest were identified of which *Shorea obtusa* had the highest importance value index (60.3), followed by *Dipterocarpus tubercalatus* (41.1), *Canarium subulatum* (39.2), *Irvingia malayana* (21.7), and *Xylia xylocarpa* (19.9). Fuelwood species most frequently harvested by villagers are *X. xylocarpa*, *S. obtusa*, *D. tubercalatus* and *C. subulatum*. Villagers mostly want to collect dry branches (78%) because they are easily burned (59%) and easy to handle (33%). Indeed, dry branches are most often collected by villagers (89%). The most important source for fuelwood collection is villager rice paddies (45%). Approximately 31% of respondents reported harvesting fuelwood in Non Chad community forest. An average amount of fuelwood consumed is 4.47 kg/household/day (0.02 m³/household/ day), while potential fuelwood volume in the forest is approximately 13,600 m³. Currently, community forest rules and regulations of fuelwood collection have no major impact on community fuelwood consumption. However, 42% of respondents reported that they had to change the place to gather fuelwood, from the community forest to other places e.g., rice field, orchard, and neighbor's rice field.

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Growing Trees for Forest Restoration: Overcoming Ecological Constraints

Cherdsak Kuarak and Stephen Elliott

In the seasonal tropical forests of northern Thailand, seed germination of forest tree species peaks at the beginning of the rainy season. Fruiting and seed dispersal occur in all months of the year, but length of seed dormancy varies among species, so that no matter when seeds are dispersed, they tend to germinate at the beginning of the rainy season. This enables seedlings to grow root systems deep enough to reach enough soil water to survive through their first dry season. However, this ecological strategy presents problems for the production of multi-species crops of tree seedlings for forest restoration, since regardless of seed dispersal time, length of dormancy and seedling growth rate, all species must grow to plantable sizes by the optimal planting time.

For species dispersed in the late rainy season, dormancy must be broken quickly and seedling growth accelerated by applying fertilizer. For species dispersed in the dry season, seed storage can be used to delay germination or seedling growth slowed by not applying

fertilizer. Otherwise, seedlings will grow to a plantable size months before the planting season. They will have to be kept in the nursery for long periods, wasting nursery resources, or they may require pruning to prevent them from out-growing their containers.

Using various examples of framework tree species for northern Thailand, this paper discusses suitable seed and seedling treatments to overcome these ecological constraints and manipulate seed germination and seedling growth to attain a healthy crop of mixed framework tree species of sufficient sizes for planting by the optimal planting time (mid-June for northern Thailand). An alternative approach to overcome these constraints is to transfer wildlings to the nursery and nurture them until the planting season. Optimal sizes of seedlings harvested from the forest and pruning treatments to reduce transplantation shock and produce well-balanced plants are discussed.

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Female Reproductive Endocrinology and Mating Behaviour in Wild Gibbon (*Hylobates lar*)

Claudia Barelli

Since recent results have revealed an interesting flexibility in group structure and mating behaviour in gibbons, (polyandrous groups and extra pair copulations, EPC), it is important to quantify female mating behaviour and the function of extra-pair copulations in wild gibbon population. It is unclear if gibbon females choose their mating partners, and if so on which male cues they may base their choice. Therefore, this study will address if gibbon females exert choice by soliciting, facilitating or refusing male partners. Because female partner choice may vary depending on a female's reproductive state, it will be necessary to detect the exact cycle stage of a female in relation to her mating behaviour to understand the function of partner choice. Endocrinological analysis of the female ovarian cycle and behavioral observations of female sexual activity will help to answer the question proposed.

It is aim of this Ph.D. project to understand the function of extra pair copulations in white handed gibbons, and whether alternative mating strategies to monogamy exist. In order to inspect this topic, I would like to investigate their reproductive biology and mating behaviour. Very little is known about their reproductive physiology in captivity and nothing in wild animals. Data on hormone profiles for different female states (cycling, pregnant and lactating), cycling changes of external genitalia (sexual swelling), sexual displays and mating behaviour could be extremely useful to determine, on one hand, the possible function of extra pair copulation giving some indications about possible mechanisms of sexual selection involved and, on the other hand, could give us a better knowledge about general reproductive biology. Genital swellings are present in gibbons (Dahl, 1992), but need to be compared with sex hormones and mating behaviour in the wild. Moreover, when combining the sexual swelling arising, the hormonal status and the mating behaviour it will be possible to test various hypotheses about their function.

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Predation of Bird Nestlings by Pigtail Macaques (*Macaca nemestrina*) in the Khao Yai National Park (Thailand)

Gilles Bottin and Marie-Claude Huynen

A number of primate species are known to prey upon eggs or nestlings of various birds. These primate predators are most of the time classified as omnivorous, which among the Old World monkeys includes almost all macaques, baboons, and chimpanzees, but also a number of other species generally thought to be vegetarian specialists, such as lemurs, guenons or mangabeys.

Previous observations indicate that a high level of nest predation occurs in Khao Yai National Park, and that macaques potentially play an important role as nest predators. The present research proposes to assess the potential impact of predation by pigtail macaques (*Macaca nemestrina*) on nestlings of two bird species, Abbott's babbler (*Malacocincla abbotti*) and Black-naped monarch (*Hypothymis azurea*), in Khao Yai National Park.

The pigtail macaque, *Macaca nemestrina*, is well represented in Khao Yai National Park, but its ecological profile is still largely unknown in Thai habitats. We propose in the present study to focus on its feeding ecology in relation to bird predation. We plan to observe ranging and foraging patterns of groups of macaques in order to determine their diet and their impact on bird populations. This should be done by following the troops, collecting general data on group size, composition, ranging (range size, location of water points and sleeping sites) and feeding ecology (time and activity budgets of groups, and species (animal and plant) consumed. Particular attention will be devoted to food search behavior (visual scanning, digging, foraging) and food processing. These observations will be coupled with the systematic recording of resource availability, with special attention to the presence of bird nests.

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Direct Seeding for Forest Restoration in Northern Thailand

Panitnart Tunjai, Cherdasak Kuarak, Stephen Elliott, and Sutthathorn Suwannaratana

Direct seeding is one method of establishing trees for forest restoration without the costs of raising nursery plants and transplanting them to the planting site. Better root development and avoidance of transplanting shock, which is common in nursery-raised seedlings, are two advantages of this technique. It might be particularly useful for steep slopes or inaccessible areas, where transportation of seedlings is difficult.

The nursery experiments are being conducted at the Forest Restoration Research Unit (FORRU) tree nursery, located in Doi Suthep – Pui National Park. The field experiments are being carried out in two areas, the first one in a degraded highland site (1200 m) in evergreen forest in Chiang Mai Province, north of Doi Suthep – Pui National Park. The second is a lowland site (350 m) in deciduous forest in Lam Phun Province. The objective of this study is to determine suitable species and techniques for direct seeding in forest restoration areas in

northern Thailand. The effects of tree species, seed treatment, soil fertility, soil preparation and weed control on seed germination, early growth of germinated seedlings and root development will be examined in both field and nursery conditions. Tree species selected for the highland site include: *Aquilaria crassna*, *Balakata baccatum*, *Carallia brachiata*, *Eugenia fruticosa*, *Sacrosperma arboreum* and *Spondias axillaris*, and species for the lowland area are *Afzelia xylocarpa*, *Artocarpus lakoocha*, *Casearia grewiaefolia*, *Eugenia cumini*, *Schleichera oleosa* and *Trewia nudiflora*. Initial results of germination and early seedling development will be presented.

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The Importance of Soil Consumption on the Ranging Behavior of Phayre's Leaf Monkeys (*Trachypithecus phayrei*) in the Phu Khieo Wildlife Sanctuary

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The distribution and availability of natural resources influences the distribution and densities of primate populations in the wild. Uncommon resources such as saltlicks, even when rarely used, may be of particular importance in influencing the size, shape, and location of primate home ranges. Here we examine the influence of saltlicks on the ranging behavior and home range size of three groups of Phayre's leaf monkeys. Each group was followed for about 7 days per month across a period 6 months. Each day, the group's location was measured every 30 minutes using a Garmin GPS. The animal movement package of the computer program ArcView was used to calculate daily path lengths, travel rates, and home range sizes for each group. All group home ranges contained at least one large saltlick, though not all saltlicks were located in the center of the range. For the group with the peripheral saltlick, daily path lengths increased by about 75% and travel speed increased by about 75% on days when the saltlick was visited. Inclusion of visits to the saltlick increased the home range size by about 25% to a size comparable to the home ranges of the two groups with centrally located saltlicks. Even though soil consumption is a rare event for Phayre's leaf monkeys (less than 5% of observed time), its importance is clear. Conservation efforts of habitat for these animals should consider not only adequate space for primate groups, but also the availability of rare resources.

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A Botanical Inventory of a Tropical Seasonal Forest in Khao Yai National Park, Thailand: Implications for Fruit–frugivore Interactions

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The diversity of plants in tropical forests makes dietary studies of frugivores difficult. This paper presents a botanical inventory of a tropical seasonal forest community in Khao Yai National Park, Thailand. The forest is valuable from a conservation perspective because it is one of the last remaining intact forests in northeastern Thailand, and is an important refuge for a tremendous number of animal and plant species. A 4-ha inventory plot measuring 200 x 200 m was established and all plants greater than or equal to 10 cm in diameter at breast height (dbh) were measured and permanently labeled. We found 1,610 stems belonging to 105 species, 76 genera and 35 families, with a combined basal area of 142.5 m². The community was dominated by species of Lauraceae, Cornaceae, Euphorbiaceae, Meliaceae, and Elaeocarpaceae. About one-third of the plant species (40 spp.) identified in this study were vulnerable to extinction because they were mostly dispersed by large frugivores, which are relatively intolerant of human impacts. If they disappear, these forests may become dominated by plant species that are dispersed by abiotic means and species with small-seeded fruits.

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

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Fruit diets of Great hornbill (*Buceros bicornis*) and Rhinoceros hornbill (*Buceros rhinoceros*) during the breeding season were studied in Budo Su-Ngai Padi National Park, Southern Thailand, from January 2003 to August 2004. The proportion by weight of Great and Rhinoceros hornbill diets were 55.6% and 73.6% figs, 41.2% and 23.8% non-fig fruit,

and 3.2% and 2.6% animals, respectively. Great hornbills selected 20 non-fig fruit species from 12 families, of which *Polyalthia viridis*, *Aglaia spectabilis*, *Dysoxylum macrocarpum*, *Syzygium* sp1 and *Canthium hirtellum* were the 5 most important using on a combined ranking based on weight, number of fruits and frequency of feeding. Rhinoceros hornbill selected non-fig fruit of 13 species from 8 families, of which the most important were *Oncosperma horridum*, *Aglaia spectabilis*, *Knema* sp1, *Polyalthia viridis* and *Dysoxylum macrocarpum*. This study categorized the breeding season into three stages: incubating phase (INC), nestling before female emergence phase (BEFORE), and nestling after female emergence phase (AFTER). Results indicated that the feeding rate on figs during INC (7.8 vs. 15.0 g/h of observation) and AFTER (7.7 vs. 13.1 g/h obs.) were significantly different between Great and Rhinoceros hornbills. But during the BEFORE period feeding rate on figs (13.2 vs. 15.6 g/h obs.) was not significantly different between hornbills. While feeding rates of non-figs during the three nest stages (INC 6.3 vs. 4.3 g/h obs., BEFORE 12.1 vs. 10.2 g/h obs. and AFTER 6.5 vs. 10.8 g/h obs.) was not significantly different between hornbills. This study summarizes only the most important fruits in the diet, which is not enough to encourage food resource management. Thus, more study on plant community is needed to supplement food resource data for hornbill conservation and management.

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Responses to Burning and Edge Effects of Small Mammals at Klong E Tao Substation, Khao Yai National Park

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Fire may effect the distribution of organisms restricted to habitat fragments, and may contribute to the loss of species. Live-trapping methods were used to determine the status of small mammals in forest, forest edge and grassland areas before and after grassland burning at Khao Yai National Park. A total of 3,600 trap-nights of sampling resulted in the capture of five species of rodent and three species of insectivore. Before burning, Yellow Rajah Rat (*Maxomys surifer*) was the most frequently caught species in the forest. Chestnut Rat (*Niviventer bukit*) was found in forest and forest edge. Noisy Rat (*Leopoldamys sabanus*) was found at the edge, while Roof Rat (*Rattus rattus*) was found in the forest and grassland, but its distribution was clearly centered at either side of the edge. Ryukyu Mouse (*Mus caroli*) was found in all three areas and was the most frequently caught species in the grassland. Common treeshrew (*Tupaia glis*) was only found in the forest. *Leopoldamys sabanus*, *Crocidura hosfieldi* and *Crocidura estrusca* were rare and only captured a few times. After burning two species *Crocidura hosfieldi* and *Crocidura estrusca* were not recaptured, presumably due to their low rate of capture. Capture rate in the forest before burning was 12.17 individuals per 100 trap-nights, more than in the forest after burn (7.72 individuals per

100 trap-nights), but the difference was not significant. Capture rate in the grassland before burning was 3.33 individuals per 100 trap-nights and after burning increased slightly to 3.50 individuals per 100 trap-nights. In general, *R. rattus* and *Mus caroli* appeared to increase after fire, and none of the common species appeared to decline, while the effects on the rare species were less clear.

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ABSTRACTS SUBMITTED BUT NOT PRESENTED

Wildlife Poaching and the Demography of a Dominant, Mammal-Dispersed Tree in Thailand

Jedediah Brodie

We know that many animal species around the world are threatened by human activities. Yet each of these species is involved in a host of interactions with the other organisms in its community, and we know much less about how direct effects on the target species ramify throughout the ecosystem via indirect effects on the interacting species. I am studying the effects of illegal hunting of sambar deer (*Cervus unicolor*), muntjac deer (*Muntiacus muntjak*), and white-handed gibbons (*Hylobates lar*) on the recruitment and demography of a dominant canopy tree, *Choerospondias axillaris* (Anacardiaceae), whose seeds are obligately dispersed by those three mammals, in the forests of Thailand. There are two main components of my project. In the first I'm comparing *C. axillaris* seedling abundance and seed dispersal levels across four national parks, where the populations of the mammals vary widely (from abundant to nearly completely extirpated) due to different levels of historical poaching intensity (which I am quantifying using questionnaires of park guards, as well as landscape attributes such as road and human population density within and surrounding the parks). Initial results from my first two field seasons indicate that, in parks where the mammals have been reduced or extirpated, *C. axillaris* seed dispersal and recruitment are precluded. In the second component of my study, on a 30-ha Forest Dynamics plot in Khao Yai National Park), I am measuring the functional similarity of the three mammals with respect to their effects on *C. axillaris* demography. Ecologists do not yet know whether there are functionally equivalent species in ecosystems, despite the conservation implications of this issue. I assess the qualitative and quantitative aspects of seed dispersal by each of the frugivore species using line transects, marked seedlings, and experimental seed planting arrays. I will construct a stage-based matrix model of the *C. axillaris* population, which can be modified to see how dispersal by each of the mammals affects the overall lambda of the tree. It is my hope that this project will help us design conservation strategies based, not on single species, but on the protection of ecologically-crucial species interactions.

The Value of Long-term Field Research: Changing Views on Gibbon Monogamy, 1939–2005 (2482–2548)

Ulrich H. Reichard

First systematic descriptions of gibbon social structure date back to the late 1930s when C. R. Carpenter observed a wild white-handed gibbon population in the foothills of Doi Dao Mountain, Chiang Mai, Thailand. He suggested a simple, static model of highly territorial individuals living monogamously in small family groups, which was later confirmed by field studies of other hylobatid species. A first challenge to an inflexible monogamy concept emerged about twenty years later when field observations of birds refuted the postulated sexual faithfulness of socially monogamous individuals. Paired males and females were observed to sometimes copulate with partners other than their current social mate. Extra-pair copulations have also been documented in some mammals, including gibbons, where they were first described in the Siamangs (*Symphalangus syndactylus*) of Ketambe, Sumatra, Indonesia, and white-handed gibbons (*Hylobates lar*) at Khao Yai National Park, Thailand. In addition to flexible sexual relationships, variable grouping patterns have been documented at Khao Yai. Besides a majority of social units centered on pairs of adults, adult trios living on one home range were also found. Recent data from Khao Yai also contrast with the original idea that gibbon pairs remain together until death, because partner changes were often caused by immigration. Male immigration was frequently accompanied by intense aggression, often leading to the replacement of a breeding resident and takeover of a female and a home range. Immigration patterns as documented in the Khao Yai population revealed another flexible aspect of gibbon monogamy, because in addition to new group formation by dispersing young adults, breeding adult replacement was found as an alternative mate acquisition strategy.

Scientific research on Khao Yai white-handed gibbons spans over 25 years and ranges among the longest continuous field studies of hylobatids and apes worldwide. Observations of Khao Yai gibbons contributed importantly to refine the static view of mammalian monogamy towards a more dynamic social system. The discovery of a variable mating system in Khao Yai white-handed gibbons has broader implications, because it can aid protection and management plans of wild and captive gibbon populations as well as rehabilitation and reintroduction projects. With its unique history in gibbon research, Thailand is suited to play a key role in Southeast Asia in developing and coordinating effective monitoring and protection programs for declining populations of the singing apes.

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