Avian abundance and diversity: an assessment of monitoring methods for forest birds at the Mo-singto Long-term Biodiversity Research Plot, Khao Yai National Park

Final Report to the Biodiversity Research & Training Program

(01 March-28 February 2006)

ความอุดมสมบูรณ์และความหลากหลายของนก: การประเมินเทคนิคการสำรวจประชากรนกป่า ณ แปลงวิจัยความหลากหลายทางชีวภาพถาวร มอสิงโต อุทยานแห่งชาติเขาใหญ่

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เสนอต่อ

โครงการพัฒนาองค์ความรู้และศึกษานโยบายการจัดการทรัพยากรชีวภาพในประเทศไทย (โครงการ BRT)

รหัสโครงการ BRT_346004

ระยะเวลาการศึกษาช่วง 1 มีนาคม 2546-28 กุมภาพันธ์ 2549

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บทสรุป

จากการสำรวจชนิดและประชากรนกโดยวิธี ไลน์ทรานเส็ค พ้อยท์เค้าท์ และ สปอตแมปปิ้ง ในช่วง พฤษภาคม 2546 – พฤษภาคม 2549 ในพื้นที่ แปลงวิจัยความหลากหลายทางชีวภาพระยะยาว มอสิงโต อุทยานแห่งชาติเขาใหญ่ ได้ทำการบันทึกนก 154 ชนิด ทั้งหมด 23,175 รายการ มวลชีวภาพโดยรวมของนกทุกชนิดในพื้นที่แปลงคือ 2 กิโลกรัม/เฮกแตร์ โดยประมาณ และมีความหนาแน่น 29.3 ตัว/เฮกแตร์ (2,930 ตัว/ตารางกิโลเมตร) โดยได้รายงานความหนาแน่นของนกชนิดที่เลือกศึกษาในรายงานฉบับนี้ ในการสำรวจแบบ ไลน์ทรานเส็คหรือพ้อยท์เค้าท์ พบว่าที่ระยะสำรวจ 80 เมตร เป็นระยะที่เหมาะสมที่สามารถสุ่มตัวอย่างนกได้เกือบทุกชนิด โดยนกปรอดโอ่งเมืองเหนือ (Alophoixus pallidus) เป็นนกที่พบได้มากที่สุดในแปลง มีความหนาแน่นประมาณ 3 ตัว/เฮกแตร์ ส่วนนกชนิดหลักๆ ที่พบโดยมากในแปลง (มากกว่าร้อยละ 85) จะมีความหนาแน่นโดยเฉลี่ยน้อยกว่า 1 ตัว/เฮกแตร์

ในรายละเอียดได้เสนอแนะและทำการเปรียบเทียบประสิทธิภาพของวิธีการสำรวจแต่ละวิธี และเป็นที่แน่ชัดว่าวิธีการสำรวจแบบเข้มข้นหรือสปอตแมปปิ้ง ในนกที่ได้ทำการเครื่องหมาย (ใส่ห่วงขาสี) เป็นวิธีที่ให้ค่าความหนาแน่นแม่นยำที่สุด แต่ก็ยังไม่ใช่วิธีที่สามารถใช้ได้กับนกทุกชนิด โดยเฉพาะอย่างยิ่งนกชนิดที่หากินบนชั้นเรือนยอดระดับสูง ส่วนวิธีการสำรวจคำนวณจากระยะทางทั้งแบบไลน์ทรานเส็คและพ้อยท์เค้าท์ ต่างให้ผลความหนาแน่นที่ค่อนข้างแม่นยำทั้งสองแบบ แต่อาจจะไม่เหมาะสำหรับนกบางชนิด โดยเฉพาะนกที่ไม่ค่อยพบเห็นในพื้นที่ อย่างไรก็ตามวิธีสำรวจแบบไลน์ทรานเส็ค อาจจะให้ผลที่ค่อนข้างดีกว่าวิธีพ้อยท์เค้าท์ ซึ่งบางครั้งอาจเนื่องจากโอกาสในการนับซ้ำหรือพบเห็นซ้ำในวิธี พ้อยท์เค้าท์มีสูงกว่า จึงต้องมีการศึกษาเพิ่มเติมเพื่อหาข้อสรุปให้ชัดเจนยิ่งขึ้น

ในช่วงเวลาที่ทำการศึกษาได้ทำการใส่ห่วงขาทำเครื่องหมายนกทั้งสิ้น 79 ชนิด จำนวน 1,207 ตัว และในจำนวนนี้มีมากกว่า 200 ตัวที่ได้พบเห็นซ้ำหรือจับซ้ำอย่างน้อย 1 ครั้ง ทำให้สามารถระบุอาณาเขตและการเคลื่อนที่ของนกได้หลายชนิด นอกจากนี้การใส่ห่วงขานกยังช่วยให้สามารถระบุรายละเอียดพฤติกรรมการทำรังของนกแต่ละตัวได้ เช่นอัตราการทำรังซ้ำหลังจากที่รังก่อนถูกกินหรือทำลาย (re-nesting) รวมทั้งระบุได้ว่าอัตราการทำรังซ้ำหลังประสบความสำเร็จแล้ว (double brooding) และการทำเครื่องหมายนกนี้ยังทำให้การศึกษารายละเอียดของนกที่มีระบบสังคมที่ซับซ้อนเช่น การมีระบบสืบพันธุ์แบบ cooperative breeding นั้นมีความเป็นไปได้ ดังนั้นจึงเป็นที่ประจักว่าการใส่ห่วงขาทำเครื่องหมายนกป่านั้นมีประโยชน์ต่อการศึกษาอย่างมาก

ตลอดระยะเวลาดำเนินงานตั้งแต่ปี 2546-2548 โครงการได้เก็บรวบรวมข้อมูลชีววิทยาการสืบพันธุ์และอัตราการประสบความสำเร็จในการทำรังของนกป่าได้ จำนวนทั้งสิ้น 688 รัง จากนก 43 ชนิด ซึ่งข้อมูลการศึกษาดังกล่าวถือว่าเป็นข้อมูลจากกลุ่มตัวอย่างของรังนกในป่าที่มีขนาดใหญ่ที่สุดเท่าที่มีการศึกษามาในภูมิภาคเอเชียและในพื้นที่ป่าฝนเขตร้อนในทวีปอเมริกาใต้ อย่างไรก็ตาม เมื่อแยกจำนวนตัวอย่างเป็นรายชนิดแล้ว ขนาดของตัวอย่างรังนกที่พบก็ยังไม่เพียงพอที่จะสรุปเกี่ยวกับอัตราความสำเร็จหรือความล้มเหลวในการทำรังได้ แต่เมื่อพิจารณาจากข้อมูลรังของนกทุกชนิดที่รวบรวมไว้ จะพบว่ามีอัตราการประสบความสำเร็จในการสืบพันธุ์ค่อนข้างต่ำ (น้อยกว่าร้อยละ 25) สาเหตุสำคัญที่ทำให้รังนกเสียหายมาจากถูกทำลายหรือถูกล่าโดยสัตว์ผู้ล่าต่าง ๆ ซึ่งสัตว์ผู้ล่าที่สำคัญได้แก่ ลิงกัง (Macaca nemestrina) และงูชนิดต่างๆ ทั้งนี้อัตราการถูกล่าและทำลายรังค่อนข้างสูง (ร้อยละ 70-90) ซึ่งถือว่าเป็นอัตราปกติของนกในป่าเขตร้อนทั่วไปและสอดคล้องกับรายงานการศึกษาจากพื้นที่อื่นๆ ข้อมูลเกี่ยวกับชนิดของสัตว์ผู้ล่าที่เข้าทำลายรังในพื้นที่แปลงวิจัยมอสิงโตกำลังอยู่ในระหว่างการศึกษา ส่วนรายละเอียดเกี่ยวกับพฤติกรรมและชีววิทยาการสืบพันธุ์ ได้มีการศึกษาในนกจับแมลงจุกดำ (Hypothymis azurea) และนกปรอดโอ่งเมืองเหนือ (Alophoixus pallidus) ส่วนนกกินแมลงป่าฝน (Malacocincla abbotti) นั้นได้มีการศึกษาทั้งชีววิทยาการสืบพันธุ์ และพฤติกรรมการเลือกพื้นที่อยู่อาศัย

ได้จำแนกตัวอย่างมูลนกจำนวน 375 ตัวอย่าง จากนก 21 ชนิด พบว่ามีเมล็ดพืชอยู่ 98 ชนิด จำนวน 21,090 เมล็ด โดยพบว่านกปรอดโอ่งเมืองเหนือกินผลไม้หลากหลายมากที่สุดคืออย่างน้อย 59 ชนิด พลองอินทร์ Dissochaeta divaricata (Melastomataceae) เป็นผลไม้ที่มีนกกินมากที่สุดโดยพบใน 66 ตัวอย่างของนก 9 ชนิด

แม้ว่าข้อมูลที่ได้จากการสำรวจและบันทึกจำนวนชนิดนกที่พบในแต่ละเดือนจะมีความแปรปรวนค่อนข้างสูง ตลอดระยะเวลา 3 ปีที่ดำเนินการศึกษา แต่สามารถสรุปอย่างคร่าวๆ ได้ว่า ช่วงเวลาที่มีอัตราการบันทึกจำนวนและชนิดของนกมากที่สุดคือในเดือนมีนาคม ซึ่งเป็นช่วง 1 เดือนก่อนที่จะเข้าสู่ฤดูการสืบพันธุ์ของนกป่าหลายๆ ชนิด (เมษายน- พฤษภาคม) ในขณะที่เดือนพฤศจิกายนเป็นเดือนที่มีอัตราการบันทึกการพบนกน้อยที่สุดเนื่องจากนกมักจะไม่ส่งเสียงร้อง แม้ว่าจะเป็นช่วงเวลาที่สามารถพบนกอพยพในพื้นที่ได้อีกกว่า 50 ชนิดก็ตาม จากการเก็บข้อมูลการผลัดขนพบว่าช่วงเวลาที่นกผลัดขนคาบเกี่ยวกับช่วงฤดูสืบพันธุ์เพียงเล็กน้อย ทั้งนี้นกส่วนใหญ่จะมีช่วงเวลาผสมพันธุ์ทำรังที่ชัดเจน และมักจะอยู่ในช่วงเวลาเดียวกันคือช่วงฤดูแล้งและฤดูฝน

ปัจจุบัน มีนักศึกษาไทยหลายคน (ระดับปริญญาตรี, ปริญญาโท 3 คนและปริญญาเอก 1 คน) ที่ได้รับการสนับสนุนทุนวิจัยจากโครงการ BRT และทำการศึกษาวิจัยต่อยอดจากโครงการนี้ (BRT_346004) มีผลงานวิจัยจากโครงการ 12 เรื่องที่ได้รับการตีพิมพ์ หรือตอบรับเพื่อตีพิมพ์ในวารสารทางวิชาการทั้งในระดับภูมิภาคและระดับนานาชาติที่ผ่านการพิจารณาจากผู้ทรงคุณวุฒิ และมีอีก 8 เรื่อง ที่อยู่ในระหว่างการเตรียมต้นฉบับเรียบเรียงเพื่อส่งตีพิมพ์ ซึ่งเป็นผลการศึกษาทั้งโดยตรง และโดยอ้อมของโครงการ

Avian abundance and diversity: an assessment of monitoring methods for forest birds at the Mo-singto Long-term Biodiversity Research Plot, Khao Yai National Park

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SUMMARY

Line-transects, point-counts, and spot mapping (May 2003-May 2006) on the Mo-singto Plot, Khao Yai yielded 23,175 registrations of 154 species of birds. The biomass of birds (all species combined) was approximately 2 kg/ha and the density 29.3 birds/ha (2930 birds/km^2). Density estimates of selected species are reported. Nearly all species can be adequately sampled within 80 m of a transect line or point. The Puff-throated Bulbul (*Alophoixus pallidus*) was the most common species on the plot, with a density of approximately 3 individuals per ha, while the majority (>85%) of species probably have densities < 1 individual per hectare.

Comparisons were made among the different survey techniques and detailed recommendations given. It is clear that intensive surveys/spot-mapping of colour-ringed birds provides the most accurate estimates of abundance, but will not work for all species, particularly those which forage mostly in the upper canopy. Distance sampling either from lines or points can provide a relatively precise estimate of abundance, but again it may not be practical for some species, particularly those which are rarely detected. The estimates from line transects appeared to be somewhat better than those from points, perhaps due to the higher chance of double-counting when sampling from points, although more study is needed to assess this.

A total of 1,207 birds of 79 species were ringed during the project. Over 200 individuals have been re-sighted or recaptured at least once, enabling delineation of territories and movements for many species. Ringing also allowed the identification of details of nesting behaviour such as the rates of re-nesting after nest failure and rates of double-brooding. Elucidation of complex social behaviour including cooperative breeding, was also possible. The overall benefits of colour-ringing for forest bird studies are very clear.

Details of nesting success were reported for a total of 688 nests of 43 species found during 2003–2006. This number of nests represents one of the largest samples known from a forested site in the Asian tropics as well as the Neotropics. The sample-size for most species, however was too small to draw detailed conclusions concerning success/failure rates, however, nesting success in most species was low (< 25%). The chief cause of nest-loss was predation, especially by monkeys (Pig-tailed Macaques, *Macaca nemestrina*) and snakes. High rates of predation on nests (70–90%) are typical for tropical passerines as reported elsewhere. A detailed study of nest predation is currently underway on the Mo-singto plot. Details of nesting behaviour are reported for Black-naped Monarch (*Hypothymis azurea*) and Puff-throated Bulbul. Nesting behaviour and habitat selection were also reported for Abbott's Babbler (*Malacocincla abbotti*).

A total of 21,090 seeds of 98 plant species were identified from 375 faecal samples of 21 species of birds. Puff-throated Bulbul appeared to eat the widest variety of fruits (59 plant species). *Dissochaeta divaricata* (Melastomataceae) was the most abundant seed, being detected from 66 samples of nine bird species.

Although monthly detection rates were highly variable during the 3-year study, the data suggests that the period of highest detection rate was March, which is roughly one month before the peak in nesting (April-May). November appeared to be the month where birds were the quietest despite the fact that an additional 50 species of migrants can be present. There was relatively little temporal overlap between breeding and moult. Most species showed a well-defined breeding season somewhat synchronized around well-defined dry and wet-seasons.

Several Thai students (BSc. interns, three MSc and one Ph.D) are currently being supported by BRT on affiliated projects derived from this project (BRT_346004). Twelve papers in international or regional English-language, peer-reviewed journals are in press or have been published, while another eight papers are in various stages of preparation as a direct or indirect result of this project.

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We are grateful to the Khao Yai Training Center, Training Division, Department of National Parks, Wildlife and Plants Conservation for providing accommodation during our visits. We thank the Wildlife Research Division, Department of National Parks, Wildlife and Plants Conservation (DNP) for making bird rings available, and Khao Yai National Park for facilitating our work.

BACKGROUND:

SE Asian forests support a high diversity of smaller birds (insectivores, frugivores, nectarivores and seed-predators). Some species, especially bulbuls, are important seed-dispersers for a great many tree species in both dry and moist forests (Corlett, 1998; G. Gale et al., unpubl. data). This total includes many species are ecologically sensitive or which are at risk. In spite of this smaller birds have received relatively little attention in comparison with large charismatic species such as hornbills.

There are very few data on absolute numbers and densities and biomass of birds in any forest habitats. In most cases, studies have barely progressed beyond inventorying species present. McClure (1974) used standardised walks/transects to record the seasonality of birds in Khao Yai; while Round and Brockelman (1998) produced estimates of species richness and diversity for some forest habitats in southern Thailand. Neither study attempted density estimates.

This report details work conducted on the bird community of the 30 ha permanent Forest Dynamics Research Plot at Mo-Singto, Khao Yai National Park under the project "Avian abundance and diversity: an assessment of monitoring methods for forest birds at the Mo-singto Long-term Biodiversity Research Plot, Khao Yai National Park", funded by the Biodiversity Research and Training Program (BRT) during March 2003-February 2006

AIMS: The principal aims of the current project were as (stated in the original proposal):

i) Determine the actual number of individuals and breeding pairs of each species on the plot through intensive mapping

ii) Examine how dispersion patterns vary among species and between seasons, and environmental features such as topography, vegetation cover, *etc.*, through the use of GIS

iii) Use a variety of sampling techniques (line transects, spot mapping, variable circular plots, intensive mist netting, and direct counting) in order to compare density estimates for a range of forest species during different seasons to serve as baseline data for a long-term monitoring program for Khao Yai and other forests.

iv) Produce detailed recommendations for forest bird census methodology

v) Collect and compile information on life-cycle parameters that will enable population monitoring

vi) Establish a basis for long-term population studies of birds on the Mo-singto plot, through building and maintaining a nucleus of individually marked forest birds.

vii) Provide specialised training and instruction in aspects of ornithological fieldwork for students

THE STUDY AREA

The Mo-Singto Permament Forest Dynamics plot is a 30 ha plot that was established in 1998 under the direction of Dr. Warren Brockelman, in collaboration with the Forest Herbarium of the Royal Forest Department and the National Parks Division (Brockelman, 1998). The topography of the plot has been surveyed accurately, and the locations of all trees down to 10 cm dbh plotted. This provides an invaluable resource and unique opportunity for monitoring bird populations through the adoption of detailed mapping methods. The plot is situated roughly 500 m from the park headquarters (Figure 1)

METHODS:

Line transects

Monthly visits were made to the Mo-Singto study plot from January 2002 onwards to May 2006 (other related projects are on-going). Mapping of birds was carried out by two to four observers walking on north-south transects of length 500 m. Initially, up to 16 transects placed 40m apart were used. From May 2003 onwards, eight transects, 80-160 m apart, (two per observer) were walked. Only one transect was walked per morning so that two mornings were necessary to cover the entire plot. Distance and bearing to each bird seen or heard within 80 m was recorded, so as to render the data amenable to analysis both by spot-mapping and line transect. Each observer walked one transect in the morning typically starting between 06:30-07:00 and finishing between 08:15 and 09:00, typically required 1.5-2.0 hours per transect –travel was slow due to the terrain and the dense vegetation. Distances were estimated to the nearest meter for visual observations, with particular emphasis on avoiding rounding distances, as this can create problems for analysis (Buckland et al. 2001). As greater than 80% of the detections were aural, distance data for aural detections were estimated and recorded in intervals 5, 10, 15, 20, 25, 30, 40, 60, and 80 meters. All observers trained together before initiating the surveys, one of us (PDR) has more than 20 years experience with the vocalizations of Thai birds and was the primary trainer. The locations of all birds heard or seen were located with reference to the nearest quadrate peg or nearest labelled tree. Bearings were measured to the nearest 5° with a sighting compass, with care taken to avoid rounding to 0° which can also cause significant problem for analysis (Buckland et al. 2001). The height of each bird was also estimated where possible. Most species were only recorded if judged to be within 80 m of the observer. However, the approximate locations of scarcer species such as Scaly-breasted Partridge *Arborophila chloropus* were recorded up to ca. 100 m. Numbers of individuals in flocks or small groups was recorded, and other relevant information such as call-type, feeding behaviour was recorded when relevant. The tree numbers of those trees from which birds were seen taking fruit were recorded. The locations of nests, when encountered, were recorded.

Point transects

A third morning on each visit was allocated for collecting distance sampling data on point transects. (We will refer to these as variable circular plots (VCPs), although technically they are slightly different from point transects). Each observer covered four VCPs, spaced 160 m apart, making a total of 16 VCPs to cover the plot. Observations (all birds seen and heard) were collected for a period of 10 minutes at each point, following a five-minute "settling-in" period. Distance was estimated and bearing were recorded for all birds heard or seen, although bearings are not required in this case. The same locations and observers were used each month.

Data was recorded in the field on standardized data forms, and transferred to a MS-Excel spreadsheet. A prototype database in MS-Access for storing and handling data was developed, but not fully utilized due to lack of staff familiar with database development. Data was analyzed using Distance software, Ver. 5.0, Beta 5 (Thomas *et al.*, 2005).

Spot-mapping

The locations of colour-banded, individually identifiable birds, all sightings of scarcer species and nest-locations were also recorded on maps. These data were combined with distribution data from distance methods (line-transects and VCPs) in order to plot approximate territory boundaries. This enabled a third estimate of density to be obtained for mainly territorial, understorey or middle storey-inhabiting species. The monthly surveys were carried out and combined with banding and colour-marking. Intensive mist-netting and banding sessions were conducted several times per year to facilitate the marking of as many individuals as possible. The chief emphasis was on understorey species due logistical constraints of canopy netting, however we were able to catch several canopy species when they came to streams to bath. Individuals were either ringed with either colour plastic or aluminium, depending on the species to reduce potential injuries. Biometrics and moult data were collected for all birds handled, and a copy of all data is deposited at Wildlife Research Division, DNP, Bangkok.

Analysis

Density estimates were produced using the DISTANCE 5.0 program (Thomas *et al.* 2005). For software settings, we followed the recommendations of Buckland *et al.* (2001) and those used by others for estimating the densities of species in the region (Kinnaird *et al.* 1996, Marsden 1999, Anggraini *et al.* 2000). Specifically, for all species, birds were entered as clusters and distance data were grouped manually at the intervals indicated above. Occasionally, groupings were combined when it was clear that particular species were not being were being grouped correctly. For example, in a few species it was clear that the interval 25-30 m was underrepresented, as it was difficult to estimate precisely at this distance. Both aural and visual observations were combined (following Kinnaird *et al.* 1996, Marsden 1999, Anggraini *et al.* 2000). For the aural detections we used the mean cluster size from our visual observations as the observed cluster size for data input. For Puff-throated Bulbul, we used independent data from our intensive field work in which mean group size was 3.07 for March-July and 3.43 for August-February. Group sizes were different due to recruitment and dispersal of juveniles, but it was generally not possible to distinguish adults from juveniles in the field, 1-month post fledging. For the model definition properties, cluster size was derived from the mean observed cluster size, otherwise size-bias regression (regression of log cluster size against estimated detection function g[x]) was used when the regression was significant at $\alpha \leq 0.15$. Models were fitted using the automated sequential selection and the Akaike's Information Criteria (AIC) stopping rule. A wide variety of key functions and series expansions were examined to fit detection functions to the data. We tested uniform, half-normal, hazard, and occasionally negative exponential (for poor fitting data) key functions with either the cosine, polynomial or hermite adjustment terms. We also tested a variety of truncation distances and found that we could truncate observations beyond 40-80 m depending on the species (species with louder calls were often recorded beyond 80 m). We chose truncation distances based on the shape of the detection function, and then using the lowest AIC function when selecting the best model among those with the same truncation distances and other input parameters, following Buckland *et al.* (2001).

Ringing

Birds were caught in mist-nets and in baited spring-traps. Spring-trapping was especially aimed at known unringed individuals of territorial birds (especially Hill Blue Flycatchers and White-

rumped Shamas). Further ringing was also carried out at streams as birds (especially canopy-living bulbuls) came to drink or bathe. Capture for ringing was highly labour-intensive except in areas close to water, presumably due to the relatively low density of understorey birds and the height of the vegetation column. Tape-luring was used to capture some species, but its effectiveness appeared limited. Nestlings were ringed wherever possible.

All birds were individually marked with a two-colour combination on one leg, and a numbered Royal Forest Department (RFD) ring, or an RFD ring and colour ring(s) on the other leg. For those species where split plastic rings were not suitable, a coloured, anodized aluminium split-rings were used. The colour combination was used to facilitate differentiate individuals in the field, thereby helping to delineate movements and territories.

All birds handled were measured, weighed, examined for stage of moult and breeding status. Selected individuals of all species were photographed using a digital camera in order to build up a reference collection of photographs for use in identification, ageing and sexing manuals. Faeces from birds in the hand where collected where possible, and retained for later examination.

RESULTS & DISCUSSION

Although the project was focussed around estimating the abundance of forest birds, as anticipated, the implementation of this work enabled a wide range of other data on avian ecology and behaviour to be collected; spawned a number of ancillary projects and enabled transfer of skills to students and interns. The results are organized based on the seven main objectives of the proposal.

i) Determine the actual number of individuals and breeding pairs of each species on the plot through intensive mapping

Numbers and diversity of birds

159 species of birds were recorded on the Mo-Singto study plot, of which 103 species (65%) are resident or thought to be resident (Table 1).

Densities and biomass of birds obtained from census and surveys:

It was not possible to count all birds on the plot with 100% certainty. Although relatively uncommon or difficult to catch species (*e.g.*, Blue Pitta, Eared Pitta, or Crested Goshawk) were caught and colour-ringed, as well as canopy dwelling species (*e.g.*, Grey-eyed Bulbul), re-sighting these species was difficult due to their secretive, wide-ranging, or canopy-dwelling behaviours. However, through a combination of methods we were able to estimate density with reasonable certainty, the abundance of the entire bird community on the Mo-singto Plot.

Line-transects and point-transects resulted in a total of 23,644 registrations of 154 species of birds. Densities of all species were estimated using distance sampling (a select sample of the more common or species of interest are listed in Table 2). Based on distance sampling, the total density (all species combined) of birds on the plot was estimated as 29.3 birds/ha (2930 birds/km^2), 95% confidence interval (27.5-31.2 birds/ha), and the estimated biomass was approximately 2 kg/ha. Biomass estimates were remarkably similar with those obtained for two lowland neotropical sites, 1.83 kg/ha for Panama (Robinson *et al.*, 2000) and 2.0 kg/ha for the Amazon (Terborgh *et al.*, 1990). Density figures were somewhat similar to Panama, 33.1 birds/ha, which was clearly higher than the 19.1 individuals/ha for the Amazon. Roughly therefore, for typical evergreen forest in central Thailand there are 3,000 individual birds or 200 kg of bird biomass in an average square kilometre of forest. Only 2.8% of the abundance was

contributed by four species of hornbills, though hornbills contributed 31.6% of total biomass. Puff-throated bulbul contributed approximately 10% of the total community abundance.

Based on the distance sampling estimates, the commonest species on the plot was the frugivore-omnivore, Puff-throated Bulbul (4.04 individuals per hectare) followed by Striped Tit Babbler (2.13 individuals/ha), Hill Blue Flycatcher (1.33 indiv./ha), Dark-necked Tailorbird (1.25 individuals/ha), and White-bellied Yuhina (1.08 individuals/ha; Table 2). Most other species for which data have been analyzed had densities of < 1 individual per ha. Densities from the intensive spot-mapping of colour-ringed birds were closely correlated with those obtained from both distance-based methods (see Section iii below).

The effective strip width (the perpendicular distance from transects in which 50% of the birds are detected) was on average approximately 40 m. This suggests a distance of 80 m was adequate for sampling nearly all the species on the plot, including Oriental Pied Hornbills, which have a loud call that can be heard for well over 100 m. Further research is needed to assess less common species with load calls, such as Crested Serpent Eagle or Scaly-breasted Partridge.

Nocturnal species
A small number of VCPs (13) were conducted in November 2004 during the hours f darkness in order to examine the feasibility of using distance-sampling for night-birds (owls and Javan Frogmouth). Using a prepared playback tape (playing uninterruptedly the calls of eight owls and Javan Frogmouth before starting to record observations) increased the number of detections, but probably biased the density estimates in favour of more responsive species, and may also cause birds to move towards the observer. This technique needs to be further evaluated but, even in its current form, it provides an index of abundance. Even with the limited effort, five of the eight resident owls known to be present on the plot were recorded during this survey.

Additional species recorded
A number of species new for the plot or for the headquarters area of Khao Yai were recorded during the project. These include a mixture of birds of disturbed habitats that are thought to have colonised along edge habitats, along the access roads into the park (*e.g.*, Racket-tailed Treepie *Crypsirina temia*); scarce migrants or winter visitors (*e.g.*, Japanese Paradise-flycatcher *Terpsiphone paradisi* and Grey-sided Thrush *Turdus feae*). The resident White-eye in the headquarters area of the park was proved to be Everett's White-eye *Zosterops everetti*, not Oriental White-eye *Z. palpebrosus*, as previously thought (Pierce and Round, 2006).

ii) Examine how dispersion patterns vary among species and between seasons, and environmental features such as topography, vegetation cover, *etc.*, through the use of GIS

It is quite clear that the spatial patterns of birds could only be mapped in detail if either they were colour-ringed and had relatively small territories (~ 1 ha) or were fitted with radio collars. Without individual marks (colour rings), it was not possible to be confident about the movement patterns and spatial distributions of the birds, because most species call infrequently and often do not counter-sing/call with their neighbours. It is much more difficult to determine territory/home range boundaries if neighbouring individuals do not frequently defend their territories. Most species on the plot, either occupied large (>>1 ha) home ranges or could not be ringed/or re-sighted in sufficient quantity to be usable. For the species that could be mapped intensively, all occupied most or all of the plot, which made mapping habitat use uninformative as most of the habitat was used at least occasionally (see Figures 3-6). However, we could map overall territories, and at least determine average territory sizes for a range of species (Table 3); while a few species such as the White-crowned Forktail had quite obvious associations with particular

geographic features (the streams, Figure 7). Other species such as the Abbott's Babbler were clearly associated with rattans, which they used for nesting and foraging. Although rattans were not mapped into the GIS for the entire plot; the only area not occupied by this species was largely devoid of rattans (Figures 8 & 9). The detailed study of Abbott's Babbler habitat selection was the focus of the thesis work of Mr. Korakoch Pobprasert (Pobprasert 2005). Detailed habitat use is also being conducted on Siamese Fireback and Silver Pheasant as part of another on-going BRT-funded study (BRT R_349004) on the plot conducted by Dr. Tommaso Savini and his student.

Seasonality

Patterns in calling rates were highly variable across the three years of surveys. However, some general patterns may be apparent, although several more years of data will be needed to confirm clear trends. It appears that the early dry season in November and perhaps December has the lowest calling rates, despite the fact that more than 50 species of migrants maybe present on the plot during in addition to the usual residents. On the other hand, March appears to be the month with the highest calling rates, which appears to correspond to a period just before the peak in the breeding season (Figure 10)

Peak breeding (based on number of species breeding) was in April–May, and the peak time for moult was during June to September (Figure 11), although we have moult data for relatively few species compared to breeding data (see also the section on moult). The apparent overlap in season is due to the relatively long breeding and moult seasons: those individuals that have finished breeding commence moult earlier. So far as known, no individuals that were still breeding began moult.

There did not appear to be any clear relation between the seasonality of breeding and the numbers of species of trees in fruit. It is likely that the timing of breeding and moult will be related to variations in the abundance of insects and other invertebrates, which is a topic for future investigation.

iii) Use a variety of sampling techniques (line transects, spot mapping, variable circular plots, intensive mist netting, and direct counting) in order to compare density estimates for a range of forest species during different seasons to serve as baseline data for a long-term monitoring program for Khao Yai and other forests.

Comparison of survey methods

Distance sampling versus intensive census (spot-mapping, ringing & nest finding)

We were able to obtain highly precise estimates of density for a subset of eight species using spot-mapping, colour ringing and nest finding. While these eight species can be considered as typically foraging in the subcanopy or below (< 10 m), these species represent a range of behaviours from mostly solitary (White-rumped Shama) to those that travel almost entirely in small flocks (Puff-throated Bulbul). All but the Puff-throated Bulbul are largely insectivorous. All eight also typically nest in the subcanopy or below as well. In particular, they all have behaviours that make it possible to catch them in mist nets, either at streams when they come to bath, at nests when they are feeding young or in spring traps.

Characteristics and density estimates for the eight species are given in Tables 4 & 5. Overall, the distance sampling methods were significantly and highly correlated with the "true estimates" derived from the intensive surveys (r_s= 0.786, p = 0.021 lines vs. intensive surveys, r_s= 0.905, p = 0.002 points vs. intensive surveys). The two distance sampling methods were also

significantly correlated with each other ($r_s = 0.833$, $p = 0.010$). The average absolute difference between the line transects and the intensive surveys was 32.6% ±25.8 SD versus 41.7% ±26.8 SD for point transects (see Figure 12). There was no significant difference between the two estimates, although the trend is suggestive (Wilcoxon Matched Pairs Test, $p = 0.069$) that perhaps the line transects were giving slightly better estimates. Three of the eight "true" estimates were outside the 95% confidence intervals predicted from line transects, while five of the eight "true" estimates were outside the 95% confidence intervals from the point transects.

iv) Produce detailed recommendations for forest bird survey methodology

Based on our experience with the surveys and monitoring on the Mo-singto Plot we can make seven specific recommendations:

1) Determining the exact density of individuals of a target species in a target area requires a large effort in terms of man power. For smaller, ground-dwelling, understory, and lower-mid canopy species with reasonably well-defined territories, spot-mapping in combination with colour-ringing is highly effective in obtaining very precise estimates of abundance and distribution. This technique also requires relatively little equipment compared to telemetry. Colour-ringing can also provide highly valuable data on survival and abundance (mark-recapture techniques), reproductive behaviour including frequency of re-nesting after nest failure, multiple brooding, cooperative breeding and other complex social behaviours. The primary drawback is that it requires highly skilled bird-ringers and bird observers. Although, such skills can be taught by labs like ourselves, we recommend preferably a year of intensive training for bird ringers (perhaps less, depending on the intensity of the training) and 3 months of intensive training for bird observers starting with minimal skills.

2) For common canopy species such as the Black-crested Bulbul or Asian Fairy Bluebird, a complete census even with many individually marked birds may not be possible. Although canopy nets may allow for more captures, re-sighting birds is highly problematic, particularly because many of these species may have territories of 10 hectares or more, which greatly reduces the chances of re-sighting marked individuals on a regular basis. For such species, radio telemetry is probably the best option, at least for determining general patterns of movement and habitat use. Likewise for more uncommon and skulking ground birds such as pittas and pheasants, radio telemetry will supply much higher quality information (although at considerably greater expense) on movement patterns, habitat use, and nesting behaviour.

3) If the goal of the project is only to estimate the abundance/density of birds (for monitoring for example), then distance sampling may be an appropriate method to use. Distance sampling obtains estimates that are surprisingly accurate or at least highly correlated with the true density for species that are: (a) relatively detectable (call relatively frequently), (b) relatively stationary (i.e., they do not travel several hundred meters back and forth across their territory within an hour); (c) and for which distances to calling individuals are relatively easy to estimate (unlike barbets, for example).

Problems with distance sampling occur when:

i) Species are particularly rare or secretive. On average, 60-80 detections are required to obtain a reliable estimate of the detection function for lines transects and 75-100 detections for point transects (Buckland et al. 2001). We found this to be true, although it was *sometimes* possible to obtain reasonable estimates with a smaller sample ($n = 50$), conversely, sometimes 80 detections gave poor results for species where distances to calling birds was difficult to estimate (i.e., Green-eared Barbets). The main conclusion is that the number of detections needed depends very much on the field conditions and the species of interest. One solution to the problem of insufficient samples is to combine data from two species that are likely to behave similarly. For

example, we were able to obtain rough estimates of density for Siamese Fireback and Silver Pheasant by combining observations together to produce a "global" detection function, which was used to estimate the densities of each species separately. For species that are extremely rare, alternative methods such as occupancy modelling (Mackenzie et al. 2005) may be required. There is now an extensive scientific literature on sampling rare or elusive species (e.g., Thompson 2004, Mackenzie et al. 2006).

ii) Species that move frequently or long distances, increase the likelihood of counting the same individual more than once at the same point or line (double-counting), leading to over-estimation. For example, for both Puff-throated Bulbul and Oriental Pied Hornbill we significantly over-estimated abundance. Both species move frequently (hornbills in particular move over relatively long distance quickly [many hundreds of meters]) and could be easily double-counted if they happen to fly parallel to transect lines.
iii) Species which are likely to move in response to the observer before being detected. For example, White-browed Scimitar Babbler appears to move away from the transect line as an observer approaches (Figure 13).

4) *Point transects versus line transects*, line transects generally obtain more detections for nearly the same effort as point transects and therefore also more likely to detect the rarer species. Lines also gave slightly better density estimates, but this needs more work to prove conclusively. However, for difficult terrain or particularly dense forest where walking straight lines is not practical, point transects are clearly a usable alternative. Distance sampling can also be conducted from curving transects (or trails, e.g., Gale and Thongaree 2006), but the analysis is more complicated, and using trails *should be avoided* because they will likely provide a highly biased sample of the habitat.

5) When conducting point transects, if the focal species is common and highly mobile, the risk of double-counting is particularly high. Several studies have found that point sampling tends to overestimate abundance (e.g., Raman 2003). We suggest reducing the total count period from 10 minutes to perhaps 5 minutes for common species. If the target species is more secretive and calls infrequently then increasing the number count stations may be necessary. Increasing the number of count stations appears to be a more efficient alternative than increasing the duration of the count period (Lynch 1995). Increasing the number of stations also tends to increase the precision of the abundance estimate (Buckland et al. 2001). If a species is likely to be disturbed or flushed away by the approach of an observer, then counting may need to begin at the moment the observer reaches the survey point, eliminating the need for the 5 minute "wait" period before the count begins.

6) Precision of density estimates is improved by increasing the number of transect lines or points. Buckland et al. (2001) for example recommend a minimum of 20 transects. Thus, 20 short transects is usually better than one long one. Buckland et al. (2001) provides formulas for estimating sample sizes needed for different number of transects and different levels of precision.

7) With bird surveys, more than 80% of the detections are aural, and therefore the probability of detecting a bird is the product of the probability that it will call while the observer is present *and* the probability of hearing the bird when it does call. Distance sampling only measures the probability of detection if it calls, thus for species that call infrequently it is highly likely that distance sampling alone will underestimate abundance. One method of reducing this problem is to use point transects to record birds at 3 or more equal time intervals. For example, sample birds for three, 3 minute periods (total of 9 minutes). This kind of data can be used not only to estimate the probability of detection if the bird calls, but also estimate the probability of a bird calling in the sample period (Farnsworth et al. 2002). However, combining such analyses is complicated and is still in the process of being developed.

v) Collect and compile information on life-cycle parameters that will enable population monitoring

Breeding success

Data has been compiled for a total of 688 nests of 43 species found during 2003–2006 (Table 6). This number of nests represents one of the largest samples known from a forested site in the Asian tropics as well as the Neotropics (Robinson et al 2000).

The sample-size for most species was too small to draw detailed conclusions concerning success/failure rates. By and large, however, nesting success in most species was very low (< 25%) and the chief cause of nest-loss was thought to be predation, especially by monkeys (Pig-tailed Macaques, *Macaca nemestrina*), squirrels and snakes. (A detailed study of nest predation is currently underway on the Mo-singto plot, BRT R_349007). High rates of predation on nests (70–90%) are typical for tropical passerines (Stutchbury and Morton, 2001).

In order to avoid bias resulting from differential discovery at nests of different stages in the cycle (nests with young are more likely to be discovered than those at earlier stages in the nesting cycle), Mayfield estimates of nesting success, based on the number of exposure days, should be used. As yet, however, these are available for very few species because a sample size of 20 or more nests is typically required to obtain reasonably precise estimates (Hensler and Nichols, 1981).

Mayfield estimates were not possible for most species, however for the few species with sufficient sample sizes, success rates appear to be highly variable among years. For example, Abbott's Babbler success ranged from 11.3% to 24.9% during 3 years of the study from 2004-2006.

Nesting behaviour

A significant amount of time was spent on watching nests in order to determine patterns of attendance and provisioning of young. Most observations were on four species (Black-naped Monarch; details below; Abbott's Babbler, 47 hrs during incubation and nestling stages from 21 nests in 2004; Puff-throated Bulbul 31 hrs from 14 nests during nestling stage in 2004 and 2005 combined, Hill Blue Flycatcher 9 hrs at two 2 nests during 2004 -2005.

In addition a few hours each were spent watching the nests of the following species:

Green-eared Barbet (five hours); Laced Woodpecker (two hours); Moustached Barbet (one hour); Red-headed Trogon (one hour); Long-tailed Broadbill (four hours); Green Magpie (four hours); White-rumped Shama (three hours); Black-crested Bulbul (five hours); Puff-throated Babbler (one hour); White-browed Scimitar Babbler (one hour).

Detailed observations on three species are presented below.

Black-naped Monarch

A total of 42 nests of Black-naped Monarch was found during the 2003– 2005 breeding seasons. However, only 26 out of 42 nests were found to be active (eggs laid), the rest was deserted in the process of building or before laying eggs. 152 hours were spent watching nesting behaviours of 26 active nests (10 pairs) during incubation and nestling stage. Currently, there are 11 certain territories occupied by monogamous pairs with 3 suspected additional territories on the plot. Average territory size for this species is 2.29±0.8 ha. Nesting started in late February and lasted

until early June. The peak nesting activity was found in April for all years. The majority of successful nests were initiated during April, especially in 2004 breeding season.

Nests were built by both sexes. Both sexes contributed equally in incubating eggs. The incubation stage lasted on average 13.5 days (13–15 days). The duration of incubation bouts was 10–12 minutes and there was average of 1.7 bouts per hour per parent. Both sexes spent up to 50% of their time on the nest per hour during daylight hours. The female is thought to brood the eggs and small young overnight (see Table 7).

The modal clutch-size was 3 (average clutch-size was 2.8 eggs). Loss of an egg during the incubation stage occurred in 25% of nests.

The duration of the nestling stage was 9–11 days (average 11 days). On average, 2.5 young were produced per successful nesting attempt. Currently, there is no evidence to suggest multiple brooding in this species. Brooding of nestlings was observed mainly in the beginning of nestling stage, and was shared equally between the sexes. Brooding of nestlings gradually declined as they approached fledging.

The rate at which food was delivered to the young showed an opposite trend to the amount of time spent brooding, as expected. During the early nestling stage (0–5 days old), both sexes combined came to the nest roughly 4 times per hour to feed. This rate increased to 9 feeds per hour in the late nestling stage. There was no difference in the rate of feeding young between the parents.

Some temperate zone birds can feed older nestlings up to 20–30 times/hr/young (Stutchbury and Morton, 2001). In our study, the highest number of feeds per hour per young was 3. In comparison to temperate zone birds, this is extremely low, however the typical feeding rate for tropical passerines is 1.3–2.2 visits/hr/nestling (Stutchbury and Morton 2001), thus feeding rates found in this study for Black-naped Monarch were at the high end for tropical species.

The parents perched by the nest for less than 10 minutes per hour probably being vigilant. Male seemed to engage in perching by the nest more than female, though the difference was not statistically significant.

Abbott's Babbler

The Abbott's Babbler nesting season appears to be relatively long, running from mid January to the end of July. The majority of individuals stay together as pairs and maintain year-round territories of approximately 1.75 hectares. Their long breeding season allows them to make several nesting attempts per year (2.5 attempts/pair/season), which is particularly important given the low nesting success, ranging from 11.3% to 24.9% (Table 6).

A total of 54 nests of Abbott's Babblers was found during the 2003 and 2004 breeding years. Nests were placed low, averaging 1.0 $\pm$0.47m above ground. Of those, 47 of the nests were placed in rattans, while the remaining 7 were placed in other shrubs. In addition, Abbott's Babbler showed a clear preference for areas with higher rattan density (Figure 9).

A M.Sc. dissertation "Nesting habitat selection of Abbott's Babbler (*Malacocincla abbotti*), Mo Singto, Khao Yai National Park" was completed by Korakoch Pobprasert in 2005.

Puff-throated Bulbul

A total of 199 nests of Puff-throated Bulbuls were found during 2003–2006, most during 2005 and 2006. The span of dates for nests with eggs was from February to July. Nesting success figures are presented below (Table 6). Three nests for which the adults were individually identifiable had at least one nest-helper attending, and provisioning the young. This is the first confirmation of cooperative breeding in any Asian bulbul (Pierce et al. 2007).

Moult

Moult in birds is the periodic shedding and replacement of feathers (Ginn and Melville, 1983). As feathers become worn and broken, moulting on a regular basis is necessary to maintain the flight efficiency and insulative properties of feathers. Because feathers are comprised largely of protein, moult is believed to be energetically costly (Payne, 1972). The costs of moult can be broken down into primary and secondary costs. The primary costs of moult are costs of feather synthesis and of maintaining the tissues necessary for feather production (Payne, 1972, Dolnik and Gavrilov, 1979). The secondary costs of moult are reduced flight efficiency and ability to thermoregulate (Payne, 1972; Tucker, 1991).

Because moult is of long duration and is energetically expensive, it is one of two (or three) key events in the annual cycle of birds, along with breeding (and migration for migratory species). In most bird species, moult and breeding are temporally separated, and due to the high energy demands of both processes (Payne, 1972). Where moult and breeding overlap, this may be because of the opportunity to take advantage of a seasonal super-abundance of resources (as in high-latitude species in the boreal summer), or due to the occurrence of asynchronous breeding seasons in some tropical species, mainly in the least seasonal areas (Payne, 1972; Foster, 1975).

Moult records are now available for 22 species. Our research at Khao Yai indicates that, for species so far examined, there is little or no temporal overlap between breeding and moult (Figure 11). This is presumably due to the fact that although the breeding season is longer than in temperate regions it is still well defined for most species and somewhat synchronized around well-defined dry and wet-seasons, unlike in less seasonal areas of the tropics (Fogden, 1972).

Most resident species at Khao Yai undergo a complete post-juvenile moult, moulting both flight feathers and contour feathers, commencing a few weeks after leaving the nest.

The Hill Blue Flycatcher appears exceptional among Khao Yai birds in showing a partial post-juvenile moult in which the juvenile tail, primaries and secondaries and a few wing-coverts are retained throughout their first year. The retained feathers are slightly different in shape and colour to the replaced feathers, thus allowing ageing of the bird up until the end of the following breeding season when they moult into full adult plumage. At least some of these yearlings have been recorded breeding in their first year.

The progress of moult of the longest flight feathers, the primaries, is relatively slow and usually covers the whole period of moult. The moult of the primaries can thus be used as an outline for the total moult period. To record the progress of moult, each bird is examined for growing primary feathers during trapping for ringing. Each feather is given a score depending on the stage of growth, ranging from 0 for old feathers and 5 for fully grown new feathers. Most passerines have a total of 10 primaries and the total moult score is therefore between 0, for birds with old feathers not yet starting to moult, and 50 for those that have completed their moult. Moult scores of those birds in active moult may be plotted against date to give a scatter diagram that gives a good indication of the moult period of the population under investigation.

The moult periods for two species for which most data is available, Black-crested and Grey-eyed Bulbul, were calculated as 127 and 133 days respectively using linear regression of moult score against date (Figure 14). The graphs show the duration of moult of the population rather than of individuals. In order to obtain better estimates of the time that individuals spend moulting, it is necessary to recapture the same individual at different stages of the moult cycle.

Moult was of relatively long duration compared to similar sized birds in temperate regions. For example the bulbul-sized, migrant Nightingale *Luscinia megarhynchos*, and the mainly resident Song Thrush *Turdus philomelos* have moult periods of only 45 and 50 days respectively (Ginn

and Melville, 1983). This may be due to several factors including food availability. Birds in temperate zones often have to moult quickly after breeding either because of the pressure to complete moult before migration or before the onset of winter. On the other hand, there is thought to be a proportionately greater 'flush' of food during the temperate summer, that facilitates easy access to sufficient protein to grow new feather rapidly. Birds in the tropics are thought to live closer to the 'food limit': although food is available year-round, there is never any seasonal super-abundance of food.

Data related to the lifecycle of the bird community of the Mo-singto Plot

Frugivory and feeding ecology

Between January 2003 and August 2005, a total of 375 discrete faecal samples containing 21,090 seeds were collected from 21 bird species. The seeds came from 81 known species of at least 40 families, 9 *Ficus* spp, two species of Loranthaceae, and six unknown (Table 8). Most of the seeds were obtained from highly frugivorous bulbuls: Puff-throated Bulbul (*Alophoixus pallidus*) 100 samples from 59 plant species; Grey-eyed Bulbul (*Iole propinqua*) 110 samples from 38 species and Black-crested Bulbul (*Pycnonotus melanicterus*) 82 samples with 37 species. The number of seeds per faecal sample varied from 1–5 species.

At least 10 fruit species were fed to nestlings and fledglings: six seed species were identified from remains beneath a single nest containing 3 young Puff-throated Bulbuls.

Dissochaeta divaricata (Melastomataceae) was the most abundant seed, being detected from 66 samples of nine bird species (12 % of all detected seeds), while *Aidia densiflora* (Rubiaceae) was the second most frequently recorded, in 53 samples from six bird species.

During April 2004–May 2005, direct observation was undertaken at 14 fruiting tree species. These 990 observation hours resulted in over 4,500 records of 46 bird species feeding on fruits. The main fruits consumers were Puff-throated Bulbul (24 %), Grey-eyed Bulbul (17 %), Asian Fairy Bluebird (11 %), and Black-crested Bulbul (10 %), respectively.

Monitoring of the phenology of fleshy-fruited trees (1,100 individuals of 78 species) along four transect-lines was continued in order to investigate food availability for frugivorous birds.

Most species of smaller birds studied at Khao Yai so far are, to some extent omnivorous, taking both fruits and insects. Some obvious exceptions seem to be a few terrestrial insectivores (pittas and perhaps Puff-throated Babbler, which take entirely animal food). Overall, the lower percentage of obligate insectivores compared with lowland Malaysian forest (see e.g. Johns, 1986) suggests that Indochinese forest birds are less specialised and incline towards being dietary generalists.

Arthropod Sampling

Limited sampling of arthropods was conducted in January and February 2005 to assess the feasibility and appropriateness of the techniques. The insects were sampled using light trapping and sweep netting. For light trapping, three light traps were placed 200 m apart around the plot. Sweep netting was conducted on three transects 20, 32, and 44.

The specimens were set and placed in incubator for drying and identified to order and family where possible.

Preliminary results indicated that insects of the Order Diptera and Hymenoptera were most common in the understory, while light traps suggested that Coleoptera and Lepidoptera were similarly common (Tables 9 & 10). The differences in numbers between sampling techniques probably reflect differences in arthropod behaviour (*i.e.*, moths are more likely to be caught at night at light traps than during the day by sweep netting).

Insect sampling will continue on the plot as part of the next phase of the project.

vi) Establish a basis for long-term population studies of birds on the Mo-singto plot, through building and maintaining a nucleus of individually marked forest birds.

Ringing and marking
A total of 1,294 birds of 79 species were ringed up to 31 March 2006 (Table 11). This comprises 1053 adults/full-grown birds and 241 pulli (nestlings).

Biometrics and moult were recorded for all birds handled since the inception of the project, and diet (from faeces) was recorded from January 2004 onwards.

During five days in January 2005, two female blue pittas were caught and transmitters fitted. The object of the work was primarily to investigate the feasibility of tracking pittas using radio-telemetry, as a precursor to the above bodies undertaking research, involving radio-telemetry on the critically endangered Gurney's Pitta (*Pitta gurneyi*) in southern Thailand. The birds were tracked for several days by a DNP researcher. Ms. Somying Tunhikorn, and a BCST Researcher, Ms. Sirirak Aratrakorn. However, both birds then apparently vanished.

Recaptures, re-sightings and movements
A total of 3,128 re-sightings of colour-ringed birds and other significant sightings were made since January 2003. Maps of territories (e.g. Figures 3-8) and movements (Figure 15) have been prepared for the most-captured/resighted species

A total of 33 migrant birds of 10 species were caught and colour ringed during the 2002–3 and 2003–4 winter periods. Of these, 11 individuals of four species were re-sighted or re-trapped on the study area in subsequent years after having returned from their summer breeding grounds in China or Russia. Some of these species are particularly faithful to their non-breeding territory. All six Plain-tailed Warblers *Seicercus soror* that were ringed in early 2003 were recorded in the following winter (2003–2004) and at least two returned during winter 2004–2005. diagram summarizing some of the on-plot movements of migrants is shown in Figure 16.

In most instances the birds have returned to the exact same winter territory that they were on in the previous year, a remarkable feat of navigation that is still not fully understood. It is only possible to prove this by the use of individual marks, further emphasizing the value of catching and ringing birds. It also shows that the fitting of rings is not detrimental to the birds' welfare as they have undergone lengthy and energetically costly migrations between their initial capture and their subsequent re-sighting on the study plot without ill-effect.

vii) Provide specialised training and instruction in aspects of ornithological fieldwork for students

TRAINING AND SUPPORT FOR STUDENTS & PARK STAFF
A M.Sc. project was completed in 2005 by Korakoch Pobprasert

A total of 4 M.Sc. projects and one Ph.D projects on birds are currently being conducted on the plot. Funding for four of these projects has been obtained from other discrete projects (including

two funded by BRT). The fifth student received some support from the present project in the initial stages of her fieldwork.

In addition to those students (referred to above) whose projects are listed below (see Ancillary projects) another five students worked as intern field assistants during the project, some of whom completed undergraduate senior projects..

We demonstrated the use of spring traps to catch terrestrial birds to one Department of National Parks researcher and one Bird Conservation Society of Thailand researcher who are working on the Gurney's Pitta conservation project in S. Thailand.

Ancillary research projects arising from work funded by BRT_346004
On-going Student research projects

M.Sc. Projects.

The effect of habitat quality on home range size, group dynamics, and breeding success in Puff-throated Bulbul (*Alophoixus pallidus*) at Mo-singto, Khao Yai National Park. MSc. Project conducted by Ms. Supatcharee Dhanasarnphaiboon, Faculty of Graduate Studies, Mahidol University.

Habitat use, movement pattern and home-ranges of the Siamese Fireback *Lophura diardi* and Silver *Pheasant L. nycthemera* in Khao Yai National Park, Thailand. M.Sc. Project conducted by Mr. Niti Sukumal, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi.

Influence of food availability on Puff-throated Bulbul (*Alophoixus pallidus*) movements. M.Sc. Project conducted by Ms. Daphawan Khamcha, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi. (Funding pending: sought from BRT)

Effects of helpers on nestlings and nesting success in the cooperative-breeding Puff-throated Bulbul, *Alophoixus pallidus*. M.Sc. Project conducted by Ms. Phetprakai Wonkson, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi. (Funding obtained from BRT and KMUTT under the project "An investigation of group composition of cooperative breeding Puff-throated Bulbul").

Ph.D Projects
Post-fledging survival and juvenile dispersal in the cooperative-breeding Puff-throated Bulbul, *Alophoixus pallidus*. Ph. D. project conducted by Ms. Wangworn Sankamethavee, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi. Funded by BRT (BRT T_350006) and the Royal Golden Jubilee Program

Non-student research projects
Determining nest predators of understorey forest birds using digital video surveillance, by Andrew J. Pierce and Korackoch Pobprasert, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi. Funded by National Research Council of Thailand and Biodiversity Research and Training programme (BRT R_350002).

Pheasant feeding and reproductive ecology, and inter-species competition in niche-use, in the Mo-Singto Long-term Biodiversity Research Plot: implications for inter-species hybridization By Dr. Tommaso Savini, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi.

PROJECT OUTPUTS

PUBLICATIONS ARISING FROM THE PROJECT

Ten papers or short notes, including two by students as lead-authors, have so far been published in international or international standard journals while three others are in press.

DHANASARNPAIBOON, S. and. ROUND, P. D. (2004) Foraging of Greater Racket-tailed Drongo (*Dicrurus paradiseus*) and Lesser Racket-tailed Drongo (*D. remifer*) in Khao Yai National Park. *Nat. Hist. Bull. Siam Soc.* 52 (1): 115–117.

NIMUAN, S., ROUND, P. D., AND. GALE, G. A. (2004) Structure and composition of mixed-species insectivorous bird flocks in Khao Yai National Park. *Nat. Hist. Bull. Siam Soc.* 52 (1): 71–79.

PIERCE, A. J. (2005) Interspecific feeding of a White-eye fledgling by a Little Spiderhunter. *Nat. Hist. Journ. Chulalongkorn Univ.* 5 (1): 41.

PIERCE, A. J. (2004) Orange-headed Thrush *Zoothera citrina* eating elastic bands. *Nat. Hist. Bull. Siam Soc.* 52(2): 217–218.

PIERCE, A. J., POBPRASERT, K. AND GALE, G. A. (2004) Breeding Ecology and Nesting Success of Abbott's Babbler *Malacocincla abbotti. Wilson Bulletin.* 116: 274—276.

PIERCE, A. J., TOKUE, K., POBPRASERT, K. AND P. D. ROUND. (2004). Observations on the breeding of the Puff-throated Bulbul *Alophoixus pallidus* in north-east Thailand. *Forktail* 20: 101–102.

PIERCE, A. J. AND P. D. ROUND. (2006) Everett's White-eye *Zosterops everetti* in KhaoYai, north-east Thailand. *Forktail* 22.: 72-74.

PIERCE, A.J., TOKUE, K., POBPRASERT, K. AND SANKAMETHAWEE, W. 2007. Cooperative Breeding in the Puff-Throated Bulbul *Alophoixus pallidus* in Thailand. *Raffles Bull. Zool.* 55 (1): 187-189.

PIERCE, A.J. AND POBPRASERT, K. (In press.) A portable system for continuous monitoring of bird nests using digital video recorders. *J. Field Ornithol.*

ROUND, P.D. 2006. Cooperative provisioning of nestlings in the White-crested Laughingthrush *Garrulax leucolophus. Forktail* 22: 89-90.

ROUND, P.D., GALE, G. A., PIERCE, A.J., POBPRASERT, K., SANKAMETHAVEE, W., TOKUE, K. , NIMNUAN, S., PATTANAVIBOOL, A. AND BROCKELMAN, W.Y. 2006. The Ecology of Forest Birds at Mo-Singto, Khao Yai. *Proceedings of the 9th Annual Conference of BRT.* Biodiversity Research and Training Program, Bangkok.

ROUND, P. D. AND GALE, G.A. (In press). Changes in the status of *Lophura* pheasants in Khao Yai National Park, Thailand: a response to warming climate? *Biotropica.*

TOKUE, K. (In press.) Predation by Pig-tailed Macaque *Macaca nemestrina* on bulbuls in Khao Yai National Park, Thailand. *Nat. Hist. Bull. Siam Soc.*

Publications in prep.

GALE, G. A., ROUND, P.D., PIERCE, A.J., NIMNUAN, S. AND PATTANAVIBOOL, A. In prep. A field test of distance-sampling methods for a tropical forest bird community.

Eight papers are still in preparation, including the paper that constitutes the major part of work carried out under the project, involving a comparison of results from different census methods (line-transects, variable circular plots and spot-mapping).

Others papers currently in preparation are:

- reproductive success of those species for which we have nesting data;
- nest-site and habitat selection of Abbott's Babbler
-breeding biology and parental care in the Black-naped Monarch
-breeding biology and parental care of the common breeding birds on the plot

Draft bird-ringing manual

A draft bird-ringing manual for use in Thailand has been distributed for comment. This contains details on recommended ring-sizes for selected species. The initial draft is in both English and Thai. Further information on techniques is being added piecemeal, s that the document is evolving and may eventually be published.

Information on ageing, sexing and moult has also been compiled for 30 species of forest birds at Khao Yai, and has been added to data for a larger number (c. 50) non-forest species, collected over the years. This will eventually form the basis for a guide to ageing and sexing of Thai and SE Asian birds.

THESES ARISING FROM THE PROJECT

Pobprasert, K. 2005. Nesting habitat selection of Abbott's Babbler (*Malacocincla abbotti*) in Mo-Singto, Khao Yai National Park. MSc. Thesis. School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi.

Popular articles

A (Thai-language) article giving instructions for studying and reporting details of nests was submitted for publication in the *Bird Conservation Society of Thailand* (BCST) *Bulletin*. A nest record card (both Thai and English versions), based on the format used in the current project, was distributed through BCST. It is hoped in this way that a standard protocol for recording and submitting details of nests, to be used by birdwatchers, bird photographers and amateur ornithologists nationwide.

The project was featured in a special issue on wildlife monitoring methods in *Advanced Thailand Geographic* magazine for 2006 (Volume 89).

Lectures, workshops and conferences

The project presented posters at the Biodiversity Research and Training Programme Annual Conference Annual Symposia in 2003, 2004 and 2006, and delivered a full paper at the Ninth Annual Symposium in 2005 (Round *et al.*, 2006).

G. Gale attended the workshop "Introduction to Distance Sampling for Ornithologists, at the University of Northern Arizona, Flagstaff, Arizona, during 10–14 January 2005. Cost of his participation was covered by the Joint Graduate School of Energy and Environment, KMUTT.

P. D. Round, A. J. Pierce and Somchai Nimnuan participated in the workshop "Advanced field techniques for the study of birds and other animals" at Khao Yai National Park, 26–27 January 2005, held by collaboration among the Royal Society for the Protection of Birds, UK, Department of National Parks, Wildlife and Plants Conservation. During the above workshop, the project organised a demonstration of mist-netting and other trapping methods.

Twelve papers or poster papers relating to this and ancillary bird-related projects conducted at Khao Yai were presented at the First and Second Field Ecology Symposia: held at King Mongkut's University of Technology, Thonburi, during 28–30 January 2005 (Forest Ecology and Restoration: (four papers), and 25-28 January 2007 (Biodiversity Management: eight papers) respectively.

G. Gale taught a one-day workshop on Distance Sampling at Kasetsart University, 26 March 2005 to members of the Department of National Parks, Wildlife and Plants Conservation, Wildlife Conservation Society, Mahidol University, and others. Data collected during the project was also used in lectures for SCBI396 Ornithology Course Unit, taught to undergraduates at Mahidol University Sai Yoke Campus, Kanchanaburi during 2004 -2006.

Other outputs

Digital images of birds in the hand have been given to Khao Yai National Park, to the Khao Yai Training Center and to the Wildlife Research Division, Department of National Parks, Wildlife and Plants Conservation.

Staff of the Khao Yai National Park participated in bird-ringing activities carried out by the project.

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Table 1. List of bird species recorded on the Mo-Singto Study Plot.
Sequence, taxonomy and nomenclature follows Round (2000) except where marked *. R resident/presumed resident; B wet-season breeding visitor; N non-breeding (winter) visitor; P Passage migrant.

Species	Thai name	Status
Scaly-breasted Partridge *Arborophila chloropus*	นกกระทาดงแข้งเขียว,	R
Red Junglefowl *Gallus gallus*	ไก่ป่า	R
Silver Pheasant *Lophura nycthemera*	ไก่ฟ้าหลังขาว	R
Siamese Fireback *Lophura diardi*	ไก่ฟ้าพญาลอ	R
Rufous Woodpecker *Celeus brachyurus*	นกหัวขวานสีตาล	R
Greater Yellownape *Picus flavinucha*	นกหัวขวานใหญ่หงอนเหลือง	R
Laced Woodpecker *Picus vittatus*	นกหัวขวานเขียวป่าไผ่	R
Greater Flameback *Chrysocolaptes lucidus*	นกหัวขวานสี่นิ้วหลังทอง	R
Black-and-buff Woodpecker *Meiglyptes jugularis*	นกหัวขวานด่างท้องดำ	R
Heart-spotted Woodpecker *Hemicircus canente*	นกหัวขวานแคระจุดรูปหัวใจ	R
Great Slaty Woodpecker *Mulleripicus pulverulentus*	นกหัวขวานใหญ่สีเทา	R
Green-eared Barbet *Megalaima faiostricta*	นกโพระดกหูเขียว	R
Moustached Barbet *Megalaima incognita*	นกโพระดกคอสีฟ้าเคราดำ	R
Blue-eared Barbet *Megalaima australis*	นกโพระดกหน้าผากดำ	R
Oriental Pied Hornbill *Anthracoceros albirostris*	นกแก๊ก, นกแกง	R
Great Hornbill *Buceros bicornis*	นกกก, นกกาฮัง	R
Brown Hornbill *Anorrhinus tickelli*	นกเงือกสีน้ำตาลคอขาว	R
Wreathed Hornbill *Aceros undulatus*	นกเงือกกรามช้าง	R
Orange-breasted Trogon *Harpactes oreskios*	นกขุนแผนอกสีส้ม	R
Red-headed Trogon *Harpactes erythrocephalus*	นกขุนแผนหัวแดง	R
Dollarbird *Eurystomus orientalis*	นกตะขาบดง	R
Blue-eared Kingfisher *Alcedo meninting*	นกกะเต็นน้อยหลังสีน้ำเงิน	R
Black-backed Kingfisher *Ceyx (e.) erithacus*	นกกะเต็นน้อยหลังดำ	N
Banded Kingfisher *Lacedo pulchella*	นกกะเต็นลาย	R
Blue-bearded Bee-eater *Nyctyornis athertoni*	นกจาบคาเคราน้ำเงิน	R
Chestnut headed Bee-eater *Merops leschenaultia*	นกจาบคาหัวสีส้ม	R
Chestnut-winged Cuckoo *Clamator coromandus*	นกคัคคูหงอน	P
Large Hawk Cuckoo *Hierococcyx sparverioides*	นกคัคคูเหยี่ยวใหญ่	N
Hodgson's Hawk Cuckoo *Hierococcyx fugax*	นกคัคคูเหยี่ยวอกแดง	R
Indian Cuckoo *Cuculus micropterus*	นกคัคคูพันธุ์อินเดีย	R
Banded Bay Cuckoo *Cacomantis sonneratii*	นกคัคคูลาย	R
Drongo Cuckoo *Surniculus lugubris*	นกคัคคูแซงแซว	R
Asian Koel *Eudynamys scolopacea*	นกกาเหว่า	R

Species	Thai name	Status
Green-billed Malkoha *Phaenicophaeus tristis*	นกบั้งรอกใหญ่	R
Coral-billed Ground Cuckoo *Carpococcyx renauldi*	**นกโกโรโกโส**	R
Greater Coucal *Centropus sinensis*	นกกระปูดใหญ่	R
Vernal Hanging Parrot *Loriculus vernalis*	นกหกเล็กปากแดง	R
Brown-backed Needletail *Hirundapus giganteus*	นกแอ่นใหญ่หัวตาขาว	R
Asian Palm Swift *Cypsiurus balasiensis*	นกแอ่นตาล	R
Oriental Bay Owl *Phodilus badius*	นกแสกแดง	R
Mountain Scops Owl *Otus spilocephalus*	นกเค้าภูเขา	R
Collared Scops Owl *Otus bakkamoena*	นกฮูก, นกเค้ากู่	R
Spot-bellied Eagle Owl *Bubo nipalensis*	**นกเค้าใหญ่พันธุ์เนปาล**	R
Collared Owlet *Glaucidium brodiei*	นกเค้าแคระ	R
Asian Barred Owlet *Glaucidium cuculoides*	นกเค้าโมง, นกเค้าแมว	R
Brown Boobook *Ninox scutulata*	นกเค้าเหยี่ยว	R
Great Eared Nightjar *Eurostopodus macrotis*	นกตบยุงยักษ์	R
Spotted Dove *Streptopelia chinensis*	นกเขาใหญ่, นกเขาหลวง	R
Barred Cuckoo Dove *Macropygia unchall*	นกเขาลายใหญ่	R
Emerald Dove *Chalcophaps indica*	นกเขาเขียว	R
Thick-billed Pigeon *Treron curvirostra*	นกเขาเปล้า	R
Mountain Imperial Pigeon *Ducula badia*	นกมูม	R
Eurasian Woodcock *Scolopax rusticola*	นกปากซ่อมดง	N
Jerdon's Baza *Aviceda jerdoni*	**เหยี่ยวกิ้งก่าสีน้ำตาล**	B
Black Baza *Aviceda leuphotes*	เหยี่ยวกิ้งก่าสีดำ	N
Oriental Honey-buzzard *Pernis ptilorhyncus*	เหยี่ยวผึ้ง	N, R
Crested Serpent Eagle *Spilornis cheela*	เหยี่ยวรุ้ง	R
Crested Goshawk *Accipiter trivirgatus*	เหยี่ยวนกเขาหงอน	R
Shikra *Accipiter badius*	เหยี่ยวนกเขาชิครา	R
Besra *Accipiter virgatus*	เหยี่ยวนกกระจอกเล็ก	R
Mountain Hawk Eagle *Spizaetus nipalensis*	**เหยี่ยวภูเขา**	R
Chinese Pond Heron *Ardeola bacchus*	นกยางกรอกพันธุ์จีน	N
Malayan Night Heron *Gorsachius melanolophus*	**นกยางลายเสือ**	R
Eared Pitta *Pitta phayrei*	นกแต้วแล้วหูยาว	R
Blue Pitta *Pitta cyanea*	นกแต้วแล้วสีน้ำเงิน	R
Hooded Pitta *Pitta sordida*	นกแต้วแล้วอกเขียว	B
Dusky Broadbill *Corydon sumatranus*	นกพญาปากกว้างสีดำ	R
Banded Broadbill *Eurylaimus javanicus*	นกพญาปากกว้างลายเหลือง	R
Silver-breasted Broadbill *Serilophus lunatus*	นกพญาปากกว้างอกสีเงิน	R

Species	Thai name	Status
Long-tailed Broadbill *Psarisomus dalhousiae*	นกพญาปากกว้างหางยาว	R
Asian Fairy Bluebird *Irena puella*	นกเขียวคราม	R
Blue-winged Leafbird *Chloropsis cochinchinensis*	นกเขียวก้านตองปีกสีฟ้า	R
Grey-backed Shrike *Lanius tephronotus*	นกอีเสือหลังเทา	N
Green Magpie *Cissa chinensis*	นกสาลิกาเขียว	R
Racket-tailed Treepie *Crypsirina temia*	นกกาแวน	R
Large-billed Crow *Corvus macrorhynchos*	อีกา	R
Black-naped Oriole *Oriolus chinensis*	นกขมิ้นท้ายทอยดำ	N
Silver Oriole *Oriolus mellianus*	นกขมิ้นขาว	N
Black-winged Cuckooshrike *Coracina melaschistos*	นกเฉี่ยวปุ้งใหญ่	N
Rosy Minivet *Pericrocotus roseus*	นกพญาไฟสีกุหลาบ	N
Brown-rumped Minivet *Pericrocotus cantonensis*	**นกพญาไฟตะโพกสีน้ำตาล**	N
Scarlet Minivet *Pericrocotus flammeus*	นกพญาไฟใหญ่	R
Bar-winged Flycatcher-shrike *Hemipus picatus*	นกเขนน้อยปีกแถบขาว	R
Ashy Drongo *Dicrurus leucophaeus*	นกแซงแซวสีเทา	N
Bronzed Drongo *Dicrurus aeneus*	นกแซงแซวเล็กเหลือบ	R
Lesser Racket-tailed Drongo *Dicrurus remifer*	นกแซงแซวหางบ่วงเล็ก	N
Hair-crested Drongo *Dicrurus hottentottus*	นกแซงแซวหงอนขน	N
Greater Racket-tailed Drongo *Dicrurus paradiseus*	นกแซงแซวหางบ่วงใหญ่	R
Black-naped Monarch *Hypothymis azurea*	นกจับแมลงจุกดำ	R
Asian Paradise-flycatcher *Terpsiphone paradisi*	นกแซวสวรรค์	R,N
Japanese Paradise-flycatcher *Terpsiphone atrocaudata*	**นกแซวสวรรค์หางดำ**	P
Common Iora *Aegithina tiphia*	นกขมิ้นน้อยธรรมดา	R
Great Iora *Aegithina lafresnayei*	นกขมิ้นน้อยปีกสีเรียบ	R
Large Woodshrike *Tephrodornis gularis*	นกเฉี่ยวดงหางสีน้ำตาล	R
White-throated Rock Thrush *Monticola gularis*	นกกระเบื้องคอขาว	N
Blue Whistling Thrush *Myophonus caeruleus*	นกเอี้ยงถ้ำ	R,N
Orange-headed Thrush *Zoothera citrine*	นกเดินดงหัวสีส้ม	N
Siberian Thrush *Zoothera sibirica*	นกเดินดงสีเทาดำ	P
Scaly Thrush *Zoothera dauma*	นกเดินดงลายเสือ	N
Grey-sided Thrush *Turdus feae*	นกเดินดงอกเทา	N
Eyebrowed Thrush *Turdus obscurus*	นกเดินดงสีคล้ำ	N
Dark-sided Flycatcher *Muscicapa sibirica*	นกจับแมลงสีคล้ำ	N
Asian Brown Flycatcher *Muscicapa dauurica*	นกจับแมลงสีน้ำตาล	N
Mugimaki Flycatcher *Ficedula mugimaki*	นกจับแมลงคำอกสีส้ม	N
Verditer Flycatcher *Eumyias thalassina*	นกจับแมลงสีฟ้า	N

Species	Thai name	Status
Hainan Blue Flycatcher *Cyornis hainanus*	นกจับแมลงอกสีฟ้า	R
Hill Blue Flycatcher *Cyornis banyumas*	นกจับแมลงคอน้ำตาลแดง	R
Grey-headed Flycatcher *Culicicapa ceylonensis*	นกจับแมลงหัวเทา	N
Siberian Blue Robin *Luscinia cyane*	นกเขนน้อยไซบีเรีย	N
White-rumped Shama *Copsychus malabaricus*	นกกางเขนดง	R
Slaty-backed Forktail *Enicurus schistaceus*	นกกางเขนน้ำหลังเทา	R
White-crowned Forktail *Enicurus leschenaulti*	นกกางเขนน้ำหัวขาว	R
Hill Myna *Gracula religiosa*	นกขุนทอง	R
Velvet fronted Nuthatch *Sitta frontalis*	นกไต่ไม้หน้าผากกำมะหยี่	R
Sultan Tit *Melanochlora sultanea*	นกติ๊ดสุลต่าน	R
Barn Swallow *Hirundo rustica*	นกนางแอ่นบ้าน	N
Red-rumped Swallow *Hirundo daurica*	นกนางแอ่นตะโพกแดง	N
Asian House Martin *Delichon dasypus*	นกนางแอ่นมาตินพันธุ์เอเชียใต้	N
Black-headed Bulbul *Pycnonotus atriceps*	นกปรอดทอง	R
Black-crested Bulbul *Pycnonotus melanicterus*	นกปรอดเหลืองหัวจุก	R
Stripe-throated Bulbul *Pycnonotus finlaysoni*	นกปรอดคอลาย	R
Puff-throated Bulbul *Alophoixus pallidus*	นกปรอดโอ่งเมืองเหนือ	R
Grey-eyed Bulbul *Iole propinqua*	นกปรอดเล็กตาขาว	R
Ashy Bulbul *Hemixos flavala*	นกปรอดสีขี้เถ้า	R
Chestnut-flanked White-eye *Zosterops erythropleurus*	นกแว่นตาขาวข้างแดง	N
Everett's White-eye *Zosterops everetti*	นกแว่นตาขาวหลังเขียว	R
Asian Stubtail *Urosphena squameiceps*	นกแว่นตาขาวสีเหลืองปักษ์ใต้	N
Common Tailorbird *Orthotomus sutorius*	นกกระจิบธรรมดา	R
Dark-necked Tailorbird *Orthotomus atrogularis*	นกกระจิบคอดำ	R
Radde's Warbler *Phylloscopus schwarzi*	นกกระจิ๊ดปากหนา	N
Yellow-browed Warbler *Phylloscopus inornatus*	นกกระจิ๊ดธรรมดา	N
Arctic Warbler *Phylloscopus borealis*	นกกระจิ๊ดขั้วโลกเหนือ	N,P
Two-barred Warbler *Phylloscopus plumbeitarsus*	นกกระจิ๊ดเขียวปีกสองแถบ	N
Pale-legged Leaf Warbler *Phylloscopus tenellipes*	นกกระจิ๊ดขาสีเนื้อ	N
Eastern Crowned Warbler *Phylloscopus coronatus*	นกกระจิ๊ดหัวมงกุฎ	N,P
Blyth's Leaf Warbler *Phylloscopus reguloides*	นกกระจิ๊ดหางขาวใหญ่	N
Sulphur-breasted Warbler *Phylloscopus ricketti*	นกกระจิ๊ดคิ้วดำท้องเหลือง	N
Omei Spectacled Warbler *Seicercus omeiensis* *	นกกระจ้อยวงตาสีทอง	N
Plain-tailed Warbler *Seicercus soror*	นกกระจ้อยวงตาสีทอง	N
White-crested Laughingthrush *Garrulax leucolophus*	นกกะรางหัวหงอก	R
Lesser Necklaced Laughingthrush *Garrulax monileger*	นกกะรางสร้อยคอเล็ก	R

Species	Thai name	Status
Black-throated Laughingthrush *Garrulax chinensis*	นกกะรางคอดำ, นกซอสู้	R
Abbott's Babbler *Malacocincla abbotti*	นกกินแมลงป่าฝน	R
Puff-throated Babbler *Pellorneum ruficeps*	นกจาบดินอกลาย	R
Scaly-crowned Babbler *Malacopteron cinereum*	นกกินแมลงหัวแดงเล็ก	R
Large Scimitar Babbler *Pomatorhinus hypoleucos*	นกระวังไพรปากยาว	R
White-browed Scimitar Babbler *Pomatorhinus schisticeps*	นกระวังไพรปากเหลือง	R
Striped Tit Babbler *Macronous gularis*	นกกินแมลงอกเหลือง	R
White-bellied Yuhina *Yuhina zantholeuca*	นกภูหงอนท้องขาว	R
Thick-billed Flowerpecker *Dicaeum agile*	นกกาฝากปากหนา	R
Yellow-vented Flowerpecker *Dicaeum chrysorrheum*	นกกาฝากก้นเหลือง	R
Buff-bellied Flowerpecker *Dicaeum i. cambodianum*	นกกาฝากอกสีเนื้อ	R
Ruby-cheeked Sunbird *Anthreptes singalensis*	นกกินปลีแก้มสีทับทิม	R
Olive-backed Sunbird *Nectarinia jugularis*	นกกินปลีอกเหลือง	R
Black-throated Sunbird *Aethopyga saturata*	นกกินปลีหางยาวคอดำ	R
Little Spiderhunter *Arachnothera longirostra*	นกปลีกล้วยเล็ก	R
Pin-tailed Parrotfinch *Erythrura prasina*	นกกระติ๊ดเขียว, นกไผ่	R
White-rumped Munia *Lonchura striata*	นกกระติ๊ดตะโพกขาว	R
Common Rosefinch *Carpodacus erythrinus*	นกจาบปีกอ่อนสีกุหลาบ	N

Table 2. Density estimates, 95% confidence intervals (CI) and coefficient of variation (CV) of the estimates, probability of detection (P), and effective strip width (ESW) of selected species with more than 40 observations (with the exception of the Puff-throated Bulbul) on the Mo-singto Plot based on line transect distance sampling. Probability of detection depends on the shape of the detection function. (If the shape of the detection function is uniform for example, the probability of detection will be close to 1.0.) The effective strip-width is the perpendicular distance from transects in which 50% of the birds are detected. For example, 50% of the Puff-throated Bulbuls were detected within 42 m of transects.

Species	No. observations	Density (individuals/ha)	Lower 95% CI	Upper 95% CI	CV(%)	P	ESW (meters)
Puff-throated Babbler	26	0.056	0.016	0.193	44.5	0.69	55
Blue Pitta	44	0.083	0.031	0.22	34.6	0.70	56
Blue-eared Barbet	76	0.151	0.103	0.222	16.4	0.65	52
Ashy Bulbul	56	0.211	0.104	0.432	27.5	0.75	45
Abbott's Babbler	117	0.397	0.173	0.912	28.3	0.67	40
White-rumped Shama	124	0.418	0.173	1.01	30.0	0.76	30
Black-throated Sunbird	97	0.424	0.224	0.803	23.8	0.64	25
Black-naped Monarch	120	0.509	0.358	0.722	13.7	0.72	29
Buff-bellied Flowerpecker	166	0.591	0.399	0.875	14.2	0.77	31
White-eye sp.*	47	0.622	0.388	0.998	19.5	1.00	40
Drongo sp.*	200	0.639	0.511	0.799	10.0	0.54	43
White-browed Scimitar Babbler	95	0.641	0.313	1.311	37.0	0.30	24
Oriental Pied Hornbill	136	0.800	0.558	1.145	16.5	0.49	39
Asian Fairy Bluebird	316	0.896	0.652	1.232	11.6	0.71	43
White-bellied Yuhina	163	1.079	0.823	1.416	11.8	0.69	28
Dark-necked Tailorbird	364	1.254	1.046	1.503	7.1	0.66	40
Hill Blue Flycatcher	376	1.328	1.064	1.656	8.5	0.74	30
Striped Tit Babbler	341	2.134	1.732	2.628	8.7	0.76	30
Puff-throated Bulbul	536	4.044	3.43	4.768	6.5	0.70	42

*White-eyes include: Everett's White-eye and Chestnut-flanked White-eye
* Drongos include: Greater Racket-tailed, Lesser-Racket-tailed, Hair-crested, and unidentified drongos)

Table 3. Number of territories and their size for some predominantly insectivorous birds on the Mo-singto plot in 2004.

Species	No. territories on the plot	Territory area (ha)	
		Range	Average
White-bellied Yuhina	15.40	0.97–1.91	1.38
Hill Blue Flycatcher	24.14	0.55–1.05	0.76
White-browed Scimitar Babbler	7.33	1.16–2.60	2.00
Black-naped Monarch*	8.73	1.49-3.09**	2.29
Abbott's Babbler	12.75	1.11–2.04	1.75
White-rumped Shama	7.25	1.59–3.10	2.47
Puff-throated Bulbul***	~26	0.73-4.86	1.80
Black-throated Laughingthrush	1.33	7.23	7.23

*Data from 2003-2005; ** Standard error; *** Data from 2006 (territory structure is complex and difficult to define)

Table 4. Eight species for which highly accurate estimates of density were possible, their foraging strata, diet guild, and social grouping. *ABB, YUH, WSB do occasionally eat fruit, but the proportion in the diet is relatively small

Species (abbreviation)	*Foraging strata*	*Diet**	*Social grouping*
Puff-throated Bulbul (PBU)	Sub-canopy/	Frugivore/insectivore	Groups (2-7 birds) year-round
Alophoixus pallidus	understorey		
Hill blue Flycatcher (HFY)	Understorey	Insectivore	"Loose" year-round pairs
Pellorneum ruficeps			
White-bellied Yuhina (YUH)	Sub-canopy	Insectivore	Pairs, small family groups (3 birds) or mixed flocks
Yuhina zantholeuca			
Black-napped Monarch (MON)	Sub-canopy	Insectivore	Year-round pairs or mixed flocks
Hypothymis azurea			
White-rumped Shama (WSH)	Understorey	Insectivore	Solitary, except for short periods in the breeding season
Copsychus malabaricus,			
Puff-throated Babbler (PTB)	Ground	Insectivore	"Tight" pairs year-round
Pellorneum ruficeps			
Abbott's Babbler (ABB)	Understorey	Insectivore	"Tight" pairs year-round
Malacocincla abbotti			
White-browed Scimitar Babbler (WSB)	Understorey	Insectivore	Pairs, small family groups (3 birds) or mixed flocks
Pomatorhinus schisticeps			

Table 5. Density estimates (individuals / ha) obtained from distance sampling (line and point transects) compared to intensive mapping of colour-marked birds. (n = number of observations, SE = standard error, 95% CI = 95% confidence interval around the estimate)

Species	Density Line transects (n, SE, 95% CI)	Density Point transects (n, SE, 95% CI)	Density Intensive mapping
Puff-throated Babbler	0.056 (26, 0.025, 0.016-0.193)	0.035 (26, 0.010, 0.020-0.062)	0.270
White-browed Scimitar Babbler	0.641 (95, 0.237, 0.313-1.311)	0.109 (69, 0.026, 0.066-0.179)	0.400
White-rumped Shama	0.418 (124, 0.125, 0.173-1.010)	0.579 (92, 0.111, 0.392-0.855)	0.467
Black-naped Monarch	0.509 (120, 0.070, 0.358-0.722)	0.640 (64, 0.168, 0.373-1.099)	0.610
Abbott's Babbler	0.397 (117, 0.112, 0.173-0.912)	0.450 (136, 0.099, 0.289-0.700)	0.806
White-bellied Yuhina	1.079 (163, 0.128, 0.823-1.416)	1.339 (98, 0.265, 0.892-2.009)	1.078
Hill Blue Flycatcher	1.328 (376, 0.112, 1.064-1.656)	1.139 (179, 0.127, 0.912-1.423)	1.785
Puff-throated Bulbul	4.079 (535, 0.266, 3.461-4.809)	4.815 (399, 0.380, 4.121-5.627)	3.430

Table 6. Success rates of nests found on the plot 2003-2006.

Species	Year	Fail as chicks	Fail as eggs	Not known to be active	Fledge at least 1 yg	Unknown outcome	Total	Known outcome	Observed % Success	Mayfield Success
Black-naped Monarch *Hypothymis azurea*	2003	1	1	8	2		12	4	50	
Abbott's Babbler *Malacocincla abbotti*	2003	6	1	2	10	3	22	17	58.8	
Asian Fairy Bluebird *Irena puella*	2003		1			1	2	1	0	
Banded Broadbill *Eurylaimus javanicus*	2003					1	1	0	-	
Blue-eared Barbet *Megalaima australis*	2003					1	1	0	-	
Blue Pitta *Pitta cyanea*	2003		1				1	1	0	
Greater Yellownape *Picus flavinucha*	2003			1			1	0	-	
Long-tailed Broadbill *Psarisomus dalhousiae*	2003			2			2	0	-	
Orange-breasted Trogon *Harpactes oreskios*	2003			1		1	2	0	-	
Puff-throated Bulbul *Alophoixus pallidus*	2003	2	1	3	1		7	4	25	
Silver-breasted Broadbill *Serilophus lunatus*	2003	1	3	1			5	4	0	
Striped Tit Babbler *Macronous gularis*	2003		1	1			2	1	0	
Thick-billed Pigeon *Treron curvirostra*	2003			1		1	2	0	-	
White-crested Laughingthrush *Garrulax leucolophus*	2003		1				1	1	0	
White-rumped Shama *Copsychus malabaricus*	2003				1		1	1	100	
White-bellied Yuhina *Yuhina zantholeuca*	2003		1				1	1	0	
Total	**2003**	**10**	**11**	**20**	**14**	**8**	**63**	**35**	**40**	

Species	Year	Fail as chicks	Fail as eggs	Not known to be active	Fledge at least 1 yg	Unknown outcome	Total	Known outcome	Observed % Success	Mayfield Success
Laced Woodpecker *Picus vittatus*	2004			1			1	0	-	
Black-and-buff Woodpecker *Meiglyptes jugularis*	2004				1		1	1	100	
Green-eared Barbet *Megalaima faiostricta*	2004					2	2	0	-	
Moustached Barbet *Megalaima incognita*	2004					3	3	0	-	
Red-headed Trogon *Harpactes erythrocephalus*	2004	1	2				3	3	0	
Orange-breasted Trogon *Harpactes oreskios*	2004		1				1	1	0	
Emerald Dove *Chalcophaps indica*	2004		1		1		2	2	50	
Crested Goshawk *Accipiter trivirgatus*	2004			1			1	1	0	
Banded Broadbill *Eurylaimus javanicus*	2004					1	1	0	-	
Blue Pitta *Pitta cyanea*	2004		1	1	1		3	3	33.33	
Silver-breasted Broadbill *Serilophus lunatus*	2004		4				4	4	0	
Long-tailed Broadbill *Psarisomus dalhousiae*	2004		1			5	6	1	0	
Asian Fairy Bluebird *Irena puella*	2004	4			1		5	5	20	
Greater Racket-tailed Drongo *Dicrurus paradiseus*	2004		1				1	1	0	
Black-naped Monarch *Hypothymis azurea*	2004	3	4	4	6		17	17	35.29	
Hill Blue Flycatcher *Cyornis banyumas*	2004	2	2	2	3		9	9	33.33	
White-rumped Shama *Copsychus malabaricus*	2004	2	2	1	3	1	9	8	37.5	
White-crowned Forktail *Enicurus leschenaulti*	2004		1		1		2	2	50	
Great Iora *Aegithina lafresnayei*	2004			1			1	1	0	
Puff-throated Bulbul *Alophoixus pallidus*	2004	6	5	4	7	1	23	22	31.82	20.7 ±9.6%
White-crested Laughingthrush *Garrulax leucolophus*	2004		3				3	3	0	
Black-throated Laughingthrush *Garrulax chinensis*	2004	1	1				2	2	0	
Abbott's Babbler *Malacocincla abbotti*	2004	10	9	4	9		32	32	28.13	24.9 ± 8.5%
Puff-throated Babbler *Pellorneum ruficeps*	2004				2		2	2	100	
White-browed Scimitar Babbler *Pomatorhinus schisticeps*	2004	3			1		4	4	25	
Striped Tit Babbler *Macronous gularis*	2004			4			4		-	
White-bellied Yuhina *Yuhina zantholeuca*	2004			1	1		2	2	50	
Total	**2004**	**32**	**39**	**24**	**37**	**13**	**145**	**132**	**28.03**	

Species	Year	Fail as chicks	Fail as eggs	Not known to be active	Fledge at least 1 yg	Unknown outcome	Total	Known outcome	Observed % Success	Mayfield Success
Laced Woodpecker *Picus vittatus*	2005				1	1	2	1	100	
Black-and-buff Woodpecker *Meiglyptes jugularis*	2005			1			1	-	-	
Green-eared Barbet *Megalaima faiostricta*	2005	2		1		4	7	2	0	
Moustached Barbet *Megalaima incognita*	2005		1			4	5	1	0	
Red-headed Trogon *Harpactes erythrocephalus*	2005	2	5	2			9	7	0	
Orange-breasted Trogon *Harpactes oreskios*	2005		2				2	2	0	
Blue-bearded Bee-eater *Nyctyornis athertoni*	2005					1	1	0	0	
Barred Cuckoo Dove *Macropygia unchall*	2005				1		1	1	100	
Emerald Dove *Chalcophaps indica*	2005	1	1				2	2	0	
Mountain Imperial Pigeon *Ducula badia*	2005		1				1	1	0	
Crested Goshawk *Accipiter trivirgatus*	2005			1			1	-	-	
Blue Pitta *Pitta cyanea*	2005	1					1	1	0	
Silver-breasted Broadbill *Serilophus lunatus*	2005			1	2		3	2	100	
Long-tailed Broadbill *Psarisomus dalhousiae*	2005		1	1		4	6	1	0	
Asian Fairy Bluebird *Irena puella*	2005		3	2	2		7	5	40	
Green Magpie *Cissa chinensis*	2005				1		1	1	100	
Bronzed Drongo *Dicrurus aeneus*	2005			1			1	-	-	
Greater Racket-tailed Drongo *Dicrurus paradiseus*	2005				1		1	1	100	
Black-naped Monarch *Hypothymis azurea*	2005	7	2	4			13	9	0	
Hill Blue Flycatcher *Cyornis banyumas*	2005	1		4	3		8	4	75	
White-rumped Shama *Copsychus malabaricus*	2005	1			2		3	3	66.7	
White-crowned Forktail *Enicurus leschenaulti*	2005				1		1	1	100	
Black-crested Bulbul *Pycnonotus melanicterus*	2005	1		1			2	1	-	
Stripe-throated Bulbul *Pycnonotus finlaysoni*	2005		1		1		2	2	50	
Puff-throated Bulbul *Alophoixus pallidus*	2005	7	33	14	7	1	62	47	14.9	8.2 ± 3.8%
White-crested Laughingthrush *Garrulax leucolophus*	2005		1				1	1	0	
Black-throated Laughingthrush *Garrulax chinensis*	2005		1				1	1	0	
Laughing Thrush sp. *Garrulax sp.*	2005		1				1	1	0	
Abbott's Babbler *Malacocincla abbotti*	2005	4	10	4	5	1	24	19	26.3	11.3 ± 6.9%
Puff-throated Babbler *Pellorneum ruficeps*	2005	1		1	1		3	2	50	

Species	Year	Fail as chicks	Fail as eggs	Not known to be active	Fledge at least 1 yg	Unknown outcome	Total	Known outcome	Observed % Success	Mayfield Success
White-browed Scimitar Babbler *Pomatorhinus schisticeps*	2005		1		1		2	2	50	
Striped Tit Babbler *Macronous gularis*	2005	1	1	2			4	2	0	
White-bellied Yuhina *Yuhina zantholeuca*	2005		1	3			4	1	0	
Black-throated Sunbird *Aethopyga saturata*	2005			1	1		2	1	100	
Total	**2005**	**29**	**66**	**45**	**30**	**16**	**187**	**126**	**23.8**	
Saimese Fire back *Lophura diardi*	2006				1				100.0	
Green-eared Barbet *Megalaima faiostricta*	2006					1	1	-	-	
Moustached Barbet *Megalaima incognita*	2006					3	3	-	-	
Red-headed Trogon *Harpactes erythrocephalus*	2006	5	4	-	1	1	11	10	10.0	
Orange-breasted Trogon *Harpactes oreskios*	2006	3	-	1	1	1	6		-	
Banded Kingfisher *Lacedo pulchella*	2006				1		1	1	100.0	
Barred Cuckoo Dove *Macropygia unchall*	2006				1		1	1	100.0	
Emerald Dove *Chalcophaps indica*	2006	1	1				2	2	0.0	
Mountain Imperial Pigeon *Ducula badia*	2006		1				1	1	0.0	
Crested Goshawk *Accipiter trivirgatus*	2006				1		1	1	100.0	
Eared Pitta *Pitta phayrei*	2006		2		1		3	3	33.3	
Silver-breasted Broadbill *Serilophus lunatus*	2006		7	2			9	7	0.0	
Long-tailed Broadbill *Psarisomus dalhousiae*	2006		1	1		2	4	1	0.0	
Asian Fairy Bluebird *Irena puella*	2006		3	4	1		8	4	25.0	
Green Magpie *Cissa chinensis*	2006				1		1	1	100.0	
Bronzed Drongo *Dicrurus aeneus*	2006			1			1	0	-	
Greater Racket-tailed Drongo *Dicrurus paradiseus*	2006				1		1	1	100.0	
Black-naped Monarch *Hypothymis azurea*	2006	2	9	6	3		20	14	21.4	
Hill Blue Flycatcher *Cyornis banyumas*	2006	4	3	1	6	1	15	13	46.2	
White-rumped Shama *Copsychus malabaricus*	2006		3		1	2	6	4	25.0	
White-crowned Forktail *Enicurus leschenaulti*	2006		2		1		3	3	33.3	
Black-crested Bulbul *Pycnonotus melanicterus*	2006	1		1			2	1	0.0	
Stripe-throated Bulbul *Pycnonotus finlaysoni*	2006	1	2				3	3	0.0	
Puff-throated Bulbul *Alophoixus pallidus*	2006	19	46	18	12	12	107	77	15.6	

Species	Year	Fail as chicks	Fail as eggs	Not known to be active	Fledge at least 1 yg	Unknown outcome	Total	Known outcome	Observed % Success	Mayfield Success
White-crested Laughingthrush *Garrulax leucolophus*	2006	1	2				3	3	0.0	
Black-throated Laughingthrush *Garrulax chinensis*	2006		2			1	3	2	0.0	
Abbott's Babbler *Malacocincla abbotti*	2006	14	18	4	10	0	46	42	23.8	15.5 ±5.4%
Puff-throated Babbler *Pellorneum ruficeps*	2006		1		1		2	2	50.0	
White-browed Scimitar Babbler *Pomatorhinus schisticeps*	2006	4	2		1	1	8	7	14.3	
Striped Tit Babbler *Macronous gularis*	2006		5	3	1	1	10	6	16.7	
White-bellied Yuhina *Yuhina zantholeuca*	2006	1	4	1		2	8	5	0.0	
Little Spiderhunter *Aracnothera longirostra*	2006		2		1		3	3	33.3	
Total	**2006**	**56**	**120**	**43**	**47**	**28**	**293**	**218**	**21.6**	

Table 7. Nesting variables for Black-naped Monarch during incubation, 2003–2005

	Incubation Intensity					# Incubation bouts*					Time nest unattended	
	Male (min)	**Male (%)**	**Female (min)**	**Female (%)**	**Total (%)**	**Male (#)**	**Male (%)**	**Female (#)**	**Female (%)**	**Total (#)**	**minutes**	**%**
Average for 2003-2005 N=23, 88 hrs	22.60	37.67	27.40	45.66	83.33	1.69	48.08	1.83	51.92	3.52	8.02	13.37
Standard Deviation	6.57	10.94	6.29	10.48	12.91	0.51	8.02	0.63	8.02	1.01	7.53	12.55
Average for 2003 N=3, 11 hrs	18.74	31.24	31.93	53.22	84.46	1.80	50.00	1.80	50.00	3.60	8.82	14.70
Standard Deviation	6.57	10.94	6.29	10.48	12.91	0.51	8.02	0.63	8.02	1.01	7.53	12.55
Average for 2004 N=12, 45 hrs	24.95	41.58	26.61	44.36	85.94	1.66	49.56	1.69	50.44	3.35	6.24	10.41
Standard Deviation	7.10	11.83	6.71	11.19	13.53	0.47	6.05	0.50	6.05	0.91	7.63	12.71
Average for 2005 N=8, 32 hrs	20.53	34.21	26.87	44.78	78.99	1.70	45.16	2.04	54.84	3.74	10.40	17.33
Standard Deviation	5.08	8.46	6.47	10.79	13.51	0.66	7.96	0.79	7.96	1.31	8.17	13.61

Table 8. Number of seeds collected from faecal samples. (Three-letter bird species codes represent: Ashy Bulbul, Asian Fairy Bluebird, Buff-bellied Flowerpecker, Black-throated Laughingthrush, Everett's White-eye, Green-eared Barbet, Grey-eyed Bulbul, Great Hornbill, Black-headed Bulbul, Little Spiderhunter, Moustached Barbet, Lesser Necklaced Laughingthrush, Oriental Pied Hornbill, Orange-headed Thrush, Puff-throated Bulbul, Stripe-throated Bulbul, Silver Pheasant, Striped-tit Babbler, White-crested Laughingthrush, and White-browed Scimitar Babbler respectively.)

Seed	ABU	AFB	BFP	BLG	CBU	EWE	GBR	GBU	GHO	HBU	LSB	MBR	NLG	OHO	OHT	PBU	SBU	SPH	STB	WLG	WSB	Total
Adinandra integerrima																6						6
Aglaia elaeagnoidea																1						1
Aidia densiflora	10				859			895						130		143				2		2039
Alangium kurzii												3										3
Alocasia glata																8						8
Ampelopsis cantoniensis					2											2						4
Apodytes dimidiata					2			1														3
Aporosa octandra								2														2
Ardisia colorata	2															2						4
Beilschmiedia maingayi								1				1										2
Bridelia isulana					1			1								5						7
Caelospermum truncatum					3											5						8
Casearia grewiifolia var.gelonioides					20																	20
Celastrus approximata																6						6
Cinnamomum subavenium								2				1				4						7
Clausena excavata																1						1
Cleistocalyx operculatus		2			2																	4
Clerodendrum paniculatum																3						3
Dendrocnide stimulans																43						43
Desmos dumosus								2							1	4						7
Diploclisia glaucessens																1						1
Dissochaeta divaricata		200	1		1018			2245			1	270				4614	13		88			8450
Embelia sessilifolia								1														1
Eurya nitida	10	52			40			225		12			2			55					20	416
Ficus altissima					1		2	75				980				8		282				1348
Ficus Apr04-A																33						33
Ficus heteropeura					12											28						40
Ficus hirta					4									12								16
Ficus July04-A					10																	10
Ficus kurzii		5							390			2										397
Ficus May04-A		7																				7
Ficus May04-B		100																				100

Seed	ABU	AFB	BFP	BLG	CBU	EWE	GBR	GBU	GHO	HBU	LSB	MBR	NLG	OHO	OHT	PBU	SBU	SPH	STB	WLG	WSB	Total
Ficus May04-E		2																				2
Ficus nervosa					50							28				105						183
Ficus sagittata		2						7				51				250						310
Ficus stricta	2	179			24			606								418						1229
Ficus vasculosa		124			13			85								12						234
Ficus villosa	173				613			429				33				799						2047
Ficus virens		45														268						313
Ficus-Dec04-A																4						4
Ficus-Mar05-A								10														10
Ficus-Nov04-A																30						30
Ficus-Nov04-B																110						110
Gironniera nervosa					10											13						23
Glycosmis mauritiana	4																					4
Hypserpa nitida								4								3						7
Ilex chevalieri	28				28			9				3				24						92
Labisia pumila																1						1
Lasianthus chinensis				2												3						5
Lasianthus kurzii																6						6
Lasianthus lucidus																9						9
Lasianthus wallichii																11						11
Leea indica																1						1
Litsea monopetala	2				5	1		5														13
Lobelia angulata																2						2
Loranthaceae1			10																			10
Loranthaceae2			6																			6
Macaranga denticulata	1			2																		3
Macaranga siamensis	2				5			8													4	19
Machilus odoratissima		1			3			11														15
Melastoma malabathricum		2	2		65											1						70
Melicope pteleifolia				2	1																	3
Michelia baillonii	2	5				1																8
Mischocarpus pentapetalus					3																	3
Morinda umbellata					14			11				3		1		33						62
Phyllanthus reticulatus					1																	1
Piper retrofractum								10								5						15

Seed	ABU	AFB	BFP	BLG	CBU	EWE	GBR	GBU	GHO	HBU	LSB	MBR	NLG	OHO	OHT	PBU	SBU	SPH	STB	WLG	WSB	Total
Piper ribesoides					1			10								22						33
Poikilospermum suaveolens			6		13			5								39					9	72
Polyosma elongata																1						1
Pothos chinensis																2						2
Premna corymbosa					7			1														8
Premna flavescens					4			1														5
Prunus arborea							3															3
Pseudodissochaeta septentrionalis																653						653
Rhus rhetsoides																2						2
Rubus blepharoneurus					28			13									1					42
Sabia limoniacea	1																					1
Sarcosperma arboreum							1															1
Saurauia roxburghii			1657					2														1659
Schefflera elliptica					13		91	168							1	182						455
Schefflera heptaphylla								32								13						45
Sloanea sigun								1														1
Stephania japonica					1			1								11	5					18
Symplocos cochinchinensis	1	4			13			13			9					14						54
Syzygium syzygoides																1						1
Tetracera lourii?																1						1
Tetrastigma lanceolarium																1						1
Tetrastigma sp.2																1						1
Trema orientalis					2			3														5
unk-apr04-A								1														1
unk-Aug04-A								3														3
Unk-feb-05-A																1						1
unk-july04-C					135																	135
unk-mar03-A	1																					1
unk-sep03-B				1																		1
Viburnum sambucinum								6								10						16
Grand Total	**239**	**730**	**1682**	**7**	**3026**	**2**	**97**	**4905**	**390**	**12**	**10**	**1375**	**2**	**143**	**2**	**8044**	**19**	**282**	**88**	**2**	**33**	**21090**

Table 9. Number and order of arthropods captured during preliminary survey using sweep netting in January of 2005. (Future methods will use beating of selected plants because it tends to be less biased)

Order	Number
Diptera	153
Hymenoptera	142
Lepidoptera	11
Hemiptera	7
Orthoptera	7
Homoptera	34
Coleoptera	28
Mantoidea	5
Strepsiptera	1
Spiders	75
Ticks	42

Table 10. Number and Order of arthropods captured during preliminary surveys using light trapping in January of 2005.

Order	Number
Diptera	113
Hymenoptera	127
Lepidoptera	107
Homoptera	25
Coleoptera	170
Collembola	1
Ephemeroptera	2
Hemiptera	6
Plecoptera	1

Table 11. Number of adults (ad) and nestlings (n) ringed during the study.
(Includes a small number of individuals ringed off plot, including 9 species not otherwise recorded)

	2002		2003		2004		2005		2006 (to 31 March)		
Species	**ad**	**n**	**ad**	**n**	**ad**	**n**	**ad**	**n**	**ad**	**n**	**Total**
Silver Pheasant							1		2		3
Siamese Fireback									1		1
Laced Woodpecker			1								1
Green-eared Barbet					5		1				6
Moustached Barbet					3						3
Orange-breasted Trogon									2	5	7
Red-headed Trogon			6				4			5	15
Blue-eared Kingfisher			2		1						3
Blue-bearded Bee-eater			2				2				4
Chestnut-headed Bee-eater							1				1
Green-billed Malkoha							1				1
Mountain Scops Owl									1		1
Emerald Dove			2		2		2				6
Red-wattled Lapwing							2				2
Crested Goshawk			2								2
Eared Pitta							1		1		2
Blue Pitta			4		6	4	2				16
Hooded Pitta					1						1
Silver-breasted Broadbill			6		3		2				11
Long-tailed Broadbill					2						2
Asian Fairy Bluebird			3	2	6	2	2	2			17
Brown Shrike					2		5				7
Green Magpie			1								1
Racket-tailed Treepie							1				1
Lesser Racket-tailed Drongo			1								1
Greater Racket-tailed Drongo			2								2
Common Iora							1				1
Black-naped Monarch			7	3	15	14	6	3	1		49
Asian Paradise-flycatcher							1		1		2
Blue Whistling Thrush			1								1
White-throated Rock Thrush					2						2
Blue Rock Thrush					1						1
Orange-headed Thrush			3		3		2				8
Yellow-rumped Flycatcher					1		3				4
Red-throated Flycatcher					2		4				6
Hainan Blue Flycatcher			1		1						2
Hill Blue Flycatcher	1		24		21	9	13	5		6	79
Grey-headed Flycatcher			1				4				5
Siberian Rubythroat							3				3
Siberian Blue Robin			8		11		4				23
White-rumped Shama			19		10	2	8	10	1		50

	2002		2003		2004		2005		2006		
Species	**ad**	**n**	**ad**	**n**	**ad**	**n**	**ad**	**n**	**ad**	**n**	**Total**
Slaty-backed Forktail			2								2
White-crowned Forktail			4		1	3		3		3	14
Black-headed Bulbul			1		2		9				12
Black-crested Bulbul			48		47		82		1		178
Red-whiskered Bulbul							8				8
Stripe-throated Bulbul			3		3		10	1			17
Puff-throated Bulbul			37	2	32	16	40	22	3		152
Grey-eyed Bulbul			56		66		27		5		154
Ashy Bulbul			4		7		8				19
Everett's White-eye					2	1					3
Asian Stubtail					2				1		3
Thick-billed Warbler							1				1
Common Tailorbird					2		4				6
Dark-necked Tailorbird					2		1				3
Dusky Warbler							1				1
Radde's Warbler					1		3		1		5
Yellow-browed Warbler			1				4				5
Arctic Warbler			2		2		1				5
Two-barred Warbler			1		5		6		1		13
Pale-legged Leaf Warbler			1		3		4				8
Eastern Crowned Warbler					1		1				2
Blyth's Leaf Warbler							2				2
Sulphur-breasted Warbler					1						1
Plain-tailed Warbler	1		5				1				7
White-crested Laughingthrush			5				3				8
Lesser Necklaced Laughingthrush			1		1		4				6
Black-throated Laughingthrush			3						1		4
Abbott's Babbler	1		32	22	10	33	7	20	6	18	149
Puff-throated Babbler			5		5		4	3		3	20
Large Scimitar Babbler			5		1						6
White-browed Scimitar Babbler			3		3	5	2	3	6	11	33
Striped Tit Babbler			2		8		12				22
White-bellied Yuhina			12		20		9				41
Ruby-cheeked Sunbird					1		1				2
Olive-backed Sunbird							1				1
Black-throated Sunbird			2		1		1				4
Little Spiderhunter	1		11		6		2		1		21
Olive-backed Pipit							3				3
Total	**4**	**0**	**342**	**29**	**333**	**89**	**338**	**72**	**36**	**51**	**1294**

Figure 1. Map showing the location of the Mo-Singto Long-term Biodiversity Plot near the headquarters of Khao Yai National Park.

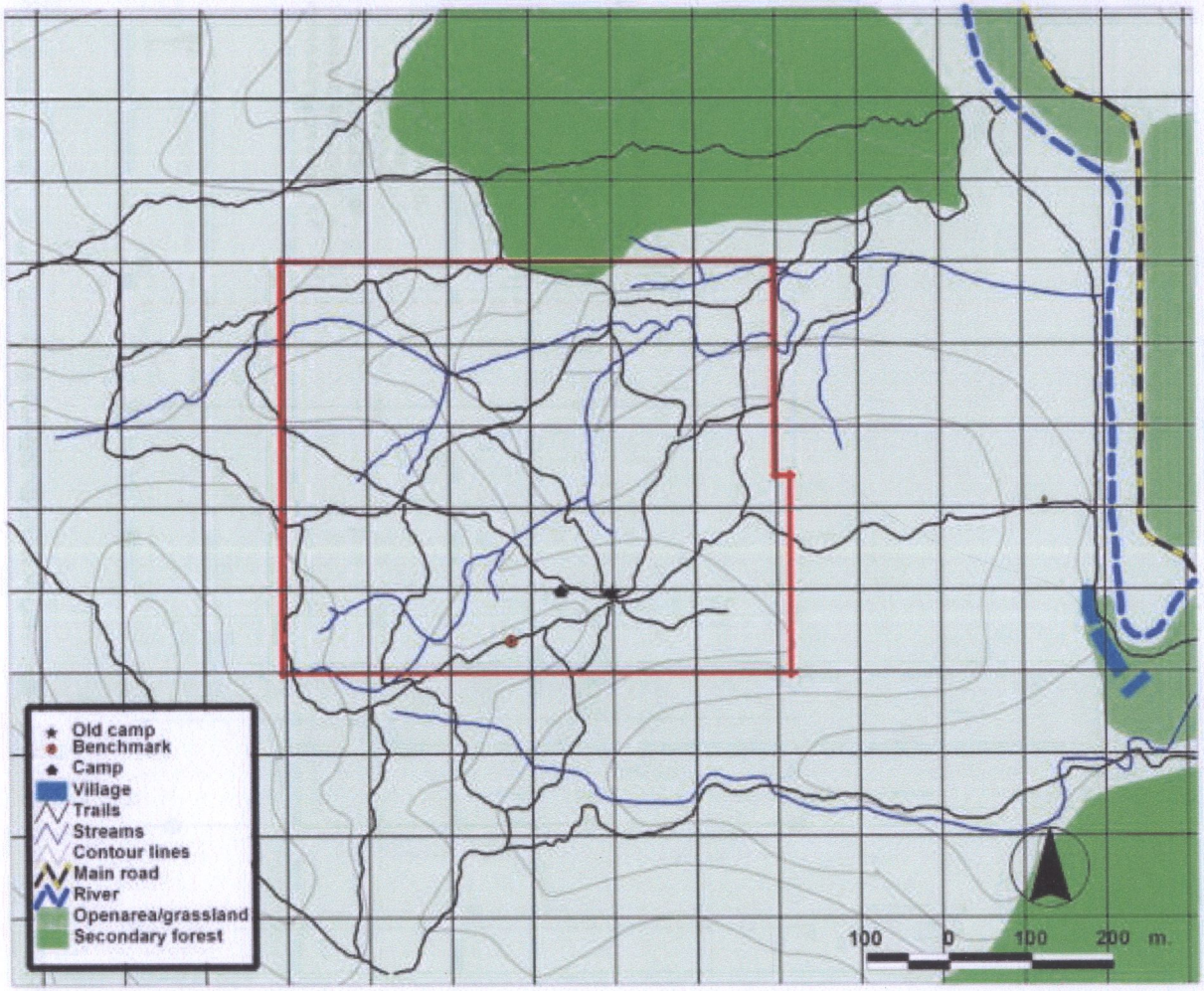


Figure 2. Positions of line and point transects on the Mo-Singto Plot

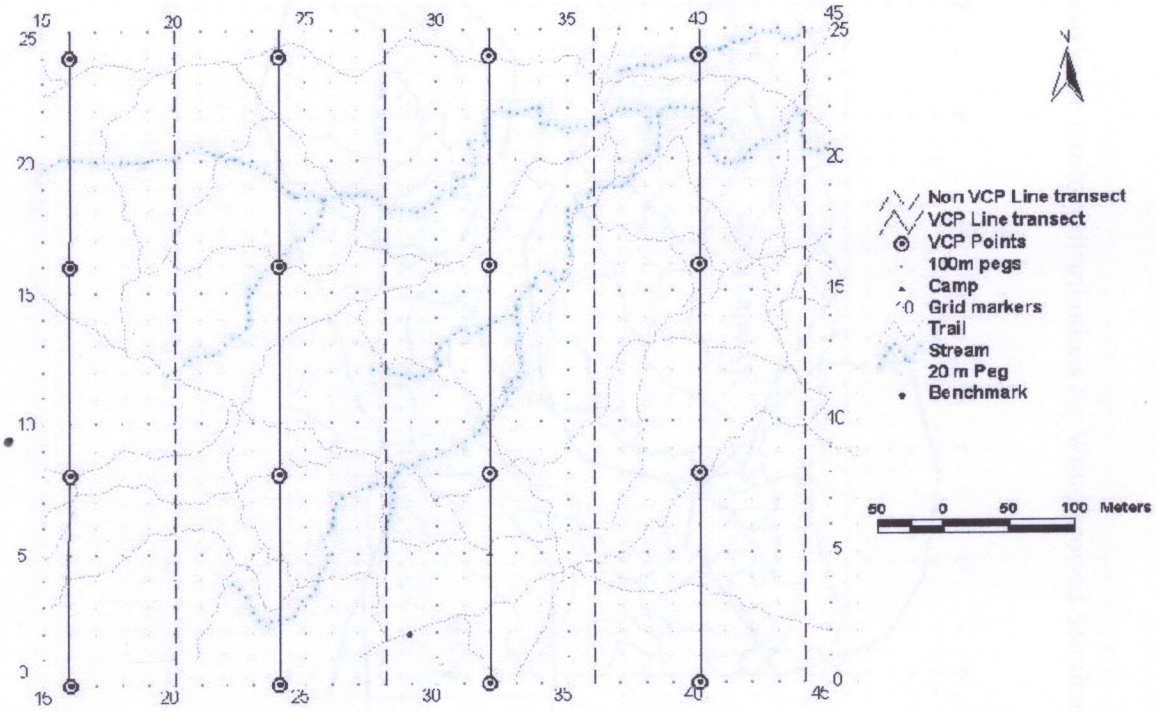


Figure 3. Approximate territory distributions for White-browed Scimitar Babbler (2004-2005)

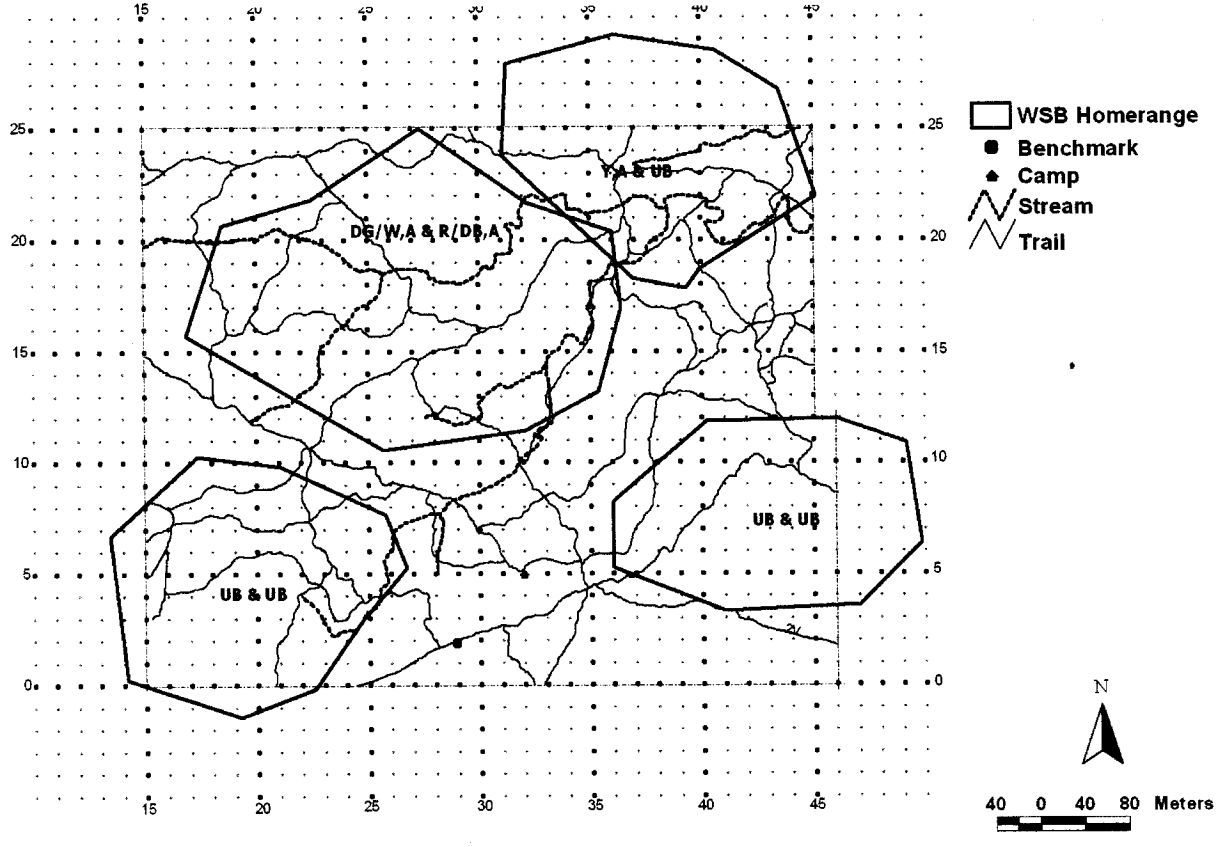


Figure 4. Approximate territory distributions for White-rumped Shama (2004-2005)

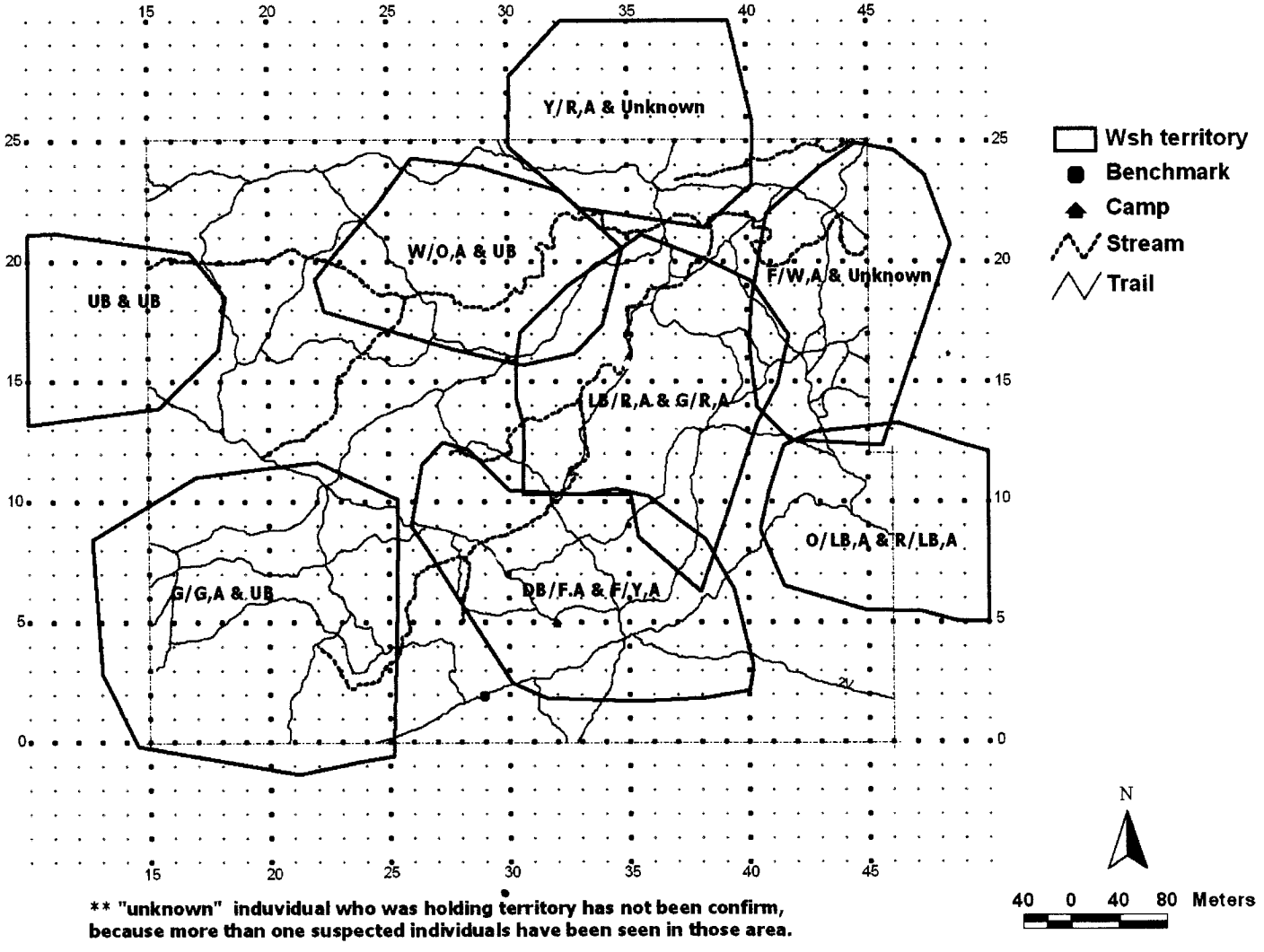


Figure 5. Approximate territory distributions for Hill Blue Flycatcher (2004-2005)

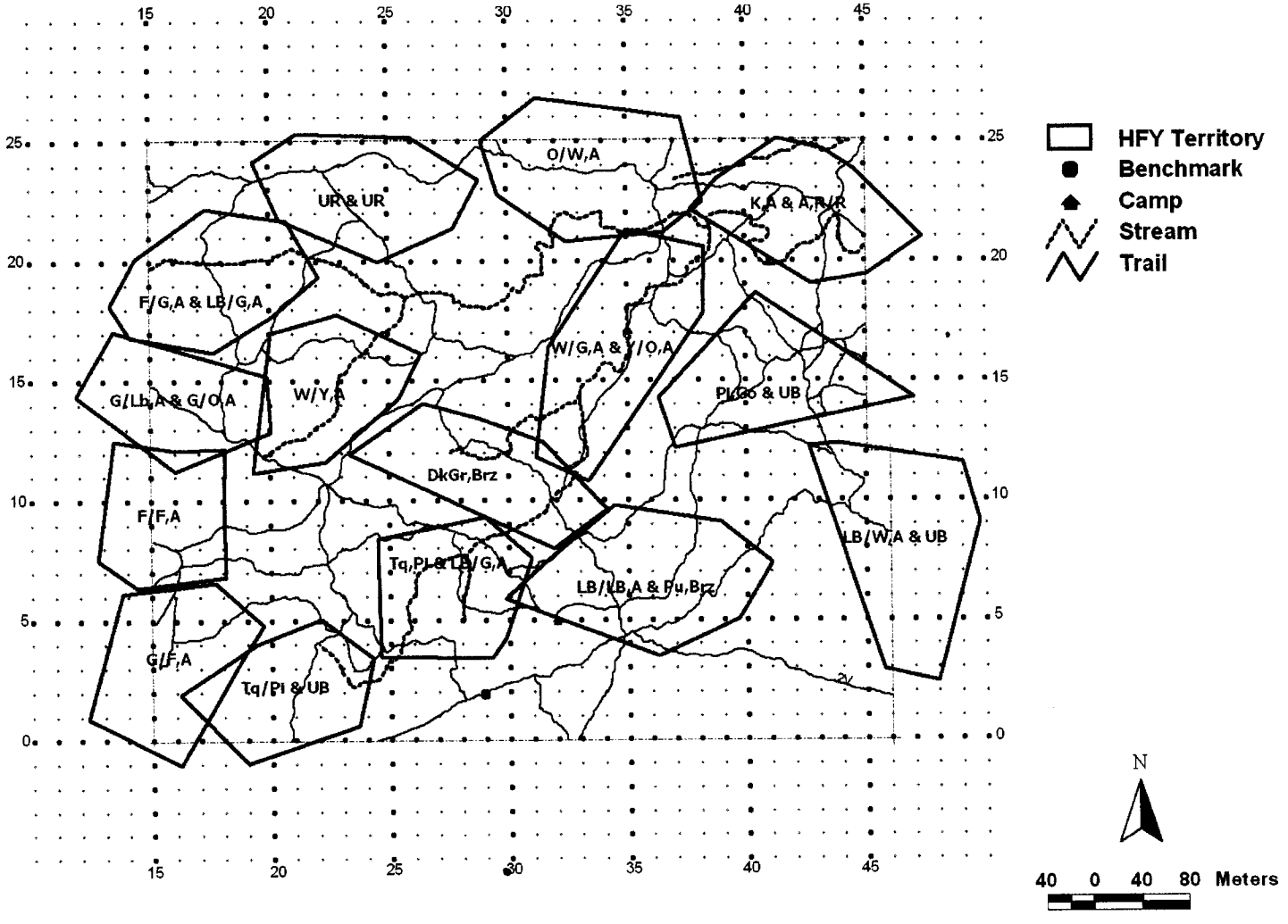


Figure 6. Approximate territory distributions for Puff-throated Babbler (2004-2005)

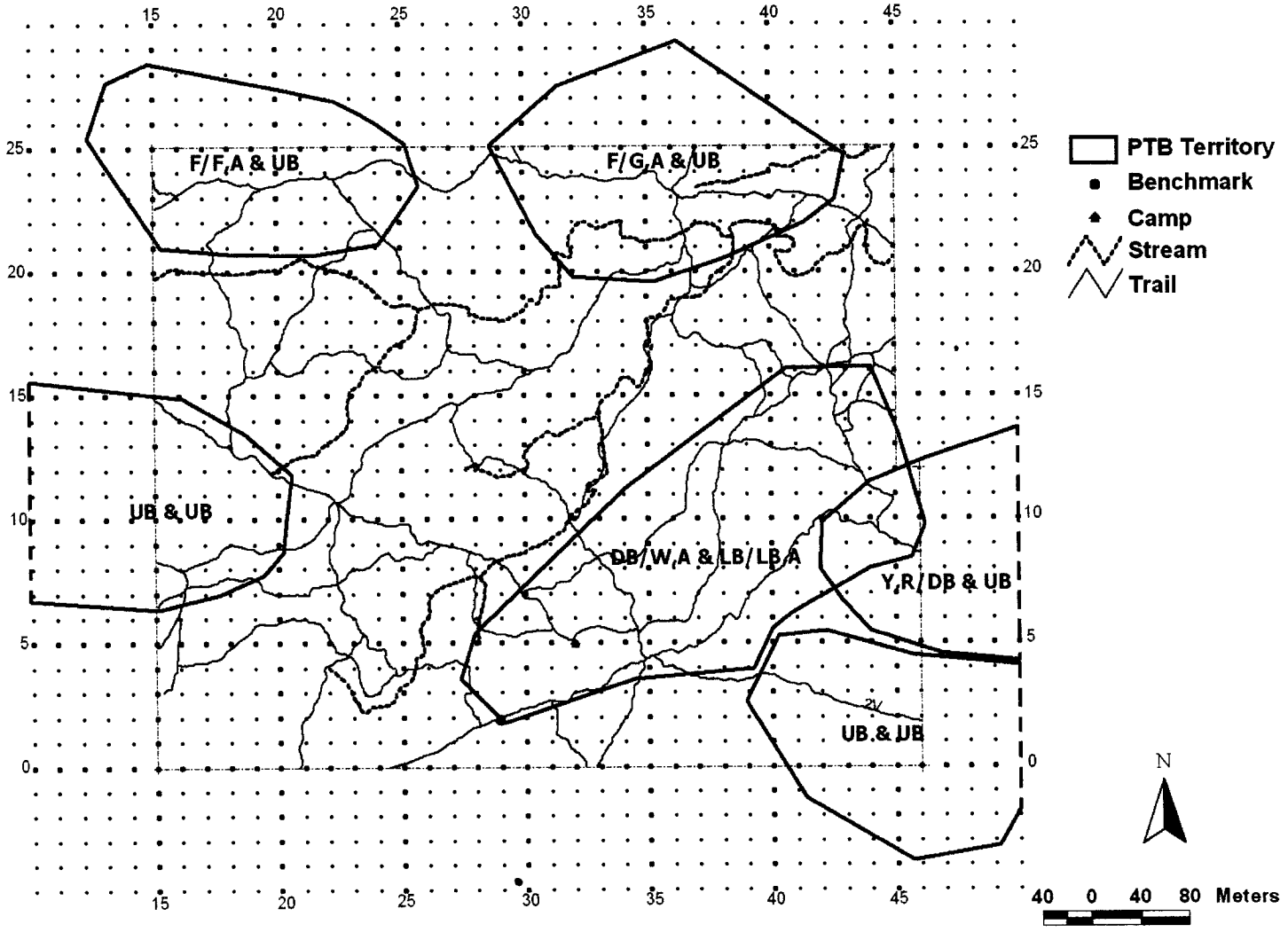


Figure 7. Approximate territory distributions for White-crowned Forktail (2004-2005)

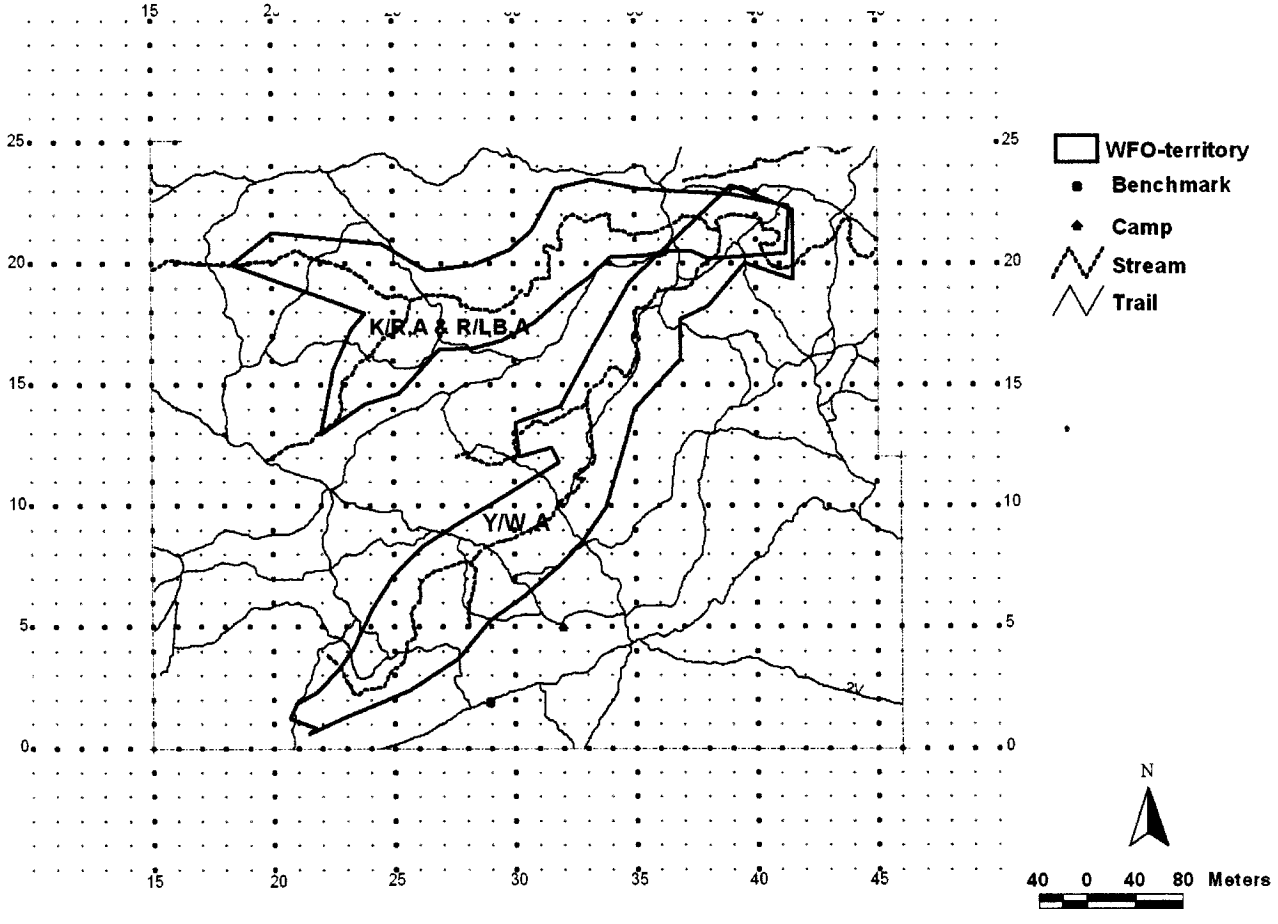


Figure 8. Approximate territory distributions for Abbott's Babbler (2006)

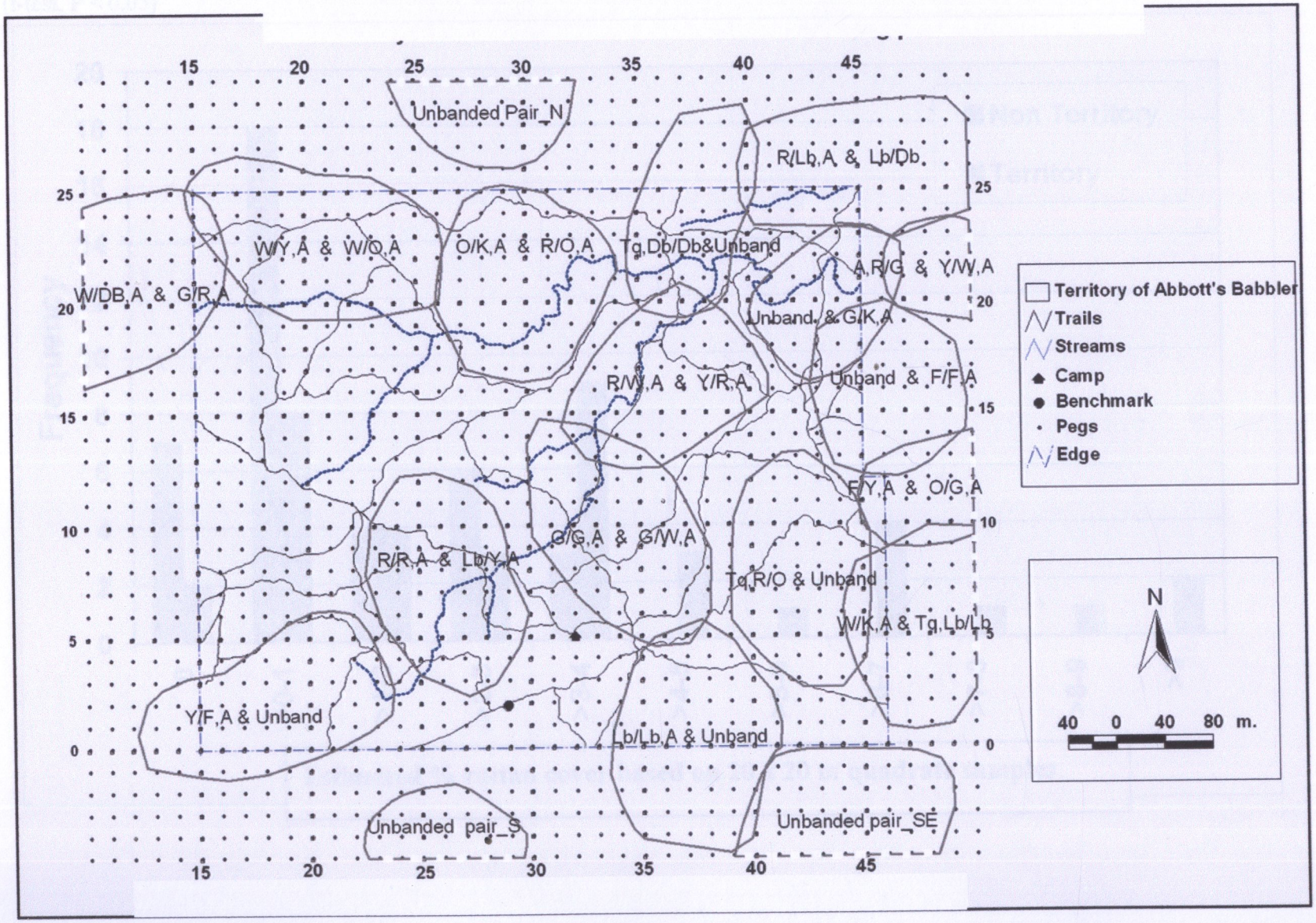


Figure 9. The percentage cover of rattans within territories and areas outside Abbott's Babbler territories. Differences are statistically significant (t-test, $P < 0.05$)

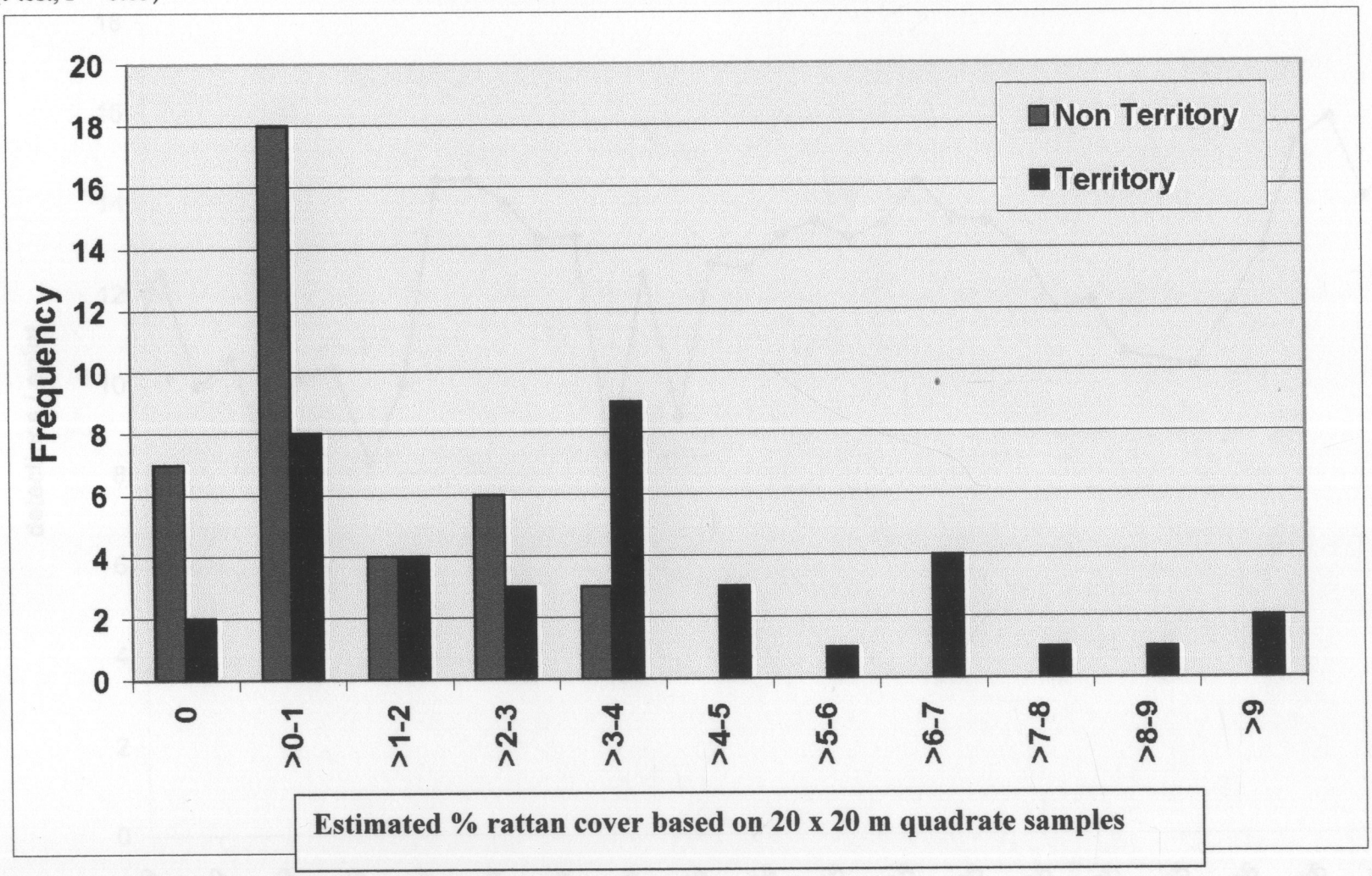


Figure 10. Average number of detections per point (May 2003-May 2006) from the point transect data.

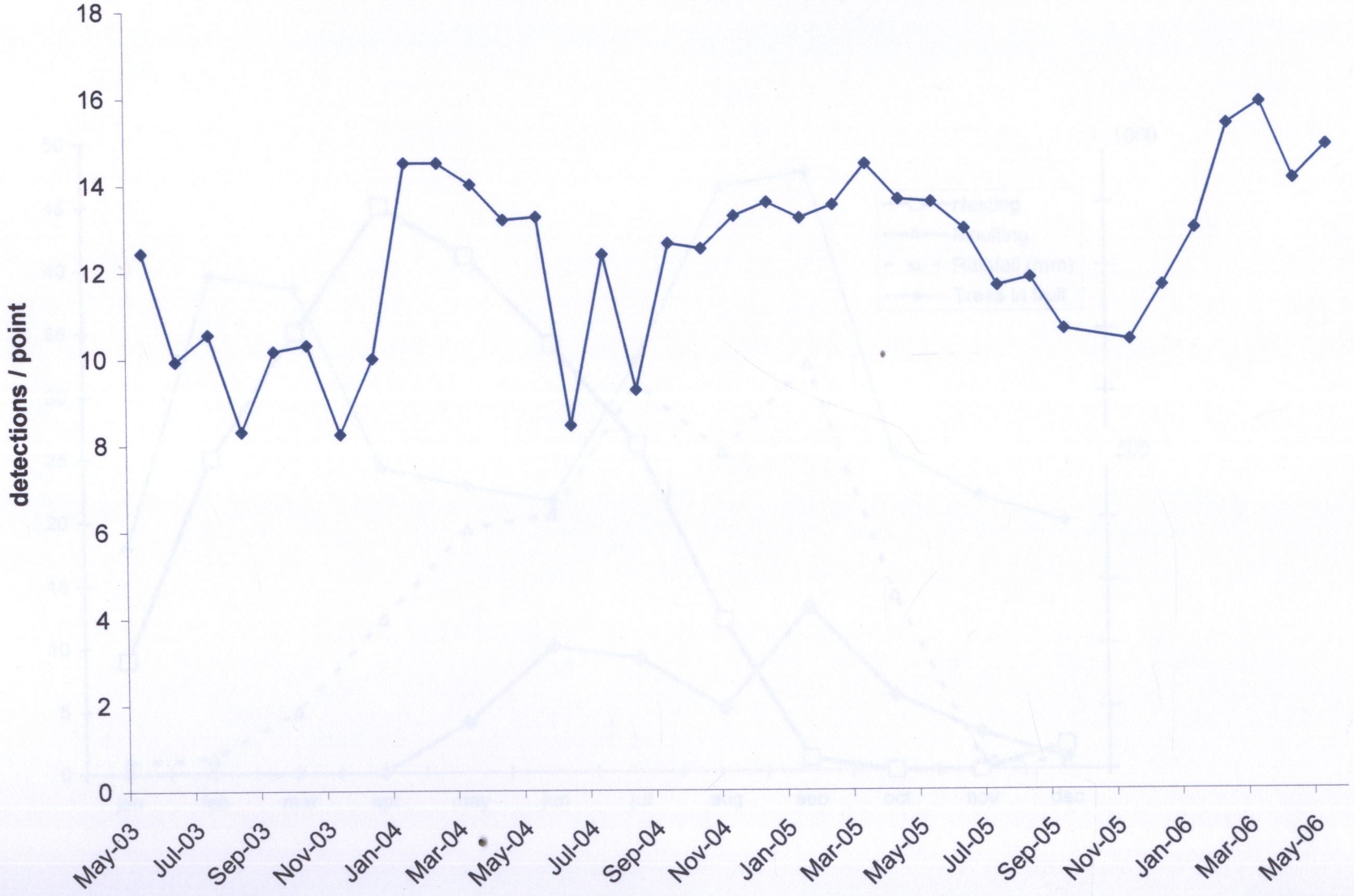


Figure 11. The seasonality of breeding and moult in relation to rainfall and fruit abundance. Units of the left y axis is number of species either nesting or molting. The units of the right y axis are rainfall (mm) and an index of the number of trees in fruit.

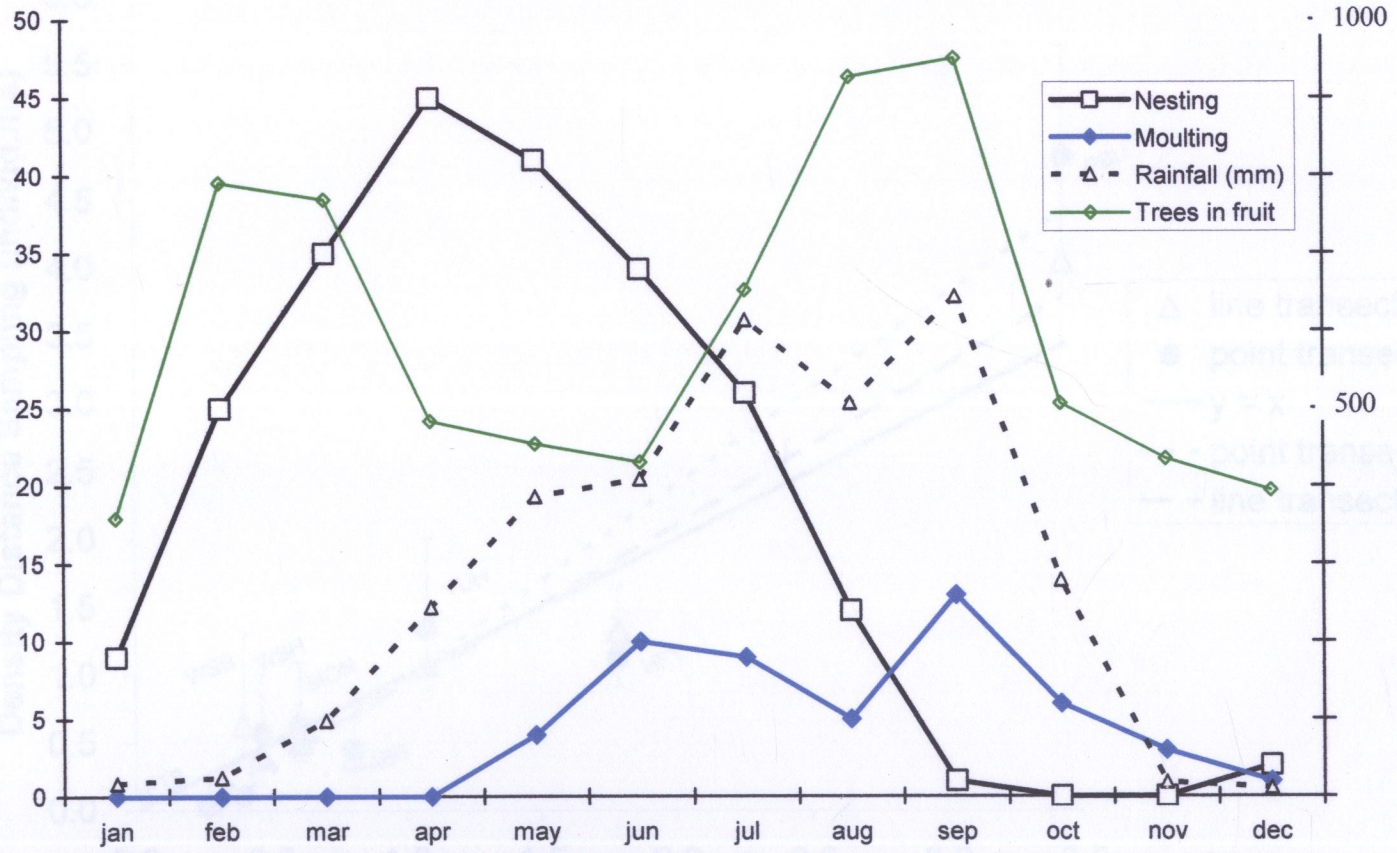


Figure 12. Correlation between estimates obtained from distance sampling methods (line transects and point transects) and "true estimates" derived from intensive spot-mapping of colour ringed birds and nest finding for eight species of understorey/middle storey birds. Error bars represent 95% confidence intervals around the estimates. (PBU Puff-throated Bulbul; HFY Hill Blue Flycatcher, YUH White-bellied Yuhina, ABB Abbott's Babbler, MON Black-naped Monarch, WSB White-browed Scimitar Babbler, WSH White-rumped Shama, and PTB Puff-throated Babbler).

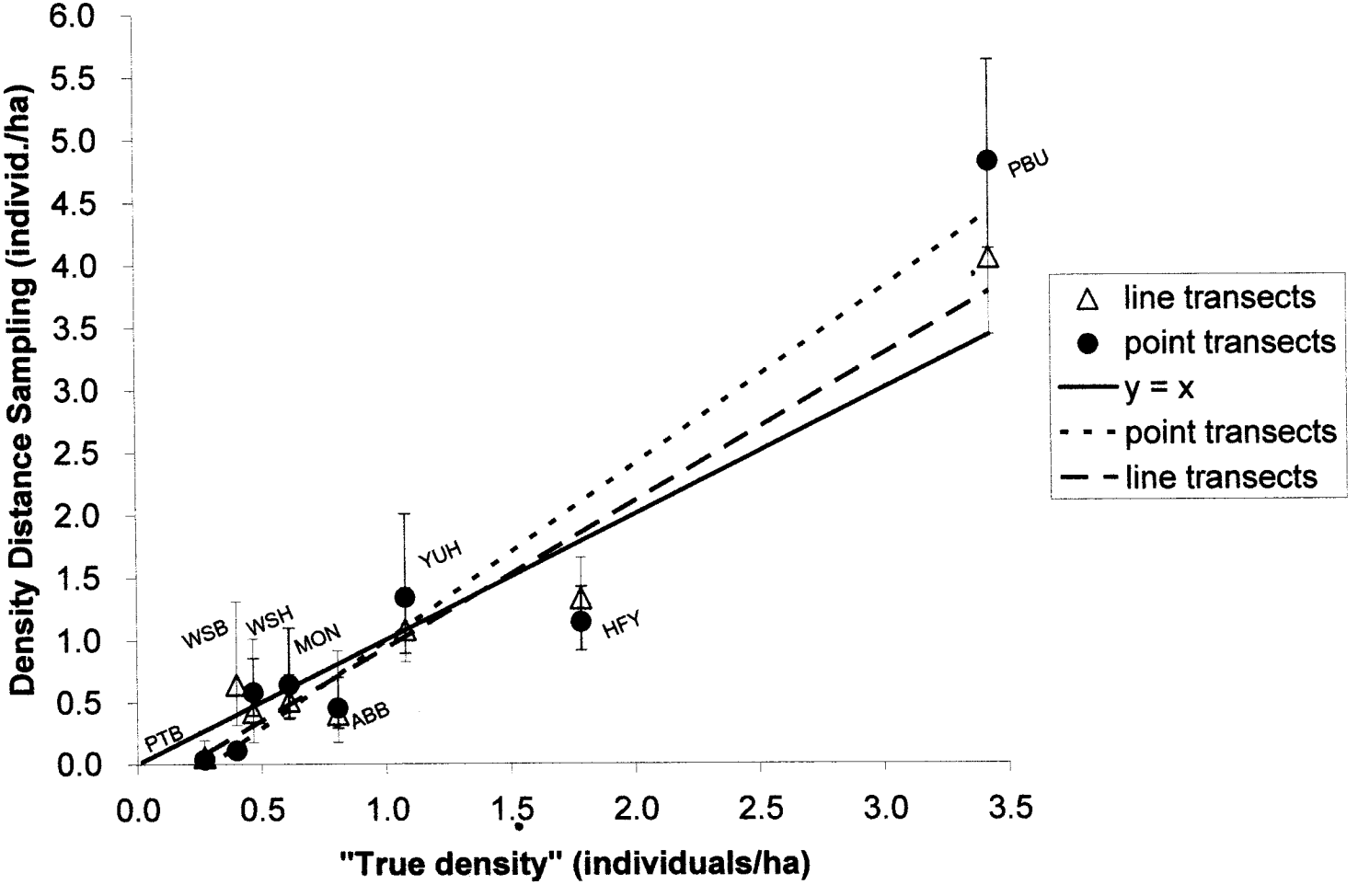


Figure 13. Sample output from program Distance showing the relationship between detection probability (y axis) and distance from the transect line (meters, x axis) for the White-browed Scimitar Babbler. The line represents the function generated by the software used to fit the data and estimate density. The histogram represents the distance data in intervals (0, 5, 10, 15 m etc.). Note the low detection probability at 0-5 m from the transect line suggesting that these birds are moving away from the observers before they are detected.

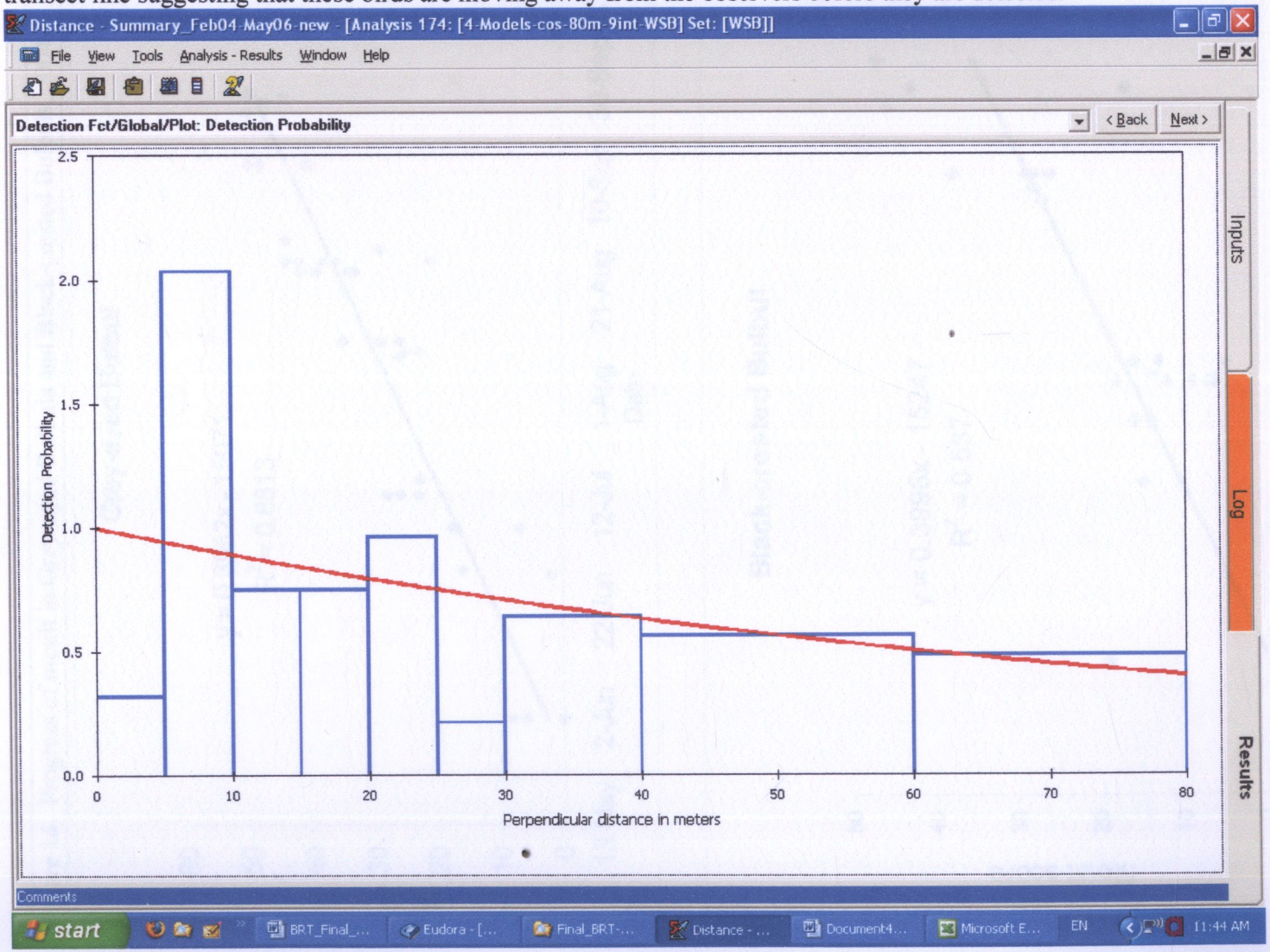
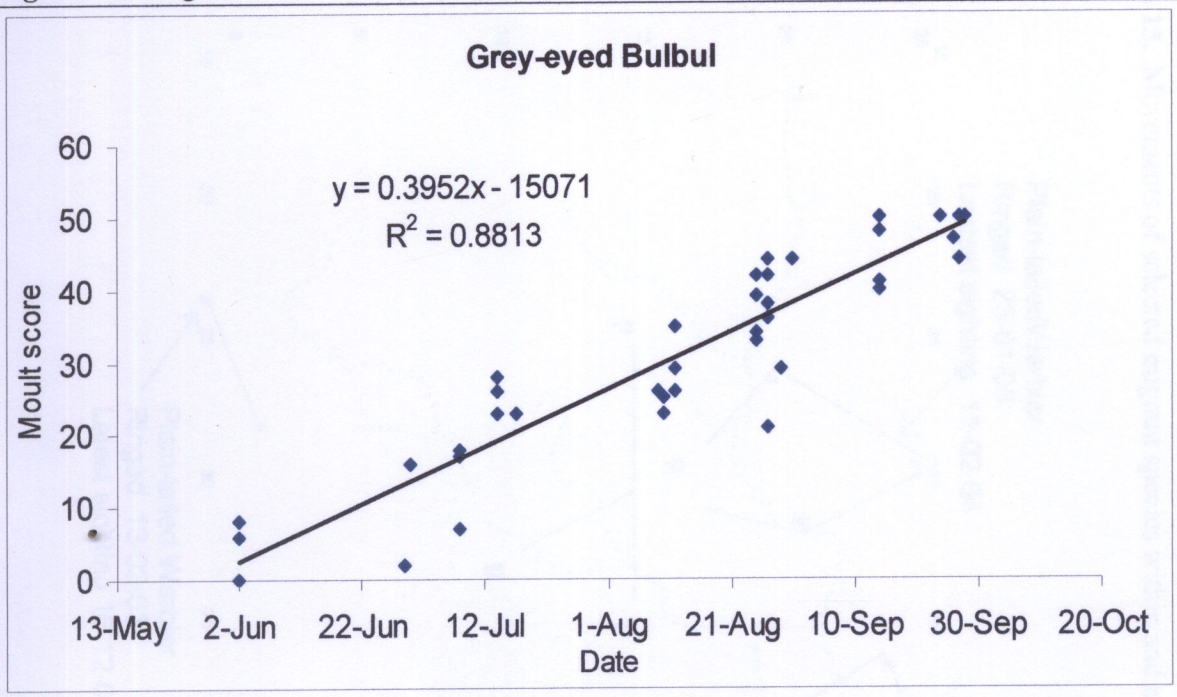


Figure 14. Progress of moult in Grey-eyed Bulbuls and Black-crested Bulbuls, 2004.



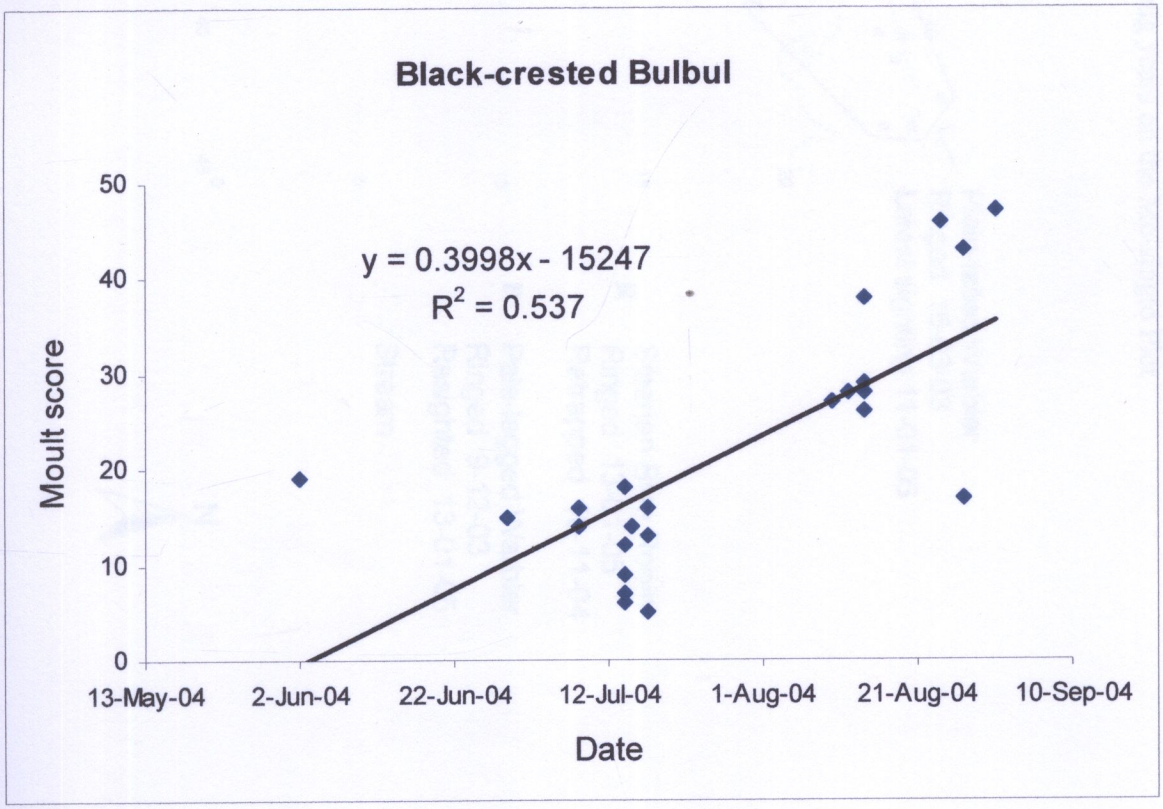


Figure 15. Movements of selected migrant species within and among years on the Mo-singto Plot

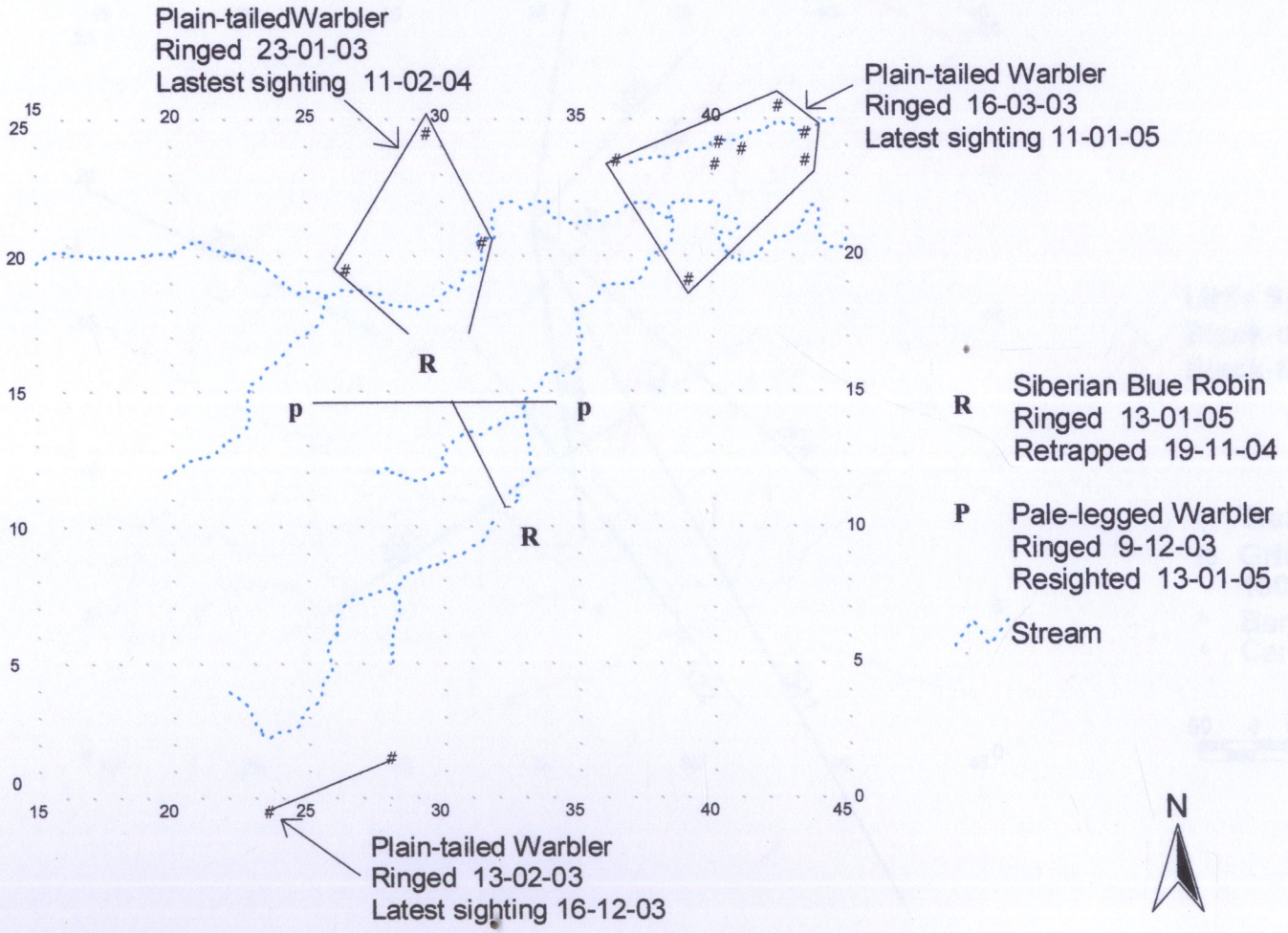


Figure 16. Movement distances (meters) of three particularly mobile species based on re-sightings or recaptures of marked individuals