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Breeding Season Habitat Use by Hume's Pheasant *Syrmaticus humiae* in the Doi Chiang Dao Wildlife Sanctuary, Northern Thailand

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Apirat Iamsiri and George A. Gale (2008) Breeding season habitat use by Hume's Pheasant *Syrmaticus humiae* in the Doi Chiang Dao Wildlife Sanctuary, northern Thailand. *Zoological Studies* **47**(2): 138-145. Breeding habitat use by the globally near-threatened Hume's Pheasant *Syrmaticus humiae* in northern Thailand was assessed in the Doi Chiang Dao Wildlife Sanctuary, perhaps the best remaining habitat for the species in the country. We modeled its microhabitat preferences in evergreen forest using MANOVA, principal component analysis, and logistic regression. At least 5 groups of birds were observed in areas from 1365 to 1560 m in elevation. Hume's Pheasant tended to use areas containing larger-diameter and taller pines more frequently than areas with oaks or other evergreen tree species. Areas with higher levels of herbaceous species richness below 50 cm were preferred over dense and uniform grassland which may have been related to their ability to detect predators or to their diet and/or foraging behaviors. As this habitat is relatively common above 1000 m and the number of detections was low, available habitat appears not to be saturated with pheasants. The reason for the apparent low numbers requires further investigation. It is also possible that Hume's Pheasant uses densely vegetated areas and steep grassy/rocky slopes but remains undetected; therefore significantly more telemetry data will be required to adequately assess their fine-scale habitat use.
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Key words: Hume's Pheasant, Thailand, Doi Chiang Dao Wildlife Sanctuary, Habitat use.

Hume's Pheasant *Syrmaticus humiae*, listed as globally near-threatened (BirdLife International 2005), is found only in very limited parts of India, Myanmar, China, and Thailand (Fuller and Garson 2000, BirdLife International 2005). In Thailand, its distribution is restricted to a few parts of the north where rough estimates suggest 200-500 individuals occur and are probably slowly declining due to hunting and habitat degradation (BirdLife International 2001). Based on observational records, its habitat has been generally described as open and dry subtropical evergreen forests with mainly oaks of the Fagaceae or conifers of the Pinaceae (Fuller and Garson 2000) or more specifically in Thailand as oak, oak-chestnut, and pine forests with interspersed patches of bracken *Pteridium and Imperata* grasslands (Humphrey and Bain 1990). A broad-scale analysis by Iamsiri et al. (2005) based on data collected from 6 sites in Thailand, concluded that Hume's Pheasant habitat was primarily evergreen hardwood forest mixed with dense pines and large-diameter oaks, with a relatively open shrub layer above 1 m in height. The objective of this study was to quantify Hume's Pheasant microhabitat use within evergreen forests of the Doi Chang Dao Wildlife Sanctuary, probably the most important area for Hume's Pheasant in Thailand based on the relative frequency of sightings and the apparent control of hunting relative to other protected areas, such as Doi

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Inthanon (Iamsiri et al. 2005).

MATERIALS AND METHODS

Study area

Doi Chiang Dao Wildlife Sanctuary, designated in 1978, has an area of 521 km^2, and is a steep limestone massif located in northern Thailand approximately 70 km from the city of Chiang Mai. The region has a mean annual rainfall of 1307 mm and a mean annual temperature of 25.6°C (OEPP 2001). The vegetation is generally deciduous below 1000 m, while evergreen above 1000 m and often associated with pines up to 1550 m in elevation. The evergreen hardwood forest is subdivided into areas with pine (EG/pine) where *Pinus kesiya* is common, and areas without pine (EGF) (Maxwell 1998). The zone above 1550 m is dominated by limestone-associated vegetation. This is also mostly evergreen, but contains several endemic species found only in limestone areas due to their basic soils, which do not support pines. The study area was located at the Den Ya Khad Ranger Station, 19°22'N and 98° 50'E (Fig. 1), the only area where the species has been reported in the sanctuary.

Habitat sampling

Based on data collected from interviews of local sanctuary staff, microhabitat surveys were restricted to evergreen forest between 1100 and 1600 m, as this appears to account for nearly all of the known habitat used by Hume's Pheasant within the sanctuary (Fig. 1). In this study, we attempted to discern structural features affecting Hume's Pheasant habitat use within the evergreen forest. Broader habitat use has been examined elsewhere (Iamsiri et al. 2005). As sampling the evergreen forest completely randomly was not logistically feasible due to the terrain and the lack of reliable transportation, we were compelled to designate, "use" and "non-use" points as a rough proxy for comparing used versus random points. Hume's Pheasant leaves relatively distinctive, easily detectable scrapes/scratch-marks in the leaf litter and soil when feeding (Iamsiri 2006). The selected non-use points were therefore carefully searched so as to give reasonable assurance that the species had not been feeding in the vicinity immediately prior to the vegetation sampling.

A team of 3 persons conducted surveys during the earlier portion of the breeding season, (5 Feb.-15 Mar. 2003) by walking trails and roads of the ranger unit, from approximately 08:00 to 18:00. It was not feasible to completely systematically search for the pheasant as the densities were low (< 1 group/km^2), and the terrain is steep with dense vegetation. Furthermore, although occupancy models (e.g., MacKenzie et al. 2002) would have been preferable, the number of detections (4 detections from 40 repeat visits to 20 point stations) proved to be too small to obtain a meaningful estimate of the probability of detection. The locations where birds were sighted ("use points") during the surveys were recorded via GPS. If the distance between 2 locations was less than 30 m, the 2nd observation was excluded, but all other observations were assumed to be independent, although we did not test this empirically. Non-use points were placed at 200 m intervals (when transport was not available) and at 500 m (when it was available) from use points along trails or roads. Based on field observations (Iamsiri 2006), 200 m was estimated to be the average distance traveled in 1 d by a Hume's Pheasant, and 500 m was considered a sufficient distance to separate individual groups (Iamsiri 2006). Non-use points were then situated 50 m perpendicular to these trails or roads in order to reduce possible effects of the trails or roads on vegetation. We searched for evidence of feeding within a 30 m radius centered at each non-use point.

For vegetation sampling, a 30 m transect centered at each use (or non-use) point, in a north-south direction was used for measuring trees and ground vegetation (Table 1). At 0, 10, 20, and 30 m along the transect, 4 quadrants were marked and the nearest tree with a diameter breast height (DBH) of > 5 cm in each quadrant was measured, including height, DBH, distance from the line, and species (categorized as pine, oak, or other). The average basal area of the trees per hectare was estimated using the point-centered quarter method (Brower et al. 1990). We used an ocular tube to estimate the percent crown closure by taking 15 readings at 2 m intervals along a transect line for the presence or absence of leaves (Bibby et al. 1992). The total "hits" of shrub leaf cover between 0 and 50 cm in height were recorded by placing a pole (2 cm in diameter) vertically at the same points as the readings for canopy cover.

The species composition, and stem density of grasses and herbaceous plants were measured at 3 plots of 1 m^2 placed at the center and at both ends of the transect line. The average percentage of ground cover, leaf-litter depth, and height of ground vegetation were also measured in these plots.

Habitat data analyses

Differences between use and non-use points were assessed using multivariate analysis of variance (MANOVA), which tested the hypothesis that habitat characteristics did not differ between use and non-use plots. MANOVA is most appropriate when more than 1 response variable has been collected, and the independent variables are categorical (Scheiner 2001). Probabilities of a habitat being used by the birds were assessed using a principal component analysis (PCA) and logistic regression. With this design, the PCA can be used to summarize patterns of covariance in the habitat variables (McGowan 1992), and logistic regression can be used to produce a resource selection probability function using presence-absence data (Manel et al. 2001), although identification of unused sites is sometimes biased due to sampling intensity (Boyce et al. 2002). MANOVA was used to examine differences in vegetation components in which the presence or absence of the bird was the main effect. As the number of use points was particularly small, we divided the habitat variables into 2 sub-groups, i.e., characteristics of trees and characteristics of ground vegetation, and then separately input them into the PCA in order to maintain an approximately 3: 1 ratio of observations relative to variables, as this is the minimum ratio suggested for a stable solution (McGarigal et al. 2000). The PCA was used to reduce the dimensionality of the dataset to obtain new meaningful measures of vegetation patterns that were independent of each other (Bailey et al. 2002). The new variables were then input into the logistic regression analysis. These analyses were conducted using SPSS for Windows 11.0.0 (SPSS, Chicago, IL, USA).

RESULTS

There were 13 use and 22 non-use points. One use point was located within a pine plantation. Birds were observed at locations ranging from 1365 to 1560 m in elevation. At least 5 groups of Hume's Pheasants were observed in the study area. The non-use points ranged in elevation from 1168 to 1672 m (Fig. 1). The recorded habitat data were averaged on a per-point basis (see Table 1).

Use and non-use point comparisons

There was no significant difference between use and non-use points within the study area for trees (Wilks' lambda, $F_{6, 28}$ = 1.135, p = 0.368) or

Table 1. Description of 2 recorded variable groups. The 1st group indicates the tree community, and the 2nd group reflects the ground vegetation community

	No.	Description	Mean (SE)	
			Use points	Non-use points
Group 1	1	Crown closure (%)	76.6 (3.5)	56.7 (6.8)
	2	Average tree DBH (cm)	24.8 (2.0)	22.9 (1.5)
	3	Average tree height (m)	16.3 (0.9)	13.6 (0.8)
	4	Basal area of pine trees (m^2/ha)	20.6 (4.9)	12.5 (3.8)
	5	Basal area of oak trees (m^2/ha)	6.3 (1.3)	5.5 (1.3)
	6	Basal area of other tree species[a] (m^2/ha)	8.1 (1.4)	8.2 (2.6)
Group 2	1	Sapling density (tree/m^2)	0.3 (0.1)	0.5 (0.2)
	2	Grass species richness (no.)	2.0 (0.3)	2.2 (0.2)
	3	Grass density (stems/m^2)	38.4 (7.3)	50.6 (8.0)
	4	Herbaceous plant species richness (no.)	6.2 (0.6)	5.3 (0.4)
	5	Herbaceous plant density (plants/m^2)	28.0 (5.4)	22.6 (2.4)
	6	Total leaf hits 0-50 cm (no. of hits)	20.2 (1.7)	16.5 (1.4)
	7	Average ground vegetation height (cm)	48.9 (6.5)	73.4 (14.7)
	8	Cover of ground leaf litter (%)	75.2 (4.9)	58.6 (5.7)
	9	Depth of ground leaf litter (cm)	4.1 (0.5)	3.9 (0.4)

[a]Basal area of trees which were neither pine nor oak. DBH, diameter at breast height.

ground vegetation (Wilks' lambda, $F_{9,\ 25} = 2.156$, $p = 0.063$). However, the cover of leaf litter at use points was significantly higher than that at non-use points (75.1% ± 17.8% vs. 58.6% ± 26.7%, *t*-test, $p = 0.035$).

Predicting probable habitat

For the tree community, the scree plot, derived by plotting the eigenvalues against the components (Field 2000), showed that the curve began to tail off after 2 factors; thus 2 factors were selected as principal components for interpretation. These 2 components accounted for 62.5% of the variable variance (Table 2). These 2 factor scores were saved as 2 new variables: PCT1 and PCT2.

Four components were chosen, also based on the scree plot technique, to describe the ground

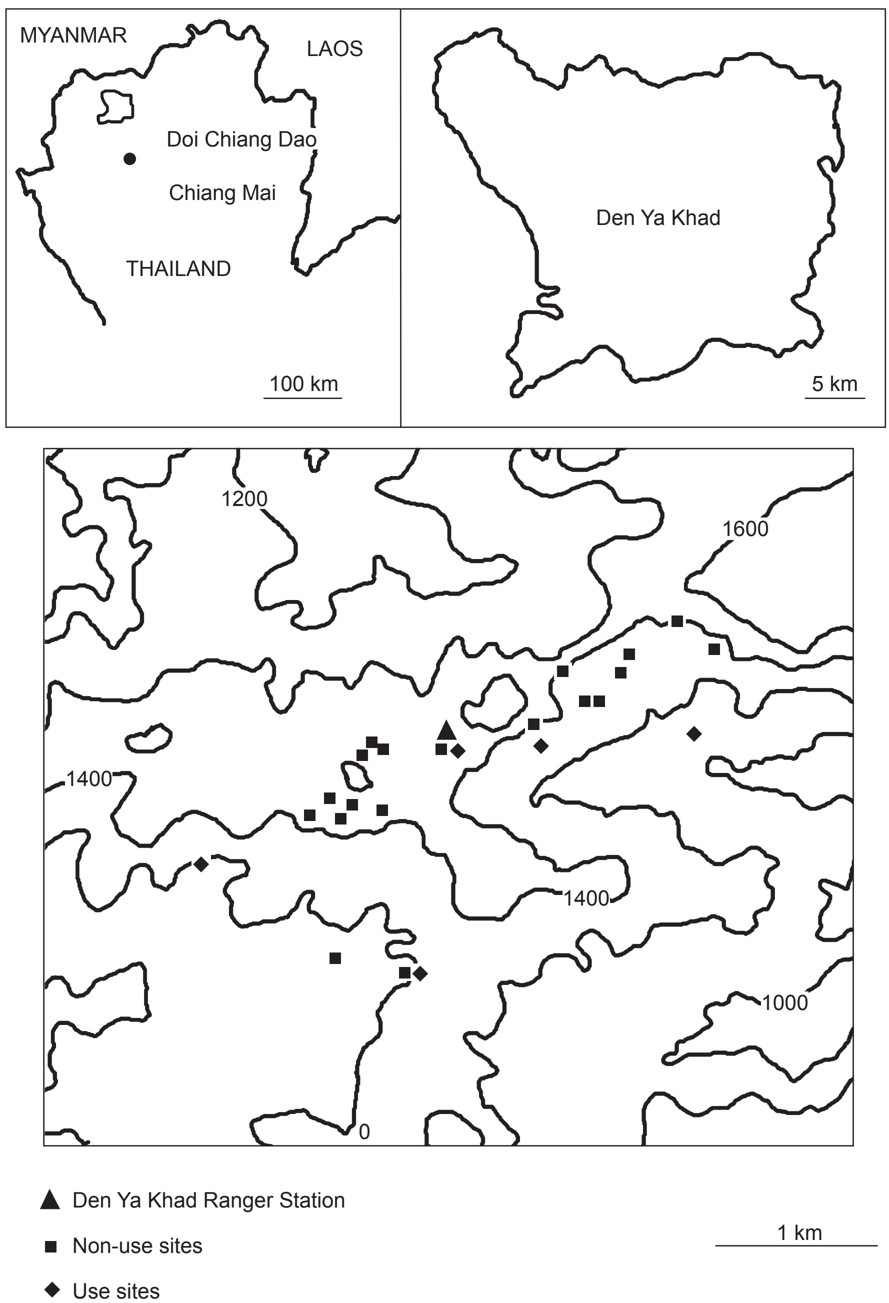

Fig. 1. Map showing the location of Doi Chiang Dao Wildlife Sanctuary and the 30 km² study area with "use" and "non-use" points located at the Den Ya Khad Ranger Station.

vegetation (Table 3). They accounted for 81.0% of the variation in the ground vegetation variables. In this case, 4 factor scores for each point were saved as new variables: PCG1, PCG2, PCG3, and PCG4.

In total, 6 new variables were analyzed by logistic regression, with 4 variables reflecting ground vegetation and 2 variables reflecting the tree community. The results, shown in table 4, suggested that PCT1 and PCG2 affected use-point probability. At a cut-off point of 0.5 for the probability of site usage, the model correctly classified 81.8% of the non-use points (specificity) and 53.8% (sensitivity) of the use points. The overall rate of correct predictions was 71.4%. The area under the receiver operating characteristic (ROC) curve was 0.766 ± 0.081 (p = 0.009), which is considered acceptable discrimination (Hosmer and Lemeshow 2000). The positive effects of the coefficients of both components (Table 4, column B) showed increasing use point probability with increasing values of PCT1 and PCG2.

DISCUSSION

The absence of a significant difference between use and non-use sites indicates that either the points selected were all located in relatively suitable habitat and/or the power of the analysis was unable to detect real differences. For example, differences between use and non-use points for the ground vegetation cover in general did approach significance and 1 variable, leaf litter cover, was significantly higher at use points. Leaf litter may provide habitat and cover for insects, a potential food source, and could be particularly important for young chicks, which require relatively large amounts of protein (Hill and Robertson 1988). However, its overall effect on habitat selection appeared to be relatively small.

Although the sample size may have been large enough to avoid concerns about violating assumptions of multivariate normality (Chiarotti 2004), it was probably too small to provide sufficient power for hypothesis testing (Cohen 1992), particularly for the tree community. For example, Cohen (1992) recommended 64 samples to detect a moderate difference between 2 independent samples with a power of 0.8.

Including PCT1 in the logistic regression model suggested that pine-dominated forest was the primary habitat used by the pheasant during at least the early portion of the breeding season. Although the pheasants were observed feeding on acorns, *Castanopsis* sp., (Iamsiri 2006), PCT2 (which reflects a gradient in the basal area of oaks) was not included in the model. Either acorns were only a minor food source and/or the birds were present, but not detected, in the more densely vegetated areas dominated by oaks. In support of the latter idea, data from the only radio-collared bird (a female) also indicated that it utilized densely vegetated areas (areas without large trees, i.e., with heights < 5 m) with relatively dense ground vegetation below 1 m (Iamsiri 2006).

The presence of PCG2 in the final logistic regression model also suggested a preference for areas with a higher species richness of herbaceous plants, higher leaf litter cover, and higher total leaf area below 50 cm, but avoidance of areas with dense and more uniform grasslands (50.6 stems/m^2). Areas with a higher species richness of herbaceous plants may provide a richer assortment of potential food items, as plant materials appear to make up the bulk of the adult bird's diet (Birdlife International 2001). They also used areas with a higher total leaf area below 50 cm indicating some preference for ground vegetation cover, which may be related to predation risk (Hill and Robertson 1988). Such a vegetation structure provides cover but also allows them to view long distances over open areas to check for approaching predators, while dense grasses could obstruct their ability to detect predators. Alternatively, these preferences may be more related to their diet and/or foraging behaviors.

The sensitivity of the model was low; thus our conclusions should be interpreted with some caution. The lack of sensitivity may have been

Table 2. Component matrix of factor scores extracted by the principal component analysis for a group of variables representing the tree community within the study area

	Principal components	
Variable	PCT1[a]	PCT2[b]
Crown closure	0.680	0.550
Average tree DBH	0.788	-0.035
Average tree height	0.817	-0.199
Basal area of pine trees	0.768	-0.268
Basal area of oak trees	0.105	0.871
Basal area of other trees	-0.155	0.449

[a,b]The 1st and 2nd principal components represent the tree community. DBH, diameter at breast height.

due to large variations in use habitats or small sample sizes (or both) (Garzotto et al. 2005). We attempted to increase the power of the analysis by subdividing the variables into groups (Poirazidis et al. 2004), but too few cases (sampling points) in relation to the number of independent variables can still alter the predictive capacity of such an analysis (Peduzzi et al. 1996).

CONCLUSIONS

Conservation and management implications

Although there were no significant differences between "use" and "non-use" points within the evergreen/pine forest at Doi Chang Dao, Hume's Pheasant used pine-associated areas more frequently than other habitat patches containing oak and other evergreen tree species. However, this might only be applicable to early breeding season use, as telemetry data suggest later-season use of densely vegetated areas dominated by oaks (Iamsiri 2006).

Interestingly, much of the sanctuary between 1000 and 1550 m has also been described as EG/pine forest (Maxwell 1998) suggesting that more habitat might be present in the sanctuary than previously thought. EG/pine forest above 1000 m is also relatively common in northern Thailand including at 5 other sites where Hume's Pheasant has been observed (Iamsiri et al. 2005). The population may also be limited by other factors, for example forest fires, predators, and other variables not measured in this study such as microclimate, water sources, and topography (Osborne et al. 2001, Robertson et al. 2001).

In addition to hunting, frequent fires appear to be a significant threat to ground vegetation and leaf litter cover and therefore to habitat quality. Iamsiri et al. (2005) concluded that fires often occur during the nesting season, and more fire-control at least near likely nesting habitats in Mar. and Apr. could enhance reproductive success. We also suggest that local participation in fire control may be a viable option and was shown to be an

Table 3. Component matrix of factor scores extracted by the principal component analysis for a group of variables representing the ground vegetation community within the study area

	Principal components			
Variable	PCG1[a]	PCG2[b]	PCG3[c]	PCG4[d]
Sapling density	-0.213	0.323	-0.010	0.559
Grass species richness	0.409	0.377	0.226	0.646
Grass density	0.698	-0.439	0.314	0.312
Herbaceous plant species richness	0.433	0.653	0.324	0.447
Herbaceous plant density	0.691	0.374	0.232	0.377
Total leaf hits 0-50 cm	0.518	0.552	-0.351	0.298
Average ground vegetation height	-0.032	-0.286	0.912	0.092
Cover of ground leaf litter	-0.712	0.516	0.268	-0.048
Depth of ground leaf litter	-0.849	0.292	0.250	0.112

[a,b,c,d] The 1st, 2nd, 3rd, and 4th principal components represent the ground vegetation community.

Table 4. Logistic regression model for Hume's Pheasant habitat, including coefficients (B), standard errors (SE), Wald statistics, *p* values, and odds ratio estimates (Exp (B)) and their 95% confidence intervals (CIs)

Variable	B	SE	Wald	*d.f.*	*p* values	Exp (B)	95% CI for Exp (B)	
PCG2[a]	1.027	0.501	4.206	1	0.040	2.793	1.047	7.452
PCT1[b]	0.948	0.480	3.895	1	0.048	2.580	1.007	6.612
Constant	-0.715	0.420	2.896	1	0.089	0.489		

[a]The 2nd principal component represents the ground vegetation community. [b]The 1st principal component represents the tree community.

effective strategy at nearby Doi Inthanon National Park (Roonwong and Onprom 2000).

Finally, because Hume's Pheasant is relatively secretive and not particularly vocal and there are only a few sightings, occurring mostly along ridges or other relatively open areas, it is also possible that the analysis was biased due to the difficulty of observing the bird in densely vegetated areas (Gu and Swihart 2004) or steep grassy/rocky slopes. Our limited radio-tracking data indicated that birds do utilize denser vegetation at least occasionally (Iamsiri 2006), and therefore significantly more telemetry data will be required to adequately assess fine-scale habitat use.

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