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HABITAT LOSS AND THE DECLINE OF GREY-FACED BUZZARDS (*BUTASTUR INDICUS*) IN TOKYO, JAPAN

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Abstract.—The occurrence of Grey-faced Buzzard (*Butastur indicus*) in central Japan was studied in the 1970s and 1990s. There was a significant decline in the number of Grey-faced Buzzards sighted; from 28 survey squares in the 1970s to zero in the 1990s. In the Tokyo areas, the amount of edge between forests and paddy fields, which was probably an important habitat for the buzzard, was markedly decreased from 1.1 ± 1.5 km in the 1970s to 0.3 ± 0.6 km in the 1990s. The decline of Grey-faced Buzzards breeding in the Tokyo region probably was caused by the habitat loss resulting from abandonment or development of traditional paddy fields (*yatoda*). These human modifications probably reduced populations of suitable prey.

Key Words: *Grey-faced Buzzard*; Butastur indicus; *population decline*; *habitat preference*; *paddy field.*

PÉRDIDA DE HÁBITAT Y DISMINUCIÓN DE *BUTASTUR INDICUS* EN TOKIO, JAPÓN

Resumen.—En la década de los 70 y de los 90 se estudió la presencia de *Butastur indicus* en el centro de Japón. Se encontró una disminución significativa del número de avistamientos de *B. indicus*; de 28 cuadrantes de muestreo en la década de los 70 a cero en la de los 90. En las áreas de Tokio, la cantidad de hábitat de borde entre bosques y campos de cultivo de arroz, el cual es probablemente un hábitat importante para la distribución de *B. indicus*, decreció marcadamente de 1.1 ± 1.5 km en la década de los 70 a 0.3 ± 0.6 km en la de los 90. La disminución de individuos de *B. indicus* que se reproducen en la región de Tokio fue probablemente causada por la pérdida de hábitat debido al abandono o a la urbanización de los campos de cultivo tradicionales de arroz (*yatoda*). Estas modificaciones humanas del hábitat probablemente reducen las poblaciones de presas apropiadas.

[Traducción del equipo editorial]

Grey-faced Buzzards (*Butastur indicus*) breed in far east Asia and throughout Japan, excluding Hokkaido. This species is migratory and winters in the southernmost Japanese islands and Southeast Asia (del Hoyo et al. 1994). Grey-faced Buzzards breed in forests associated with wetlands or grasslands and primarily prey on amphibians and insects (Momose et al. 2005). In Japan, they mainly breed close to ''*yatoda*'' or ''*yatsuda*'' (Azuma et al. 1998, 1999), which are paddy fields developed within the narrow strip of arable land in steep forested valleys. The Grey-faced Buzzard population appears to be in decline in Japan (Higuchi and Morishita 1999); however, no research has been undertaken to determine their breeding status and assess the factors responsible for their decline.

Since the 1960s, Japan has experienced drastic social and economic changes, such as the replacement of firewood by fossil fuel for home heating and cooking purposes, an exodus from rural districts to urban areas, and an expansion of intensive agriculture (Takeuchi et al. 2003). Since most *yatoda* are small and located on slopes at the base of hills, they are not well suited to intensive

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agriculture. Therefore, these paddies have been either retired from agriculture or developed into other forms of land use, including housing estates and industrial facilities. Abandoned *yatoda* have become overgrown by shrubs and bushes, and undergo succession to broad-leaved forests. In addition, many *yatoda* paddies that are still in use have been restructured to facilitate intensive farming. This restructuring work includes replacing open ditches with pipes, which cannot be used by wildlife.

Work by Kojima (1982, 1999), Azuma et al. (1998), and Deng et al. (2003, 2004) on Grey-faced Buzzards have indicated the importance of hillside woodlands for nesting. Also, Azuma et al. (1998), Kojima (1999), and Azuma (2003) documented that buzzards used paddy fields for foraging. Hasegawa et al. (1996) studied Grey-faced Buzzards on the Izu Islands, where they nested and foraged in ravines. As these studies focused on *yatodas* on islands, they may not include the full range of habitats used by breeding Grey-faced Buzzards. In this paper, we analyze Grey-faced Buzzard distribution across the range of habitats within Tokyo, Japan. In so doing, we examine the environmental factors that may explain the distribution of Grey-faced Buzzards in this area, document the change in distribution between the 1970s and the 1990s, and evaluate the likely causes of that change.

METHODS

Bird Surveys. Bird surveys were conducted in Tokyo, central Japan in the 1970s (1973, 1974, and 1978) and 1990s (1997). We divided the area of Tokyo into 1.1×0.9-km squares. For the most part, these survey squares were distributed evenly across Tokyo. Even distribution of survey grid squares was not possible in the western part of Tokyo because of the difficult access and rough terrain. We sampled 317 survey squares in the 1970s and 324 squares in the 1990s. One bird sampling transect of ca. 1 km in length was established in each of these survey squares. The surveys were carried out twice in May and June with an interval of $\geq$1 wk. We walked along transects at ca. 2 km/hr and recorded the species and the number of birds heard and seen. We assumed that all Grey-faced Buzzards were breeding birds because this region was in the middle of their breeding range (Momose et al. 2005). The buzzards flying high above the tree canopy were assumed to be passing over the habitat and not counted as territorial birds in the square. During the 1990s, only the occurrence of the Grey-faced Buzzard was recorded; thus, if one or more buzzards were observed, we recorded this as an occurrence in the 1970s. We compared the squares ($N = 307$) where surveys were conducted both in the 1970s and 1990s.

In addition, a questionnaire was distributed to the members of Wild Bird Society of Japan living in Tokyo, and the local literature was reviewed. Data from these sources were used to augment our information on Grey-faced Buzzard breeding status.

Relationships of Environmental Factors and Occurrence. We analyzed the habitat preferences of Grey-faced Buzzards in Tokyo by superimposing the sites where the species was sighted during the 1970s onto vegetation maps from 1974 and 1998 (Tokyo Metropolitan Government 2003) with a Geographical Information System (ArcView, ESRI). Land cover was placed into one of nine classes: forest (broad-leaved deciduous forest, broad-leaved evergreen forest, mixed forests, and conifer plantation), shrub (orchard and nursery), wooded area (park and residential area with $\geq$50% tree coverage), grassland (crops and forbs), bamboo stands (bamboo and dwarf bamboo), wetland (marsh and reed bed), open water, rice paddy, and urbanized area. For each survey square, areas of each land-cover class and the length of edge (km) between forests and paddy fields and between forests and grasslands were calculated.

After excluding survey squares for which information on vegetation cover was incomplete, we used 285 squares for the analysis. Discriminant analysis was employed to determine the relationship between the occurrence of Grey-faced Buzzards and vegetation cover type. The importance of each variable was determined by the partial correlation coefficients of the F values. The variables were selected for inclusion in a stepwise manner according to the F values. The threshold value for inclusion was an F value 5.0. We used cross validation to evaluate the stability of discriminant analysis by EXCEL Multiple analysis (ESMI Co., Ltd. Tokyo, Japan).

Data from vegetation maps from 1974 and 1998 were compared to determine which factors were correlated with the changes in the distribution of Grey-faced Buzzards.

RESULTS

Grey-faced Buzzards were observed in 28 survey squares in the 1970s, whereas in the 1990s no buzzards were sighted. The results of a questionnaire and a literature review added only two survey squares as occupied by this species in the 1990s (Fig. 1). This indicated substantial decline of Grey-faced Buzzards breeding in Tokyo between the 1970s and the 1990s. The independent variables that best explained the sightings of Grey-faced Buzzards were (in order of importance) the edge length between forest and paddy field, the total forest area, and the edge length between forest and grassland (Table 1). These three variables accounted for 90.9% of the variation ($N = 285$).

The squares where Grey-faced Buzzards were sighted in the 1970s, but not in the 1990s, were characterized by significant changes in the edge length between forest and paddy field (Fig. 2) and the total forest area (Fig. 3, Wilcoxon's test with Bonferroni adjustment, $P < 0.05$). In these sample squares, the mean forest-paddy field edge length

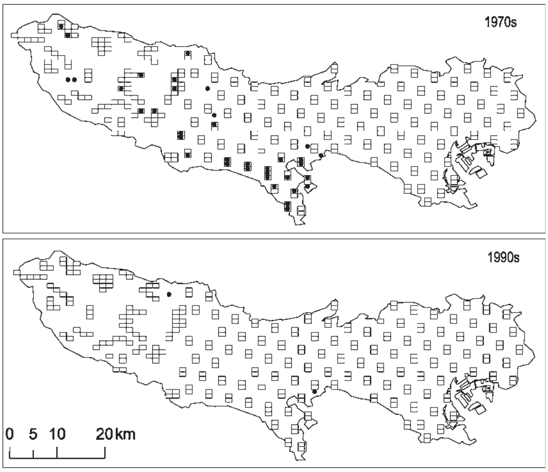

Figure 1. Survey area for Grey-faced Buzzards in Tokyo, Japan in the 1970s and 1990s. White squares indicate where surveys were conducted and no buzzards recorded. Darkened squares indicate survey sites where buzzards were recorded.

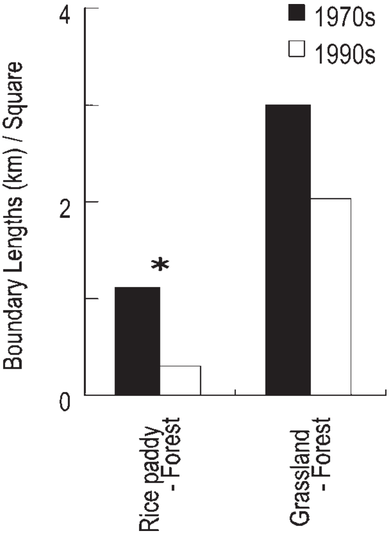

Figure 2. Mean length of forest-paddy field and forest-grassland within survey squares occupied by breeding Grey-faced Buzzards in 1970s and disappeared in 1990s. * Differences between 1970s and 1990s were statistically significant, $P < 0.05$.

decreased from 1.1 ± 1.5 (SD) km to 0.3 ± 0.6 km, the forest area from 64.6 ± 28.7 ha to 51.3 ± 36.0 ha and the mean forest-grassland edge length from 3.0 ± 2.8 km to 2.4 ± 2.3 km. The mean area of paddy fields declined from 5.8 ± 7.3 ha to 2.0 ± 2.9 ha and contributed to the overall reduction of forest-paddy field edge length per square (Fig. 3). Residential areas have replaced 52.6%, and grassland 23.5%, of the paddy fields of Tokyo since the 1970s.

Table 1. Results of discriminant analysis of factors influencing distribution of Grey-faced Buzzards in Tokyo.

	CLASSIFICATION COEFFICIENT	MAHALANOBIS DISTANCES	*F*	*P*
Edge length between forest and paddy field (km)	0.003	3.352	32.1	<0.001
Forest area (ha)	0.021	4.697	10.2	0.002
Edge length between forest and grassland (km)	0.001	4.996	5.7	0.017
Constant	−3.998			

DISCUSSION

The Grey-faced Buzzard occurrence declined between the 1970s and 1990s (Fig. 1), which has been reported by Higuchi and Morishita (1999), Endo and Hirano (2001), and Kawakami and Higuchi (2003). The buzzards are easy to find because they perch conspicuously on the top of utility poles and on prominent high and exposed branches at the forest edge, or call frequently while flying. Therefore, it was unlikely that we missed birds in the 1990s survey. In addition, the number of breeding buzzards in our region in recent years seemed stable with minor annual fluctuations (Hirano et al. 2004, M. Ueta unpubl. data). Therefore, it is unlikely that the small number of buzzards observed in 1990s survey was due to annual fluctuations.

Not only forest area, but lengths of edge between forests and paddy fields, and those between forests and grasslands, were correlated with the presence of breeding Grey-faced Buzzards. This suggests that the species needs a landscape with small paddy fields intermixed within a forested area, which is represented by the *yatoda* system. This landscape is different from either extensive paddy fields or large forests. Few buzzards are observed in the extensive

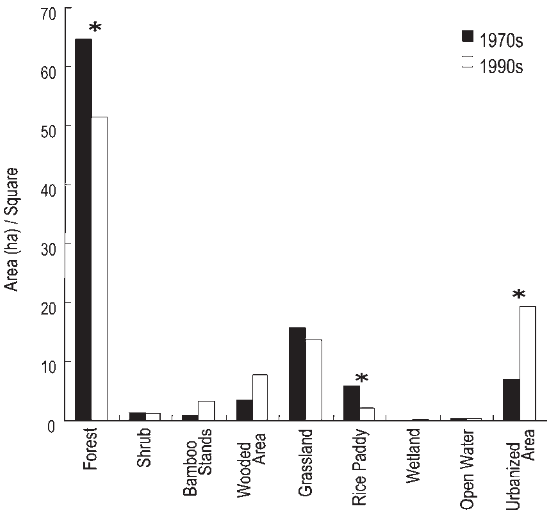

Figure 3. Mean land cover composition within survey squares occupied by breeding Grey-faced Buzzards in 1970s and disappeared in 1990s. * Differences between 1970s and 1990s were statistically significant, $P < 0.05$.

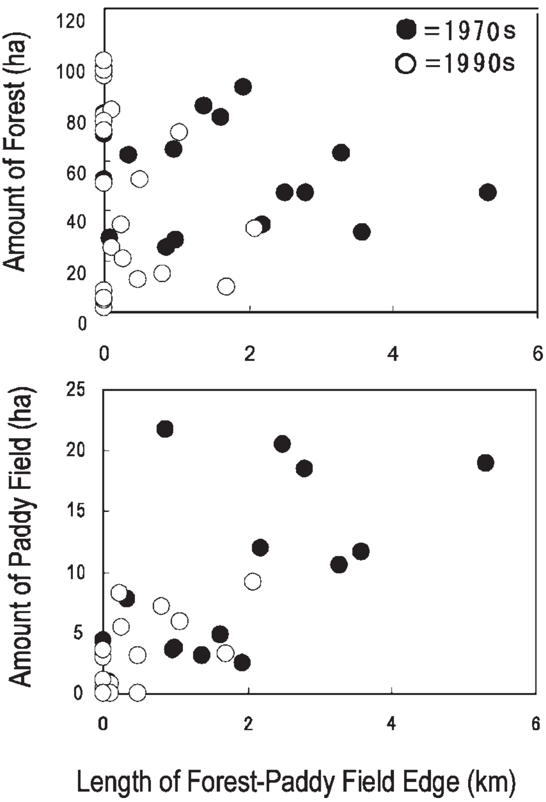

Figure 4. The relationship between length of forest-paddy field edge (km) and area of forests or paddy fields (ha).

paddy fields in west-central and northeastern Tokyo and the large, relatively-contiguous forests in western Tokyo.

The length of edge between forests and paddy fields, which had a clear association with buzzard distribution, was markedly reduced due to the loss of paddy fields. Thus, we suggest that habitat loss was primarily responsible for the decline of Grey-faced Buzzards breeding in Tokyo.

Our results support the suggestion by Azuma et al. (1999) that the *yatoda* are favorable breeding habitat for Grey-faced Buzzards because they provide amphibian and insect food throughout the breeding season as well as suitable nesting sites.

In spring and early summer, paddies provide the buzzards with a suitable hunting habitat for frogs (e.g., Japanese brown frogs [*Rana japonica*]) and in late summer when the rice grows too tall for efficient foraging, forested areas in turn provide hunting areas for arboreal prey (e.g., tree frogs [*Hyla arborea*] and insects; Azuma et al. 1998). Both species of frogs lay eggs in paddy fields, where the tadpoles develop. As they mature, they disperse from the paddy fields to the woodlands. Therefore, a combination of woodlands and paddy fields is indispensable for these two frog species to complete their life cycle. In extensive paddy-field landscapes, where mechanized farming has been introduced, pipe drain systems have been installed, resulting in the decline of frogs (*R. japonica* and *R. brevipoda*; Fujioka and Lane 1997, Azuma and Takeuchi 1999). Thus, the decrease in *yatoda* landscapes and the subsequent increase in more intensively-cultivated larger paddy fields probably have resulted in an overall decline in the number of frogs per unit of paddy field.

Although extensive paddy fields in lowlands are maintained, there is a nationwide trend in Japan to abandon rice cultivation in *yatoda* paddies because they are relatively less productive (ARC 1998). As few, if any, primeval wetlands exist in the lowlands of central Japan, wetland species, such as frogs (e.g., *R. japonica*), salamanders (*Hynobius* spp.), and Ruddy Crakes (*Porzana fusca*) utilize paddy fields as surrogate wetlands (Fujioka and Yoshida 2002). The wet and open condition of a *yatoda* habitat would have originally been maintained by natural disturbances, such as seasonal flooding and occasional wildfire. As these natural disturbances are now suppressed by human intervention; however, active rice cultivation in *yatoda* paddies is required to maintain a *wetland* habitat. It is highly desirable, but not realistic to recover or reconstruct natural wetlands for wetland species (including Grey-faced Buzzard) that historically have come to depend on paddy fields. As conventional rice farming in *yatoda* paddies is no longer economically viable, the establishment of incentive programs to encourage the maintenance of *yatoda* habitats are needed. The implementation of a price support program for the rice cultivated in *yatoda*, including its use for brewing *sake* (Moriyama 2000); the production of ''*yatoda* brand rice'' by volunteer workers to support the farmers in maintaining *yatoda* paddies (Sasaki 2000); and the use of *yatoda* paddies for educational purposes (Moriyama 2000) are some of the proposals that could facilitate *yatoda* conservation.

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