

Ecological Research and its Relationship to the Conservation Programme of the Golden Eagle and the Japanese Mountain Hawk-Eagle

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ABSTRACT

Two large raptors, the Golden Eagle *Aquila chrysaetos* and the Japanese Mountain Hawk- Eagle *Spizaetus nipalensis orientalis*, live in mountainous areas of Japan. Conservation plans have been established based on each raptor's ecology and population.

Golden Eagle: The population size is quite small. Two eggs are laid, but due to sibling aggression, only one eaglet survives. Since 1986 breeding success has dropped to crisis level. Conservation consists of two goals: 1) Increase fledgling numbers by fostering the second chick, and 2) protect from human disturbance the eagles' "high frequency use areas" which contain their nest site and main hunting areas during the breeding period.

Japanese Mountain Hawk-Eagle: Distribution is uniform throughout Japan even in mountainous areas covered with forest. Only one egg is laid. The fledglings' home range is located not only around the nest, but also within the parents' breeding territory, at least until the following spring. The principal conservation goal is to protect the breeding territory which contains the nest site and home range of the fledgling, thereby helping the fledgling reach independence. Because of the difficulty in determining the hunting areas outside of the breeding territory without radio-telemetry, a system of home range protection should be established to compensate for damage caused by human activities. Compiling accurate scientific data leads to appropriate conservation plans which are most likely to be accepted by the government agencies.

INTRODUCTION

Two large raptors, the Golden Eagle and the Japanese Mountain Hawk-Eagle, inhabit mountainous areas in Japan (Brown & Amadon 1968, Grossman & Hamlet 1964, Hidaka 1996). Although both eagles are listed as endangered species in the Japanese Red List (Environment Agency of Japan, EAJ 1991) and are under legal protection (EAJ 1993), in the past ten years both species have been jeopardized by environmental destruction caused by developers or forestry companies (Hirai 1994,

The Society for Research of the Golden Eagle, TSRGE 1983-1997, Yamazaki *et al.* 1996, Yamazaki 1997). Largely because of a lack of information about their ecology, no adequate and effective conservation plans have been put into practice (Yamazaki 1994a), and government officers and environmental impact assessment researchers have treated these two large raptors as the same species. Recently however, as a result of our research to understand their ecology and population status, effective plans for each raptor have been incorporated into conservation plans by the Government and construction companies.

STUDY AREA AND METHODS

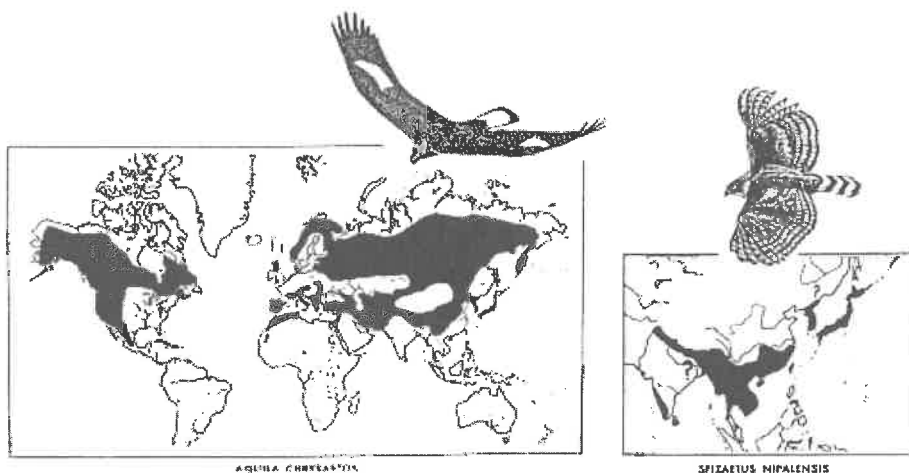
Japan is located in the north-east part of South East Asia. The climate is temperate and most of the mountainous areas are covered with trees. The Society for Research of the Golden Eagle (TSRGE) was established in 1981 and consists of approximately 150 members throughout Japan. The Society has been monitoring every known pair of Golden Eagles and collecting data on their ecology. The Project Team for Research and Conservation of the Japanese Mountain Hawk-Eagle (PTRCJMHE) began research on the ecology of the Japanese Mountain Hawk-Eagle using wing markers and transmitters in 1987. We adopted radio-telemetry because Mountain Hawk-Eagles cannot be easily observed during their usual behaviour under the forest canopy.

RESULTS

1) Legal status

Both the Golden Eagle and the Japanese Mountain Hawk-Eagle are listed as endangered species in the Japanese Red Data Book, and are under legal protection (EAJ 1991, 1993). Recently, conservation of both species has become the social argument against construction of dams, wide roads and resort facilities in mountainous areas. In most development cases, an environmental impact assessment is required by prefectural regulation, but most assessments and proposed conservation mitigation plans ignored the ecology of these two large raptors. As a result, effective conservation management has not been practised.

Figure 1. Distribution of Golden Eagle and Japanese Mountain Hawk-Eagle



2) Distribution in the world

The Golden Eagle is widespread in the northern hemisphere and is distributed in all mountain landscapes with natural grassland to open woodland (Fig. 1). Six subspecies are normally recognized, the smallest of which, *A. c. japonica*, lives in Japan and Korea (Grossman & Hamlet 1964, del Hoyo *et al.* 1994). Mountainous areas of Japan appear to be covered more or less completely by dense forest so the Japanese subspecies of Golden Eagle has survived by somehow utilizing a scattered hunting area (Yamazaki 1997).

Three subspecies of the Mountain Hawk-Eagle are found from tropical S.W. India (*S. n. kelaarti*), the Himalayas of India and Nepal east through S. China and Hainan to E. China and Taiwan, and South to North Indochina and North Malay Peninsula (*S. n. nipalensis*), to temperate Japan (*S. n. orientalis*, Fig. 1, del Hoyo *et al.* 1994). Consequently, Japan supports two large raptor subspecies whose distribution is mostly limited to mountainous areas and whose specific ecological needs require unique conservation plans.

3) Population and home range in Japan

Due to the natural scarcity of open areas, the number of pairs of the Golden Eagle is estimated approximately at only 160 (TSRGE 1983-1997) and their distribution is not uniform (Table 1). Compared with the scarcity of the Golden Eagle, more than 1000 pairs of Mountain Hawk-Eagle are estimated to live uniformly throughout Japan (Table 1).

Table 1. Population and home range of Golden and Mountain Hawk- Eagles in Japan.

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Population	160	> 1000
Number of pairs		
Distribution	Scattered, 61% inhabit northern Japan	Uniform, same density throughout Japan
Home Range or density	21-237 km ²	1 breeding pair per 25-28 km ²
Distance between neighbouring nests	Irregular	Regular, mean = 4 km (1.5-5.6 km)

The home range of the Golden Eagle varies greatly between 21-237 km² (TSRGE 1983- 1997) depending on the distribution of hunting areas. The home range of the Mountain Hawk-Eagle is normally under about 20 km² and the mean density of breeding pairs is calculated at one per 25-28 km² uniformly throughout Japan (The Project Team for Research and Conservation of the Japanese Mountain Hawk-Eagle, TPTRCJHE 1995, Yamazaki *et al.* 1995). Nests were also spaced regularly at approximately 4 km apart.

4) Hunting pattern and hunting area

The Golden Eagle forages while flying above natural grassland, bush, forest edge and deciduous forest in winter (Table 2). The existence of the more open deciduous forest enables the Golden Eagle to live in forested mountain areas of Japan (Yamazaki 1997) by flying from one hunting area to another within their large home range. The proportion of "flight" time during the day was about 17%, and much greater than the 5% "flight" time of the Mountain Hawk-Eagle. Cooperative hunting among partners is a characteristic of Golden Eagles where prey hide inside bush or forest in winter (Hidaka 1996, Yamazaki 1997). Their main prey is the Japanese wild hare (*Lepus brachyurus*), Copper Pheasant (*Phasianus soemmerringii*), and large snakes during the breeding season and summer (TSRGE 1983-1997, Yamazaki 1997).

Mountain Hawk-Eagles mainly forage by "perch hunting" or "ambush hunting" inside or along forest edge (Table 2). They sometimes perch on a branch for an extensive amount of time waiting

until prey appears. They never hunt cooperatively and the pair bond is maintained only during the breeding season (Yamazaki *et al.* 1995). They prey on various small and medium- sized mammals and birds (Yamazaki 1994b, Yamazaki 1997). This hunting strategy makes it very difficult to identify their location without the use of radio-telemetry.

Table 2. Hunting pattern and area of Golden Eagles and Mountain Hawk-Eagles in Japan.

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Hunting method	Soaring, single or cooperative	Perch and ambush, single
Hunting area	Grassland, bush, forest edge, deciduous forest in winter	Gap or forest edge, forest interior
Prey	Few species: hare, large snakes, copper pheasant	Varied: small to medium sized wildlife in forest
Distribution of prey	Distribution density varying within home range	Uniform distribution within home range

5) Breeding success

The breeding success of the Golden Eagle has been monitored since 1981 (TSRGE 1983-1997). Breeding success was 47.1% between 1981-1985, the same level as in other countries (Table 3). After 1986 breeding success dropped to a less than replacement level of 26.7% between 1991-1995. Fewer than 20 fledglings were observed.

Nationwide, monitoring of the Japanese Mountain Hawk-Eagle has not been completed so an accurate average value of breeding success is not available. A small sample of pairs that have been monitored for more than 10 years show that the trend is the same as the Golden Eagle: after 1991 the average breeding success dropped to around 10-35% (TPTRCJMHE 1996, Yamazaki *et al.* 1996, Table 3).

Table 3. Breeding success (%) of Golden Eagles and Mountain Hawk-Eagles in Japan.

*sample data from just one area.

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle*</i>
1981-1985	47.1	85.7
1986-1990	41.0	62.5
1991-1995	26.7	36.8
Lowest	22.2 (1995)	16.7 (1996)

6) Breeding strategy

Golden Eagles usually lay two eggs, but due to sibling aggression, in 98.3% of breeding nests the second hatched eaglet dies (TSRGE 1983-1997). In contrast, only one egg is laid by Mountain Hawk-Eagle pairs (Table 4). After leaving the nest the fledgling Golden Eagle spends about one month near the nest, then it flies to the hunting area with its parents.

Table 4. Breeding strategy of Golden Eagles and Mountain Hawk-Eagles in Japan

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Clutch size	2-3	1
Home range of fledgling within one year	Home range of parent	Within 1000 m of nest
Food transfer from parent	Short period	Long period
Fledgling dispersal	6 months after fledging	2-3 years after fledging

The fledgling Mountain Hawk-Eagle resides within 1000 m (usually 500 m) of the nest site at least until the following spring (Yamazaki 1994b). The fledgling acquires its hunting skills around the nest site while receiving food from its male parent. The result of radio-tracking of fledglings revealed that although they gradually enlarge their home range after the next April, they do not disperse rapidly from their nest sites and appear there again even two to three years after fledgling (TPTRCJMHE 1996).

7) Structure of home range

The analysis of the home range is important to establish an adequate conservation area. Because the Golden Eagle flies while foraging, it is not difficult to observe its behaviour and to analyse the inner structure of the home range. Through three years of intensive research of one pair, we were able to model the inner structure of the Golden Eagle home range (Table 5, TSRGE 1994). There is a core area we called the "high frequency use area", which is delineated by the higher frequency of the parents' appearance than in the rest of the home range. This area contains a nesting place and most of the main hunting areas during the breeding period. Connected to this "high frequency use area" is a "buffer zone" where alternative and potential hunting areas for the breeding season are located.

Table 5. Structure of home range of Golden Eagles and Mountain Hawk-Eagles in Japan

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Territory	Occupied all year	Breeding territory is occupied inside the core area only during the breeding period.
Home range	Nearly equals the territory	Centre is home range of the fledgling; breeding territory is occupied during the breeding period.
Home range	Almost the same between pairs	Not completely the same; breeding territory is almost the same.

Analysis of the Mountain Hawk-Eagle home range is almost impossible without the use of radio-telemetry because they spend most of the daytime perched on branches either resting or foraging. With more than 10 years of telemetry research we were able to discern the structure of its home range (Table 5). The home ranges of hawk-eagle neighbours overlap (Hidaka 1996), and the breeding territory is occupied by the pair only during the breeding period (Yamazaki *et al.* 1995). The core area accommodates nesting sites, the home range of the fledgling, the breeding territory, and most hunting areas throughout year and it is approximately 7-8 km surrounding the nest site. The range centre of the breeding territory is described as the home range of the fledgling.

8) Problems of environmental impact assessment without using radio-telemetry

From our intensive study of both species, their ecology and behaviour, the structure of their home range differs and depends on their habitat and ecological needs. Research of the Golden Eagle is not difficult, but because the home range structure fluctuates annually, one year of research is not adequate to correctly evaluate habitat use (Yamazaki 1994a). It is very difficult to observe hunting behaviour and to identify individuals of Mountain Hawk-Eagle and almost impossible to visually analyse the structure of the home range. The most serious problem of Mountain Hawk-Eagle research is overestimation of the high frequency use area from the course of flights because only flight behaviour is observable by visual methods (Table 6).

Table 6. Problems with environmental impact assessment studies without the use of radio-telemetry for Golden Eagles and Mountain Hawk-Eagles in Japan.

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Observation	Easy	Difficult
Appearance of other individuals	Not often	Often
Identify individuals	Easy	Difficult (fledgling is easy)
Finding the nest site	Comparatively easy	Usually difficult
Identify hunting area	Not difficult	Almost impossible
Analysis of home range structure	Possible	Impossible
Serious problems	Annual fluctuation of home range structure	Overestimation of the high frequency use area from flight observations

9) Minimum information necessary to establish conservation plans

Before completing the conservation model of each species we decided on the following minimum necessary information (Table 7). Although both eagles are listed as endangered species the critical levels of their respective populations are different. Currently, the annual number of Golden Eagle fledglings is too small to maintain the population in Japan (Yamazaki 1997). Because the habitat of the Golden Eagle is not distributed uniformly, the home range size of each pair varies greatly (TSRGE 1983-1997). We can easily imagine that the structure of the home range is different for each pair. Fortunately, it is possible to analyse the structure of the home range of the Golden Eagle because of its aerial hunting style. The most important area to protect is at least the minimum area necessary for reproduction, the "high frequency use area", but annual fluctuation of this area must be measured and included in the protected area (Yamazaki 1994a).

Table 7. Minimum information needed to establish conservation plans for Golden Eagle and Mountain Hawk-Eagles in Japan.

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Population size	Critical	Vulnerable
Breeding success	Drastic decrease	Drastic decrease
Home range variation among pairs	Varies greatly	Similar
Hunting area	Scattered in home range	Distributed uniformly
Specifying the hunting area	Not difficult	Almost impossible
Hunting area for breeding	High frequency use area	Core area (usually within 1.5km of the nest)
Minimum area needed for reproduction	High frequency use area; annual fluctuation occurs	Breeding territory (core area desirable); range centre (home range of fledgling is easy to identify and mostly the same between years)

By contrast, the home range of the Mountain Hawk-Eagle is similar throughout Japan, but it is difficult to locate its hunting areas and the range of each pair due to the densely forested habitat. However, we realized that most of the hunting areas for breeding are located within the core area. We also discovered that the most important range to protect for breeding success is that area where the fledgling resides until the following spring (TPTRCJMHE 1996, Yamazaki 1994b). Fortunately, it is comparatively easy to determine this area because the fledgling tends to perch on top of trees and has a conspicuous whitish breast.

10) Conservation models

The Golden Eagle: The emergency plan is to increase fledgling numbers by fostering the second chick, thereby maintaining the minimum population (Yamazaki 1997). Captive breeding is also necessary. In addition to these attempts, we have repaired nests which are not in good condition (Table 8, TSRGE 1983-1997). Habitat conservation is also needed. Due to the variation of each home range and the yearly fluctuation of its high frequency use area, at least three years of research is necessary to reveal the structure of the home range (Yamazaki 1994a). Once known, the "high frequency use area", which includes the nesting area and hunting areas during the breeding period, must be protected from human disturbance.

Table 8. Conservation models for Golden Eagles and Mountain Hawk-Eagles in Japan.

	<i>Golden Eagle</i>	<i>Mountain Hawk-Eagle</i>
Emergency plan to increase fledglings	Foster the second chick; captive breeding; nest repairing	Not necessary
Habitat conservation plan	Must be designed for each territory	Can establish a typical conservation model
Purpose and length of assessment research	Analyze structure of home range; at least three years of study	Specify home range of fledgling; at least one breeding period
Area to be strictly protected	High frequency use area	Breeding territory, especially home range of fledgling before independence
Theme for conservation of hunting area	Protection of hunting area used in breeding	Compensation for damaged areas
Special research	Causes of breeding failures	Causes of breeding failures

The Japanese Mountain Hawk-Eagle: An emergency plan for increasing fledgling rate is not necessary right now. The principal of conservation is to establish protection of the home range and to apply it to every pair throughout Japan. The most important point is to protect the home range of fledglings (Yamazaki 1994b) and the breeding territory to help maintain their number. Concerning the remaining area of the breeding territory, because of the difficulty in determining hunting areas by observation, we propose that construction companies compensate for damaged forest by providing adequate hunting area in alternative locations inside or close to the core area. In addition to these plans, it is a matter of course that research to analyse the causes of breeding failure is also necessary for both species.

CONCLUSION

Raptors are at the top of the food chain. Their conservation can therefore support the conservation of the entire ecosystem. If their conservation model is not defined and effective, we fail to protect not only the endangered raptors but also our natural environment.

First, sufficient scientific research about the ecology and habitat use of raptors is needed to establish an effective conservation model. Compiling accurate data leads to appropriate conservation decisions. Approximately 40% of raptors in the world are found in tropical forest (Thiollay 1985) and most of them are soon to be endangered. Up to today, the conservation models for raptors were decided upon in European and American countries (Newton 1990), but they are not always effective for raptors living in tropical forest. Even more information about the basic ecology of large tropical forest raptors in Asia is needed to adequately conserve and protect them and their habitat.

We completed our conservation models according to our special research for each species. These accurate conservation models persuaded the government and construction companies to accept and implement recommended plans.

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