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WINTER DIET OF THE GREATER SPOTTED EAGLE (*AQUILA CLANGA*) IN THE AMVRAKIKOS WETLANDS, GREECE

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The Greater Spotted Eagle (*Aquila clanga*) is a globally-threatened raptor, which breeds from Eastern Europe to the Pacific coast of the northern Far East and winters locally in southern Europe, Asia, the Middle East, and sub-Saharan Africa as far south as Uganda and Kenya (Tucker and Heath 1994). The main reasons for its decline are habitat destruction and degradation (in both forests, where the species nests, and wetlands, where it forages), disturbance during the breeding season, illegal shooting (mainly in migration), and to a lesser extent, nest robbing (Tucker and Heath 1994, Meyburg et al. 2001). The primary proposed conservation measures include the establishment of protected areas in the breeding habitat of the species, preservation of a mosaic of breeding-feeding habitat, protection of wetlands, avoidance of disturbance during the breeding season within 300 m of nests, as well as improvement of legislation,

international cooperation, monitoring, and research (Meyburg et al. 2001). The biology of the Greater Spotted Eagle has not been examined to a great extent; additionally, its diet has been examined almost exclusively during the breeding season (e.g., Priklonsky 1960, Galushin 1962, Pankin 1972, Ivanovsky 1996). Few studies of any kind have been conducted in the winter quarters of this species (Moltoni 1943, Francois 1992, Qingxia 1996)

Although an important population of Greater Spotted Eagles winters in the extensive wetlands of northern and central Greece (45–85 individuals), up to now it has received very little attention (Hallmann 1989, Handrinos and Akriotis 1997). Here, we present the results of an examination of Greater Spotted Eagles at a key wintering site, the Amvrakikos wetlands, western Greece, where up to 12 individuals winter each year.

STUDY AREA AND METHODS

Our study area was in the Amvrakikos wetlands, western Greece (38°59'–39°11'N, 20°44'–21°07'E). Amvrakikos is a Ramsar Wetland, a Special Protection Area, and proposed National Park. It is one of the largest wetlands in Greece covering 220 km² including river deltas, coastal

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lagoons, extensive saltmarshes, reedbeds, relic riparian woods, and grazed grasslands. Large areas bordering the salt marshes have been drained and support intensive agriculture and livestock farming. The roost site of the Greater Spotted Eagles observed was located in a small clump of very tall *Eucalyptus* trees on the banks of the Arachthos River, <2 km away from a major village. This roost is ca. 2 km from the estuarine wetlands of the river delta and is in a region of intensive agriculture, dominated by citrus plantations. The scattered trees along the bank of this region of the river include white poplar (*Populus alba*), willows (*Salix* sp.), ashes (*Fraxinus* sp.), and common alder (*Alnus glutinosa*). Amid the native riparian trees are a few planted eucalyptus (*Eucalyptus* sp.), some reaching a considerable height (ca. 40 m). In the winter of 2001–02, eagles roosted exclusively on the *Eucalyptus* sp., but they did not seem to use these trees in the winter of 2002–03, although they did gather to roost in the tree stands in the vicinity. In other parts of Amvrakikos, eagles roost on oaks (*Quercus* spp.) in the adjacent limestone hills (100–300 m elevation) 1–5 km away from the wetland habitats. We located four such roosts in the Amvrakikos, but pellets were collected only from the one at the Arachthos Delta because the others were in relatively inaccessible areas (steep, forested hills), or difficult to pin-point with precision (woodlots in marshes).

The diet of the species was studied by the analysis of pellets that were collected in January and March 2002 from under the regular roost, in a small *Eucalyptus* clump, which was used by six to seven Greater Spotted Eagles. Up to two Common Buzzards (*Buteo buteo*) were also seen to use the trees near the *Eucalyptus* trees, but not near the eagles. Buzzard pellets were easily distinguished from those of the eagles by a combination of both size and form (eagle pellets were ca. 70–120 × 30–50 mm and had a generally loose form, while those of buzzards were ca. 50–75 × 20–35 mm and were quite compact). Because of these differences and in combination with their location, we feel that it is unlikely that pellets of the two species were confused. Prey remains were identified with the help of reference books (Brown et al. 1987, Chinery 1993, Macdonald and Barrett 1993). The number of prey items was determined by counting the number of skull and major limb bones represented, when these were present; unless these indicated otherwise, we assumed the presence of one individual of each prey type per pellet.

RESULTS

We collected 57 pellets from the *Eucalyptus* roost, used by 6–7 individuals. The size of the pellets was ca. 70–120 × 30–50 mm. In the study area, the Greater Spotted Eagle preyed primarily on birds, but it also took mammals, reptiles, amphibians, fish, and insects (Table 1). By numbers, among 95 prey items, birds comprised 84.2% of the diet, followed by insects, mammals, reptiles, fish and amphibians (Table 1). By mass, birds were even more important (94.6%), while other prey were of comparatively minor importance. The most important birds, in terms of biomass, were ducks, particularly Eurasian Wigeons (*Anas penelope*) and Common Teals (*Anas crecca*), as well

as Common Moorhens (*Gallinula chloropus*), Common Coots (*Fulica atra*), Little Egrets (*Egretta garzetta*), and small gulls (*Larus* spp.). We also found lead shot in 3.2% of the pellets.

DISCUSSION

Although the sample was comparatively small, some interesting conclusions may be drawn. The proportion of birds found in the diet was higher in the Amvrakikos wetlands than in any other study of the Greater Spotted Eagle. Priklnsky (1960), in the mouth of the Belaya River, Russia, based on pellet analysis (78 pellets and 274 prey items) reported the diet of the species, consisting of 69.0% mammals, 23.0% reptiles, 7.7% birds, and 0.3% fish (only vertebrates included). In addition, insects occurred in 29.4% of the pellets and carrion (primarily moose [*Alces alces*]) in at least 20.5% of the pellets. Study of the prey remains in the nests of the eagles also revealed a predominance of mammals and birds. Most mammals were small rodents, while most reptiles were snakes. Priklnsky (1960) summarized the results of several studies as follows: mammals 66.0–88.6%, birds 46.2–97.0%, insects 5.5–34.0%, and reptiles 0.0–12.3% (occurrence in pellets). Galushin (1962) in the valley of the Oka River during the period 1954–57, found the following yearly variation in diet: mammals 42.6–68.0%, birds 32.0–69.0%, fish 0.0–1.8%, and reptiles and amphibians each 0.0–0.6% (based on prey numbers). In Byelorussia, Ivanovsky (1996) found that 50 prey items (from remains) were 53.8% mammals, 21.1% amphibians, 17.4% birds, and 7.7% reptiles. Qingxia (1996) studied the diet of the eagles wintering in the Lishan Nature Reserve (China) and found the diet consisted of about equal numbers of mammals and birds ($N = 68$ prey items). The mammals consumed were mostly rodents, as well as some rabbits, collectively making up 52.1% of the diet by biomass. A variety of bird species were also eaten (47.9% of diet by biomass), including several gamebirds (Phasianidae).

Often, the study of pellets can result in biased estimates of diet composition; that is, this methodology can lead to the underestimate of certain prey types (particularly amphibians) and the overestimate in others. Vlachos and Papageorgiou (1996) found that a large proportion of the prey delivered in the nests of Lesser Spotted Eagles (*Aquila pomarina*), as recorded by direct observation, consisted of frogs, but these were only infrequently represented in the pellet analysis. Also many, or all, of the insects found in pellets in this and other studies, may have been ingested secondarily (i.e., consumed by the eagle prey).

Nearly all the prey species identified inhabited wetland habitats, particularly the salt marshes and coastal lagoons (Table 1). Surprisingly, few species of prey from the adjacent agricultural lands were taken (e.g., the small rodents and beetles).

The high proportion of water birds in our study was

Table 1. Diet of the Greater Spotted Eagle (*Aquila clanga*) in the Amvrakikos Wetland ($N = 57$ pellets).

COMMON NAME	SCIENTIFIC NAME	NUMBER	PERCENT NUMBER	PERCENT BIOMASS
Insects	Insecta	5	5.3	<0.1
Ground beetles	Carabidae	5	5.3	<0.1
Fish	Pisces	2	2.1	3.1
Mulletts	Mugilidae	2	2.1	3.1
Amphibians	Amphibia	1	1.1	0.1
Frogs	<i>Rana</i> sp.	1	1.1	0.1
Reptiles	Reptilia	3	3.2	0.5
Snakes	Colubridae	3	3.2	0.5
Birds	Aves	80	84.2	94.6
Little Egret	<i>Egretta garzetta</i>	3	3.2	4.7
Eurasian Wigeon	<i>Anas penelope</i>	11	11.6	27.4
Common Teal	<i>Anas crecca</i>	17	17.9	15.9
Unidentified ducks	<i>Anas</i> spp.	5	5.3	7.8
Spotted Crake	<i>Porzana porzana</i>	1	1.1	0.3
Water Rail	<i>Rallus aquaticus</i>	2	2.1	0.7
Common Moorhen	<i>Gallinula chloropus</i>	16	16.8	14.9
Common Coot	<i>Fulica atra</i>	4	4.2	8.7
Unidentified rails	Rallidae	1	1.1	0.3
Northern Lapwing	<i>Vanellus vanellus</i>	1	1.1	0.6
Common Redshank	<i>Tringa totanus</i>	1	1.1	0.4
Common Snipe	<i>Gallinago gallinago</i>	1	1.1	0.3
Unidentified scolopacids	Scolopacidae	1	1.1	0.3
Yellow-legged Gull	<i>Larus cachinnans</i>	1	1.1	3.7
Unidentified small gulls	<i>Larus</i> spp.	5	5.3	4.7
Hooded Crow	<i>Corvus corone</i>	1	1.1	1.6
Reed Bunting	<i>Emberiza schoeniclus</i>	3	3.2	0.3
Unidentified passerines	Passeriformes	4	4.2	0.4
Unidentified birds	Aves	4	4.2	1.9
Mammals	Mammalia	4	4.2	1.7
Eastern Hedgehog	<i>Erinaceus concolor</i>	1	1.1	1.6
Unidentified voles	<i>Microtus</i> sp.	1	1.1	0.1
Unidentified mice	<i>Mus</i> spp.	2	2.1	0.1
Total	—	95	—	—

probably due to their high availability in the area, compared with other potential prey during the study period. The winter of 2001–02 was relatively “severe” with periods of frosts, thus reptiles and amphibians would hardly have been available to the eagles (in fact, the presence of reptiles and amphibians, even in low numbers, was surprising). This may be true, to a lesser extent, for the smaller mammals as well. On the other hand, large numbers of waterfowl winter in the Amvrakikos wetlands, including up to 100 000 ducks and coots in certain years. The eagles mostly hunt prey from perches (often on low tamarisk, *Tamarix* spp.), or from embankments, or patrolling by gliding low over extensive wetland areas,

where many water birds are present. These areas, as well as providing relatively abundant prey, also provide cover suitable for the eagles to surprise their prey. We made relatively few observations of the eagles over large open lagoons or the surrounding sandy spits, in which the highest numbers of waterfowl winter.

As well as capturing healthy prey, the eagles probably also took injured or dead birds, as suggested by the presence of lead shot in two pellets. The presence of lead shot in the pellets indicated that the Greater Spotted Eagle fed on birds shot, but not retrieved by hunters (see also Hallmann 1989). Lead shot is considered to be a serious threat for many wetland raptors, such as the West-

ern Marsh-Harrier (*Circus aeruginosus*) in France (Pain et al 1997). Therefore, the potential effect of lead shot on the Greater Spotted Eagle should be investigated.

Stands of trees, which provide perches for look-outs and roosting, are important for the hunting eagles and should be protected. Riparian woodlots and large trees are often cut by local inhabitants, and thus roost sites (actual or potential) may be threatened by this activity.

Poisoning is also a potential threat. Because several unauthorized refuge dumps exist in the Amvrakikos Wetlands, the threat of poisoning through scavenging at dumps is present. Also, eagles could feed on poisoned carrion laid out illegally by local farmers for deterring foxes and other canines. Therefore, extent of scavenging and the susceptibility of the Greater Spotted Eagle to such poisoning should be investigated.

RESUMEN.—Se examinó la dieta de águilas *Aquila clanga* en los humedales de Amvrakikos en el oeste de Grecia por medio de análisis de egagrópilas. Con base en el número de presas, la dieta estuvo compuesta principalmente por aves (84.2%) y por cantidades menores de insectos (5.3%), mamíferos (4.2%), reptiles (3.2%), peces (2.1%) y anfibios (1.1%). Las aves fueron supremamente importantes en términos de biomasa (94.6%); las presas principales fueron patos del género *Anas*, y los ráldidos *Gallinula chloropus* y *Fulica atra*. La gran mayoría de las presas correspondió a especies que se encuentran casi exclusivamente en humedales.

[Traducción del equipo editorial]

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