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Occurrence of Griffon Vulture *Gyps fulvus* in Slovenia in the period from 1980 to 2005

Pojavljanje beloglavih jastrebov *Gyps fulvus* v Sloveniji od leta 1980 do 2005

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The authors of the article have gathered and processed data on the occurrence of Griffon Vulture *Gyps fulvus* in Slovenia. The habitat analysis was made for the sub-Mediterranean region and part of the Dinaric region, in which the Griffon Vulture occurs (Kambreško, Banjšice; Trnovski gozd, Nanos and Hrušica; Pivško podolje and Vremščica; Javorniki and Snežnik). Altogether, 242 observations of this species were made in Slovenia in the last 25 years, during which 672 birds were recorded. The bulk of the data concerns observations of single individuals (45%). Eight or more birds were recorded in less than 5% of all observations. Concurrently, 24 individuals were recorded at the most. The birds as well as thermals were registered largely in the warm part of the year. The vultures characteristically glided above the higher lying slopes exposed to the south (SW), notably over areas with altitudes between 600 and 1200 m a.s.l. There were no differences between exposure distribution of Griffon Vultures and thermals. The majority of birds were observed on the southern margins of Trnovski gozd, Nanos and Snežnik, and in Čičarija and Kraški rob (Karst Edge). In spite of the 65% forest density, only 30% of the Vultures were observed over forests. In 70%, the birds were seen gliding above unforested areas. Above these areas, the thermals characteristically occurred as well. The thermals are probably the main reason for the predictable occurrence of Griffon Vultures in Slovenia, whereas the slopes and ridges are significant for the vultures' movements also at the time when there are no thermals above them. Owing to the rising air masses along the natural barriers, they enable the Griffon Vultures the so-called slope soaring, with the aid of which they can also cover very long distances, which actually explains the occurrence of Griffon Vultures at Dinaric ridges.

Key words: Griffon Vulture, *Gyps fulvus*, Slovenia, thermals
Ključne besede: beloglavi jastreb, *Gyps fulvus*, Slovenija, vzgorniki

1. Introduction

The Griffon Vulture *Gyps fulvus* in Europe inhabits mainly countries bordering the Mediterranean. The species' stronghold is Spain, which supports around 80% of the total number in Europe. In 1999 there were 17300 – 18100 breeding pairs. The Greek and French populations, with 173 – 194 and 589 – 639 breeding pairs respectively are also significant (BirdLife 2004). The closest breeding colonies to Slovenia are on the Kvarner islands (N part of the Adriatic sea; Croatia) with 90 – 100 breeding pairs (Radović *et al.* 2003) and a reintroduced colony of 10 – 20 breeding pairs in Italy *(own data)*. The Italian colony however was established in 1992 in Forgaria nel Friuli (province of Udine) as a result of a reintroduction project. The first successful breeding was observed in 1996 (Genero & Perco 1997).

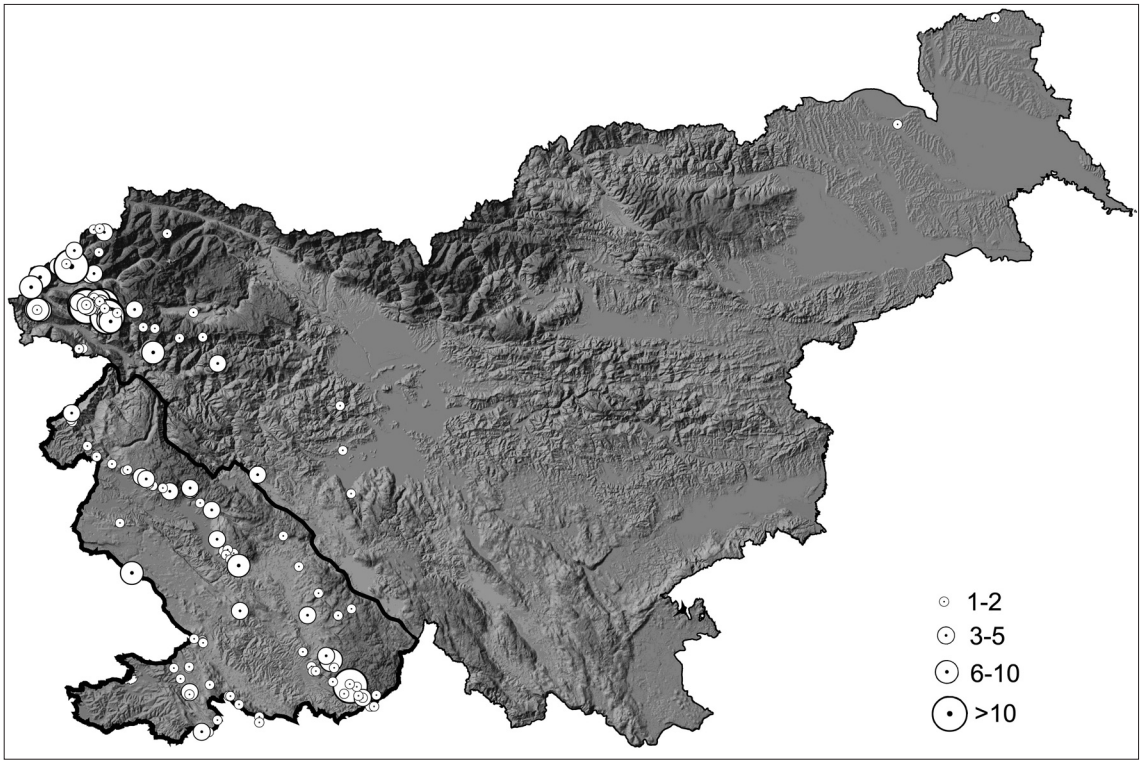

Figure 1: Records of Griffon Vulture *Gyps fulvus* in the last 25 years in Slovenia; dot size indicates the number of birds observed; black border indicates the study area

Slika 1: Opazovanja beloglavih jastrebov *Gyps fulvus* v zadnjih 25 letih v Sloveniji; velikost pik označuje število osebkov, črni rob pa meje preučevanega območja

Griffon Vultures do not breed in Slovenia but are mainly summer visitors during the passage from Kvarner towards Alps (Sušić 1990). Some birds were observed together with the Italian population (Genero & Perco 1997). They are also regular visitors in the Alps (Genero 1985, 1988 & 1995). Outside the Alpine region, only individual and random observations have been made (Gjerkeš 1994, Grošelj 1991 & 1999, Lipej & Gjerkeš 1995, Senegačnik *et al.* 1998, Surina 1999, Szymanski 2002, Šere 1998, Šinigoj 2002). Benussi (1997) published randomly collected data for the area of Trieste.

The aim of this article is to present new data concerning the occurrence of the Griffon Vulture in Slovenia and to identify the features of the landscape where they were observed.

2. Material and methods

2.1. Field recording of Griffon Vultures

The data were collected from the literature and several unpublished sources. Appeals for data were made through the media, membership of DOPPS – BirdLife Slovenia, homepage [www.ptice.org] and via e–mail groups. Only records with location date and number of observed birds were taken into consideration.

The data were processed using programs ArcView 3.3 (ESRI 2002) and IDRISI Kilimanjaro (Eastman 2003).

Each record was discussed with the author in order to determine location within 100 m. In cases where the exact location was not known, the data were used only for overall presentation of Griffon Vulture's occurrence in Slovenia and excluded from the habitat analysis.

2.2. Variable measurements

The habitats where vultures were observed were analysed for the sub-Mediterranean and Dinaric regions (Kambreško, Banjšice; Trnovski gozd, Nanos and Hrušica; Pivško podolje and Vremščica; Javorniki and Snežnik; regions identified according to Perko & Orožen–Adamič 1998). Since the data for the Alpine

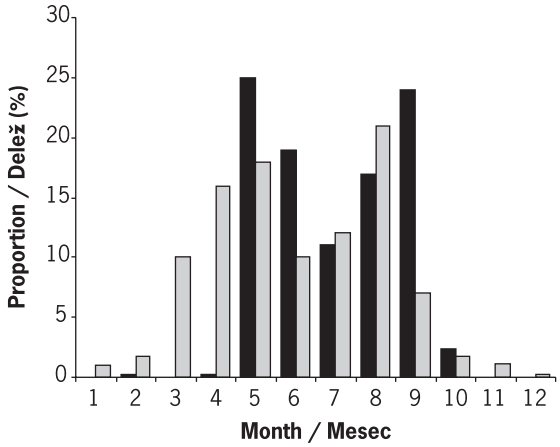

Figure 2: Seasonal distribution of Griffon Vulture *Gyps fulvus* records (black; N = 622) and thermals (grey) in Slovenia

Slika 2: Sezonska razporeditev opazovanj beloglavega jastreba *Gyps fulvus* records (črna barva; N = 622) in vzgornikov (siva barva) v Sloveniji

region were collected by systematic observation only on a few locations, the Alpine region was not included in habitat analysis.

Altitudes of the ground under the flying vultures were acquired with the digital model of relief (DMR100) using ArcView program. Exposure and slope were ascertained by Idrisi program as well as a land use map (MKGP 2002). Land use was classified as forest (code 2000) and open areas (all other codes). Data on thermals (columns of rising warm air) were acquired from the internet [www.friulano.it/t2t_euromap_thermals.php?] for the square between 12 – 16°E and 44 – 46°N. These data on thermals were processed as for observations of Griffon Vultures, and were obtained with GPS technology from paragliders in years 2002 – 2004.

2.3. Statistical procedures

In order to identify preferred land structures for flying Griffon Vultures, data were compared with 180 randomly selected points generated in the Idrisi program all over the sub-Mediterranean and Dinaric regions. Environmental descriptors were altitude and slope as continuous, and exposure and land use as discontinuous variables. We used a multiple logistic regression (method stepwise forward) in SPSS program to detect those significant variables that determine the probability of detecting a Griffon Vulture over particular environmental features.

3. Results

In 242 observations over the last 25 years, 672 birds were recorded. Most of the data are based on observation of individual birds (45%), in 15% two birds were observed, in 13% three birds and in less than 5% cases more than eight birds were observed at once. The maximum number of observed birds was 24. The data are shown on Figure 1.

3.1. Seasonal occurrence

Almost all data were recorded in warm periods of the year, 97% (N = 622) between the beginning of May and the end of September. Most thermals were also present in summer months, the differences being in spring (March, April), when thermals were relatively frequent but observations were scarce. The seasonal occurrence is shown on Figure 2.

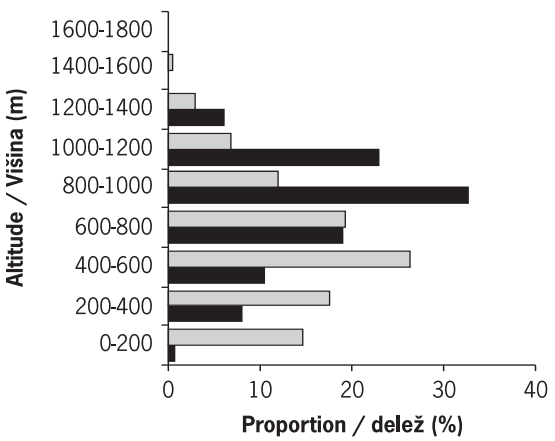

Figure3: Altitudinal distribution of Griffon Vulture *Gyps fulvus* records in the study area (black; N = 162) and altitudinal distribution of the entire study area (grey; N = 2826)

Slika 3: Višinska porazdelitev opazovanj beloglavega jastreba *Gyps fulvus* v preučevanem območju (črna barva; N = 162) in višinska porazdelitev celotnega obravnavanega območja (siva barva; N = 2826)

3.2. Landscape analysis

In order to analyze the landscape parameters of observations, we used 90 records (see Methods) in which 162 birds were observed.

Classification table shows correct classification of model in 79.8% of cases.

The SPSS output is shown in Table 1.

Table 1: Differences in habitat variables among Griffon Vultures *Gyps fulvus* observations and randomly selected points in the study area using logistic regression model (SPSS output)

Tabela 1: Razlike v spremenljivkah habitata med opazovanji beloglavega jastreba *Gyps fulvus* in naključno izbranimi točkami na območju raziskave; uporabljen je bil model logistične regresije (izpis programa SPSS)

Variables / Spremenljivke	Wald	df	Sig.	Odds Ratio/ Razmerje obetov
open areas / odprte površine	29.9172	1	<0.001	5.8596
exposition / smer neba				
joint / skupno	31.1813	8	<0.001	
N / S	1.8048	1	*ns*	0.1796
NE / SV	1.9735	1	*ns*	3.0123
E / V	0.4126	1	*ns*	0.5558
SE / JV	1.0503	1	*ns*	0.3683
S / J	0.1085	1	*ns*	1.2908
SW / JZ	3.6945	1	0.0546	4.3313
W / Z	0.0264	1	*ns*	0.8792
NW / SZ	0.0378	1	*ns*	1.1830
slope / naklon	10.9390	1	<0.001	1.3791
altitude / višina	20.0060	1	<0.001	1.6736

3.3. Altitude

Most of the birds were observed above high ground and 75% were flying over areas with altitudes between 600 and 1200 m a.s.l. (Figure 3). Odds for the presence of Griffon Vultures were significantly increased ($p < 0.001$) with increasing altitude. Odds ratio increase was 1.67 for an increase of 200 m. The majority of birds were observed above the hillsides of Trnovski gozd, Nanos, Snežnik, Čičarija and Carst Edge.

The difference between altitudinal distribution of Griffon Vultures and of thermals was significant ($\chi^2 = 28.93$; $p < 0.001$) due to the lower altitudes of thermals.

3.4. Exposure

The exposure of sites where birds were observed and exposure of the entire study area are shown on Figure 4. In more than half the cases (55%), birds were seen on south-west exposures. The parameter in the logistic model was significant (Wald = 31.18, $p < 0.001$); the odds ratio is the highest on SW expositions (Exp B = 4.33; $p = 0.054$).

There were no differences ($\chi^2 = 13.67$; *ns*) between exposure distribution of Griffon Vultures and thermals.

3.5. Slope

The distributions of inclinations where birds were observed and of the entire study area are shown on Figure 5. The majority of birds (77%) were seen above areas with inclinations of between 5 – 25 degrees.

The parameter in the logistic model was significant (Wald = 10.93, $p < 0.001$). Odds ratio increase was 1.34 for 5° slope increase.

The differences in inclinations of Griffon Vulture observation points and of thermals were significant ($\chi^2 = 73.48$; $p < 0.001$).

3.6. Land use

In spite of 65% forests coverage, 30% of all vultures were observed above the forests in the study area. The rest were observed above open areas with much smaller proportion of forest (30%). The parameter in the logistic model was significant (Wald = 29.92, $p < 0.001$). Odds ratio for non-forest areas was 5.86 compared with forest areas.

Thermals were, similar to Griffon Vultures, distributed significantly ($\chi^2 = 1.86$; *ns*) over open areas (Table 2).

Table 2: Proportion of land use in entire study area and on locations where Griffon Vultures *Gyps fulvus* were observed or where thermals appeared

Tabela 2: Delež rabe tal v obravnavanem območju in na lokacijah, kjer so bili opazovani beloglavi jastrebi *Gyps fulvus* oz. so se pojavljali vzgorniki

Land use / Raba tal	Study area/ Raziskovano območje	*Gyps fulvus*	Thermals / Vzgorniki
open areas / odprte površine (%)	34.5	69.8	60.6
forests / gozdovi (%)	65.5	30.2	39.4

4. Discussion

Vultures are typical gliders. They depend on cliffs as nesting places, domestic livestock carrion as food (Tucker & Heath 1994) and also areas where wind thermals facilitate soaring (Cramp 1980; Gensbol 1987). The reasons for their occurrence in Slovenia and the Alpine region are feeding areas on highland pastures which are an important source of domestic livestock carrion during the summer (Genero 1995, Gluz *et al.* 1971). Their longer trips depend mainly on thermals over open and dry areas and rising air-currents over upland and mountain areas (Cramp 1980, Tucker & Heath 1994). This can explain why they occur in Slovenia mainly in warm periods of the year, when the thermals are frequent (Figure 2).

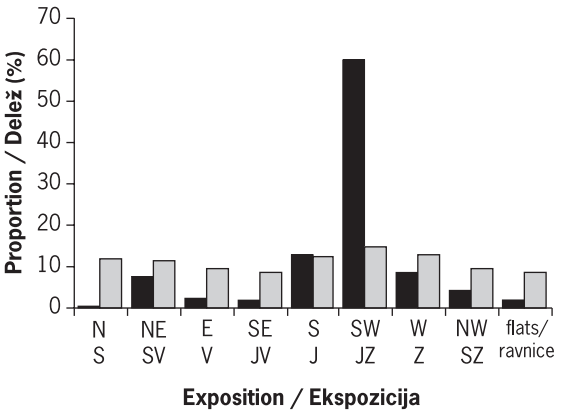

Figure 4: Expositional distribution of Griffon Vulture *Gyps fulvus* records in the study area (black; N = 162) and expositional distribution of the entire study area (grey)

Slika 4: Ekspozicijska porazdelitev opazovanj beloglavega jastreba *Gyps fulvus* v preučevanem območju (črna barva; N = 162) in ekspozicijska porazdelitev celotnega obravnavanega območja (siva barva)

Thermal winds are probably one of the main reasons for the predictable occurrence of Griffon Vultures. Comparison of the studied parameters between entire study area and locations where Griffon Vultures were observed suggests that Griffon Vultures do not appear at random locations within the area. They significantly appeared above open or less forested hillsides on higher altitudes which are SW exposed. Thermal winds were registered on areas with the same characteristics as those typical for Griffon Vultures occurrence. There were no significant differences between the distribution of Griffon Vultures and the occurrence of thermals, as compared to exposure and land use.

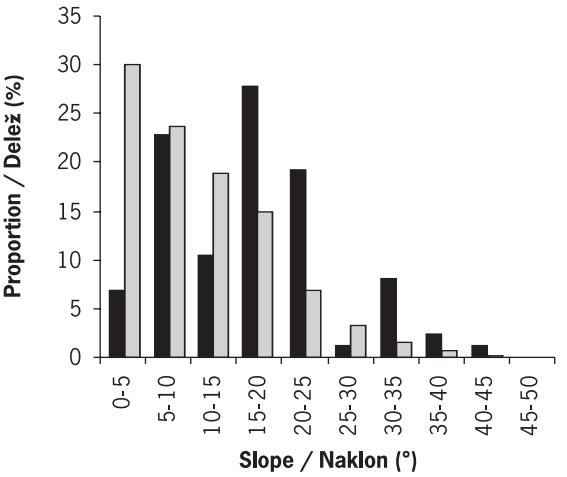

Figure 5: Slope distribution of Griffon Vulture *Gyps fulvus* records in the study area (black; N = 162) and slope distribution of the entire study area (grey)

Slika 5: Pobočna porazdelitev opazovanj beloglavega jastreba *Gyps fulvus* v preučevanem območju (črna barva; N = 162) in pobočna porazdelitev celotnega obravnavanega območja (siva barva)

Comparison with altitude and inclination distribution showed difference. The reason could be that hillsides and ridges are important for vultures, even when there are no thermals above them. Air currents, to which hillsides act as barriers, are forced to rise, enabling birds to soar (Gill 2000).

These results could explain why concentrations of Griffon Vultures were found along the Carst and Dinaric ridges. These areas are essential for the presence of the species in Slovenia as they serve as corridors for these birds. They enable the colony from Kvarner to reach the Alps as well as the Italian colony. In the opposite direction, Italian vultures can join with the colony from Kvarner. There are probably no other natural corridors in the area that would enable migrations in these directions. Registered thermals also indicate continuation of such corridors from Kvarner towards the Alps (Figure 6).

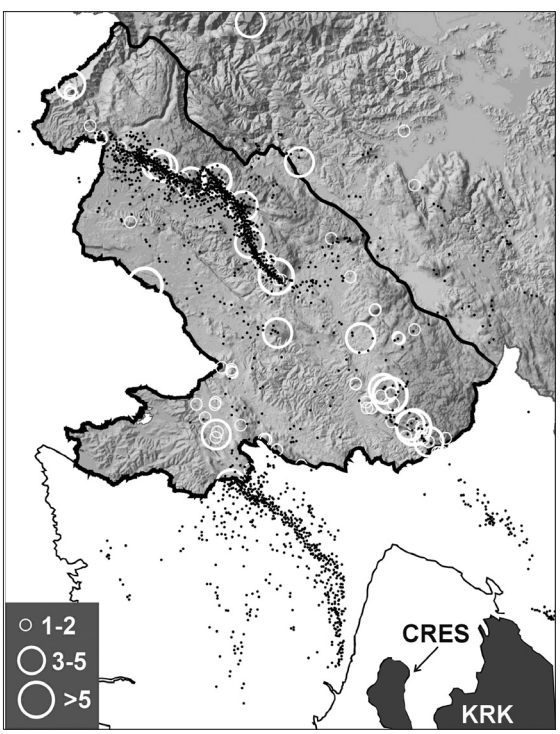

Figure 6: Occurrence of thermals (black dots) in the study area and Istria; grey colour indicates Krk and Cres islands in the Kvarner region with breeding colonies of Griffon Vulture *Gyps fulvus*; white rings indicate records of Griffon Vultures in the study area

Slika 6: Pojavljanje vzgornikov (črne pike) v preučevanem območju in Istri; siva barva ponazarja otoka Krk in Cres v Kvernerskem zalivu z gnezdečimi kolonijami beloglavega jastreba *Gyps fulvus*; beli krožci ponazarjajo opažanja beloglavih jastrebov v preučevanem območju

The vultures fly through these corridors almost in line. This phenomenon is most obvious at Trnovska planota and Nanos, where all observations have been located very close to their edge. This can be explained by the fact that Griffon Vultures soar.

According to data from literature (Cramp 1980, Gluz *et al.* 1971), daily migratory distances of breeding vultures do not exceed 50 – 60 km. The Slovene border is around 50 km away from the Croatian colony and 30 km from the Italian. That is why in Slovenia we can expect predominantly non–breeding birds. In one day Croatian breeding vultures probably reach only the south-western part of Slovenia (S hillsides of Snežnik and Čičarija, together with Carst Edge) while breeding birds from Italy should visit the Slovenian Alps frequently. There are several records of small groups of vultures observed on Breginjski Stol. In the morning they fly from Italy to Krn and, after a few hours, return in the opposite direction (L. Božič *pers. comm.*).

Because data were collected unsystematically they could be biased by different observational activity in the different regions. According to the geographical distribution of sightings for Slovenia published in the journal Acrocephalus (Tome 2000), vulture observations are located in the areas where few observations of any birds have been made. No observations of this species have been recorded from the SW part of the study area where there has been higher observational activity. Also the field surveys for the New Breeding Bird Atlas of Slovenia where the same observation effort is used for whole study area show that registrations of vultures in Atlas surveys are on the same locations as unsystematically collected data (*own data*).

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5. Povzetek

Avtorja članka sta zbrala in obdelala podatke o pojavljanju beloglavega jastreba v Sloveniji. Analiza habitata je bila napravljena za submediteransko in del dinarske regije, v kateri se beloglavi jastreb pojavlja (Kambreško, Banjšice; Trnovski gozd, Nanos in Hrušica; Pivško podolje in Vremščica; Javorniki in Snežnik). Skupaj je bilo v zadnjih 25 letih zbranih

242 opazovanj beloglavih jastrebov v Sloveniji, med katerimi je bilo opazovanih skupaj 672 ptic. Največ podatkov zadeva opazovanje samo enega osebka (45% opazovanj). Opazovanj z več kot osmimi osebki je bilo skupaj manj kot 5%, hkrati pa je bilo opazovanih največ 24 osebkov. Ptice kot tudi termalna dviganja so bila registrirana predvsem v topli polovici leta. Jastrebi so značilno jadrali nad više ležečimi, južno orientiranimi pobočji (JZ) območja, večinoma nad terenom med 600 in 1200 m n.v. Med porazdelitvijo ekspozicij na lokacijah termalnih dviganj in opazovanj beloglavih jastrebov ni bilo razlik. Največ ptic je bilo opaženih na južnih obronkih Trnovskega gozda, Nanosa in Snežnika ter v Čičariji in na Kraškem robu. Kljub 65% gozdnatosti območja je bilo samo 30% jastrebov opazovanih nad gozdom. V 70% primerih so ptice jadrale nad negozdnimi površinami. Prav tako so se značilno nad negozdnimi površinami pojavljali vzgorniki. Ti so verjetno tudi glavni razlog za predvidljivo pojavljanje beloglavih jastrebov v Sloveniji, pobočja oz. grebeni pa so za premike jastrebov pomembni tudi takrat, kadar ni termičnih dviganj zraka nad njimi. Jastrebom zaradi dvigajočih se zračnih mas ob barierah omogočajo t.i. pobočno jadranje, s pomočjo katerega lahko premagujejo večje razdalje. To pa tudi pojasnjuje zgoščeno pojavljanje jastrebov na kraških in dinarskih grebenih.

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