Greifvögel & Eulen in Österreich	61–68	Wien, 2006

GIS-supported analyses of Golden Eagle (*Aquila chrysaetos*) habitats: characteristics of some eagle ranges in Austria

Michael J. McGrady[1] and Josef Pennerstorfer[2]

Abstract

Landcover in 1-minute squares (n = 103) occupied by golden eagles in Austria are described. Data were from Lower Austria, Upper Austria, and Carinthia, and comparisons between the regions (Bundesländer) were made. In general, eagles were found in squares that were more open than expected, a result that agrees with data on eagles from elsewhere in their range. Although the preference was for open areas, mixed forest was the most common closed habitat type in eagle squares. Eagles generally avoided landcovers associated with more intensive human activity. The analysis is a first step in understanding the landcovers preferred by golden eagles in Austria, but suffer from the coarse scale of the landcover dataset (CORINE), the incompleteness of eagle data (only 3 Bundesländer), and the coarse scale (1-minute squares) at which it was analysed.

Key words: golden eagle, *Aquila chrysaetos*, habitat, Austria, GIS.

Zusammenfassung

GIS-unterstützte Analyse von Steinadler (*Aquila chrysaetos*)-Habitaten: Merkmale einiger Gebiete in Österreich

Die Verbreitung des Steinadlers (*Aquila chrysaetos*) erstreckt sich weit über die nördliche Hemisphäre. Die österreichische Population, welche etwa auf 350 Brutpaare geschätzt wird, beschränkt sich im Wesentlichen auf alpine und subalpine Bereiche in Höhenlagen zwischen 800 und 2100 m Seehöhe.

In der Gesamtheit der Verbreitung werden überwiegend offene Lebensräume besiedelt, in einigen Ausnahmefällen jedoch (z.B. Ungarn, Japan) finden sich auch Reviere in Gebieten mit höherem Waldanteil. Das Populationswachstum und die Arealerweiterung in den vergangenen 40–100 Jahren zeigten in Österreich, wie auch in anderen Ländern, eine zunehmende Besiedelung proportional stärker bewaldeter Bereiche. Die Fähigkeit des Steinadlers auch bewaldete Areale zu besiedeln beruht möglicherweise in seiner Natur als Generalist, aber auch an der Verfügbarkeit von Beute und dem Angebot von Nistplätzen durch höhere Bäume (DVORAK et al. 1993, ZECHNER 1995, ZECHNER 1996, HALLER & SACKL 1997, WATSON 1997, LEDITZNIG 1999, LEDITZNIG & LEDITZNIG 2001, MCGRADY et al 2003).

Die Hauptziele der vorliegenden Studie waren:

- Das Erlangen eines besseren Verständnisses der Verbreitung des Steinadlers in Österreichs durch einen Vergleich der Landbedeckung in Brutgebieten und Gebieten ohne Brutnachweis in gleichen Höhenbereichen
- Die Erfassung der Unterschiede in der Landbedeckung von Brutgebieten in unterschiedlichen Regionen (Bundesländern)
- Die Einschränkungen der verfügbaren Landbedeckungsdaten und Steinadler-Verbreitungsdaten zu verstehen.

Die Steinadler-Verbreitungsdaten, welche mit einer Genauigkeit von 1 × 1 geographischer Minute (~ 225 ha) verortet sind, wurden von BirdLife Österreich zur Verfügung gestellt. Die Daten beschränkten sich auf die Bundesländern Niederösterreich, Oberösterreich und Kärnten.

[1] Am Rosenhügel 59, A-3500 Krems. E-mail: *MikeJMcGrady@aol.com*

[2] Augasse 3, A-3494 Theiß. E-mail: *josef.pennerstorfer@boku.ac.at*

Die räumlichen Analysen erfolgten unter Verwendung des geographischen Informationssystems Arc View 3.25. Insgesamt wurden 103 Minutenfelder mit Brutnachweisen analysiert, auf ihre Landbedeckung untersucht und Vergleiche zwischen den einzelnen Bundesländern angestellt. Generell wurde eine Präferenz zu offenen Bereichen festgestellt, ein Ergebnis welches sich mit den Daten aus dem gesamten Verbreitungsareal deckt. Trotzdem scheint auch eine gewisse Bevorzugung von Mischwäldern gegeben zu sein. Landbedeckungsklassen mit erhöhter menschlicher Nutzung werden in der Regel gemieden.

Diese Untersuchungen stellen nur einen ersten Schritt zum Verständnis der von Steinadlern bevorzugten Landbedeckung in Österreich dar. Unzulänglichkeiten ergeben sich vor allem noch aus der relativ groben Auflösung der Landbedeckungsdaten (CORINE), der Unvollständigkeit der Adler-Verbreitungsdaten (nur 3 Bundesländer) und der Auflösung (1 × 1 Minutenfeld) auf welcher die Analysen erfolgten.

Introduction

The golden eagle (*Aquila chrysaetos*) is widely distributed across the northern hemisphere. In Austria the population is estimated to be at least 350 pairs, which are distributed mostly in alpine and subalpine areas from 800 to 2100 m asl.

Throughout their global distribution golden eagles are associated mostly with open landscapes, but in some places (e.g. Hungary, Japan) home ranges have a large amount of forest cover. In Austria and other countries golden eagle population growth and range expansion over the past 40–100 years has seen more breeding ranges being established in areas of proportionally higher forest cover. This ability to occupy more forested areas is probably linked to the generalist nature of the golden eagle as much as the availability of prey and the existence of nesting places, including larger trees (see DVORAK et al 1993, ZECHNER 1995, ZECHNER 1996, HALLER & SACKL 1997, WATSON 1997, LEDITZNIG 1999, LEDITZNIG & LEDITZNIG 2001, MCGRADY et al. 2003).

There were three main aims of this study:

(1) To take a first step in better understanding golden eagle distribution in Austria by comparing the landcover in areas where eagles breed to landcover in areas within the same altitude range where they are not known to breed.

(2) To examine differences in landcover in eagle areas between regions (Bundesländer).

(3) To better understand the limitations in the datasets on landcover and eagles in Austria.

This exploration of the data will guide future analyses that will aim to:

- Describe the landcover and terrain features of golden eagle breeding ranges in Austria,
- Better understand the range of landscapes and terrains in which golden eagles will nest,
- Estimate the present number of breeding eagles in Austria, and
- Provide some prediction about how the population might expand into new areas for breeding.

Ultimately, these analyses may provide information useful to conservation and land management efforts in Austria and elsewhere, especially where land use changes, including

changes in extent of forest cover, forest composition and grazing regimes, have occurred. The results we present however, are exploratory, and may not be representative of the situation of golden eagles in Austria or of golden eagles in forested environments.

Methods

Data on golden eagle breeding locations were provided by BirdLife Austria. These data register the 1 minute latitude × 1 minute longitude square (~ 225 ha in Austria) in which eagles breed.

Spatial analyses were done by using the geographic information system ArcView® 3.25.

Habitat composition was analyzed within 1-minute squares occupied by eagles in Lower Austria, Upper Austria, and Carinthia. The landcover within minute squares where eagles occur was compared to the landcover throughout all of Austria, within the same elevation band. Also, the landcover in three regions in Austria where eagles breed, Lower Austria, Upper Austria and Carinthia were compared to one another (Fig. 1).

Data on landcover within squares were extracted from the CORINE landcover database for Europe. CORINE uses 1:100,000 scale satellite imagery to characterize European landcover into 44 landcover types. Austria is classified into 28 landcover types. Accuracy of CORINE data is estimated at 30 m (AUBRECHT 1996). For these analyses CORINE data were aggregated into 13 different landcover types.

An electivity index (below) was calculated for habitats by comparing the habitat composition in occupied nesting squares to the habitat composition in all squares within the elevation range of eagle nesting in Austria.

Electivity index = (P obs - P exp) / (P obs + P exp)

The value of the electivity index ranged between -1 and 1. Habitats that were 'avoided' had a negative value; 'preferred' habitats had a positive value, and habitats that occurred in proportion to their availability in the wider landscape had a value of zero. Similarly, on the regional scale, we compared the habitat composition in occupied squares for each region to all squares within the elevation range within that region (compare SCHUSTER1990, D'OLEIRE-OLTMANNS 1991, BLASCHKE 1997).

Results

Of 356 squares searched for eagles, 103 were occupied. Mean elevation within 1 minute squares occupied by eagles was 397–2381 m asl. Twelve CORINE landcover types were found in squares used by eagles in Austria. In general eagles avoided habitats associated with more intensive human activity (e.g. agricultural or urban habitats), and showed a preference for relatively open habitats that were not intensively used by humans (e.g. natural grassland). Of the forest habitats types found in eagle areas, mixed forests were the only type used more by eagles than expected. Figure 2 shows the overall electivity of habitats by eagles on an Austrian national scale.

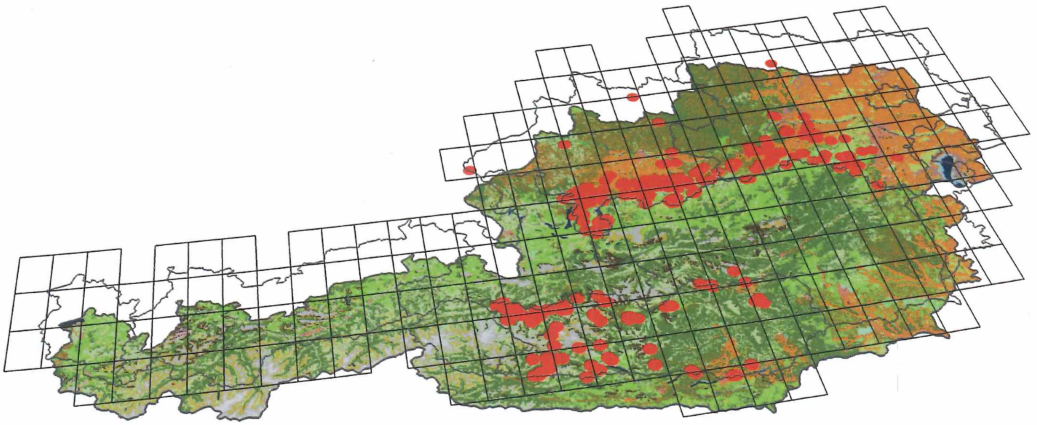

Fig. 1: Overlay of golden eagle data and CORINE landcover
Abb. 1: Verschneidung von Steinadler-Daten und CORINE Landcover

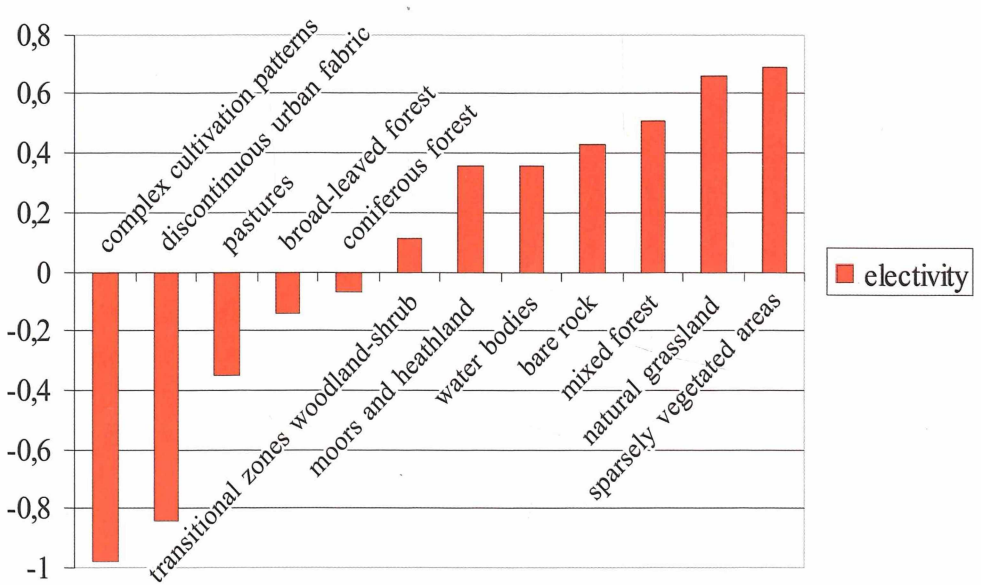

Fig. 2: Electivity of habitats by golden eagles (Lower Austria, Upper Austria and Carinthia) (n = 103).
Abb. 2: Elektivität der Habitate von Steinadlern (Niederösterreich, Oberösterreich und Kärnten) (n = 103).

Ten habitat types were found in areas of Carinthia within the elevation range of eagles. The relative preference of habitats shown by eagles in Carinthia was similar to that shown on a national scale, with habitats associated with human activity and more closed habitats being less preferred by eagles than open areas where human activity was low. Figure 3 shows the electivity of habitats by golden eagles in Carinthia.

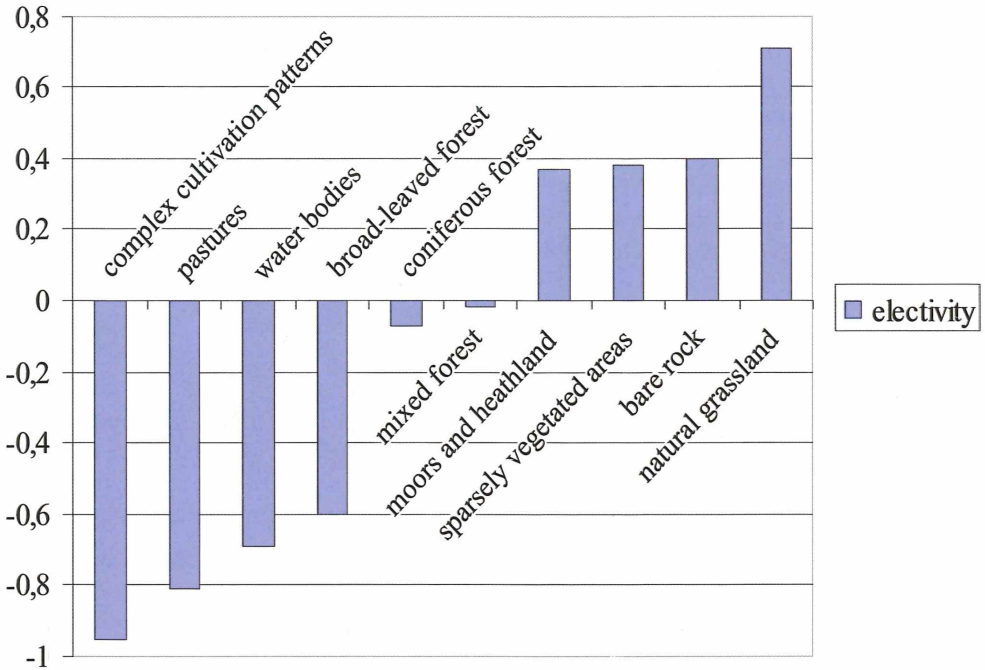

Fig. 3: Electivity of habitats by golden eagles in Carinthia (n = 40).
Abb. 3: Elektivität der Habitate von Steinadlern in Kärnten (n = 40).

Nine habitat types occurred in eagle areas in Upper Austria. As in the other regions, undeveloped, open areas tended to be selected, and areas of high human activity and closed (forested habitats) were avoided in Upper Austria. Unlike other regions, water bodies were found to be important to eagles (Fig. 4).

In Lower Austria 10 habitat types were found in eagle squares. Transitional zones of shrubland and forest were used by eagles in Lower Austria, a habitat type that was not found in eagle-occupied squares in other regions (Fig. 5).

Discussion

It must be emphasized that these analyses are only a first step in understanding data on eagles and their habitat in Austria, and as such the results must be viewed cautiously. Many characteristics of the data, including accuracy, form and scale could contribute to false interpretation. Data on eagle distribution in Austria is incomplete, and we analysed data from only some of the regions. At a national scale we lacked data from Tirol, Salzburg, Vorarlberg and Styria. These regions are mostly alpine in character, and likely contain many eagle pairs. Even in the regions where we had data from relatively large numbers of known pairs, our data might have been incomplete. Because some squares had more than one nesting pair the electivity of some habitats might have been affected.

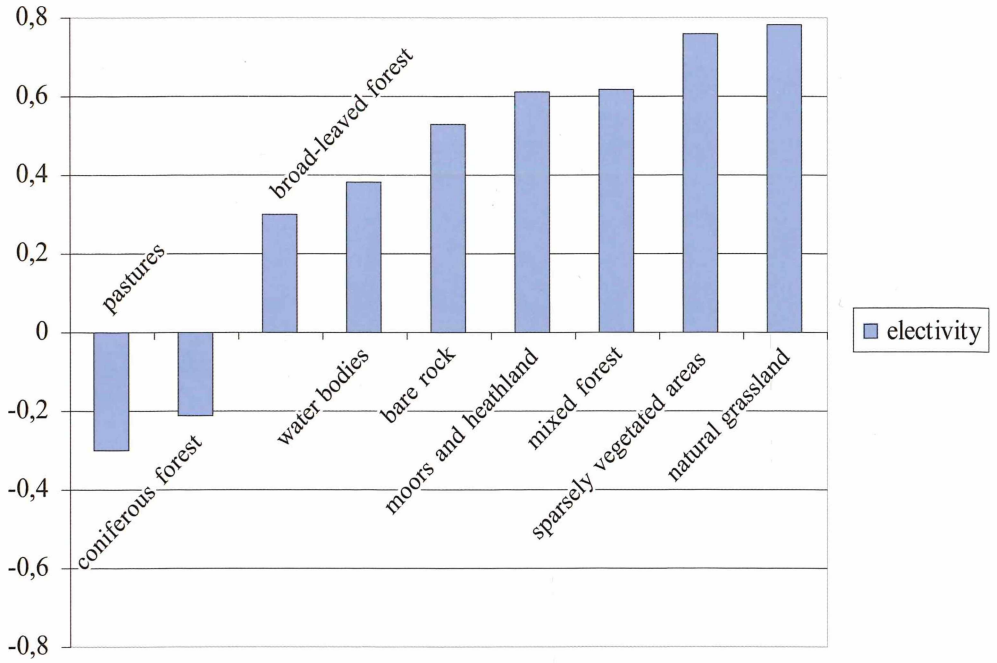

Fig. 4: Electivity of habitats by golden eagles in Upper Austria (n = 38).
Abb. 4: Elektivität der Habitate von Steinadlern in Oberösterreich (n = 38).

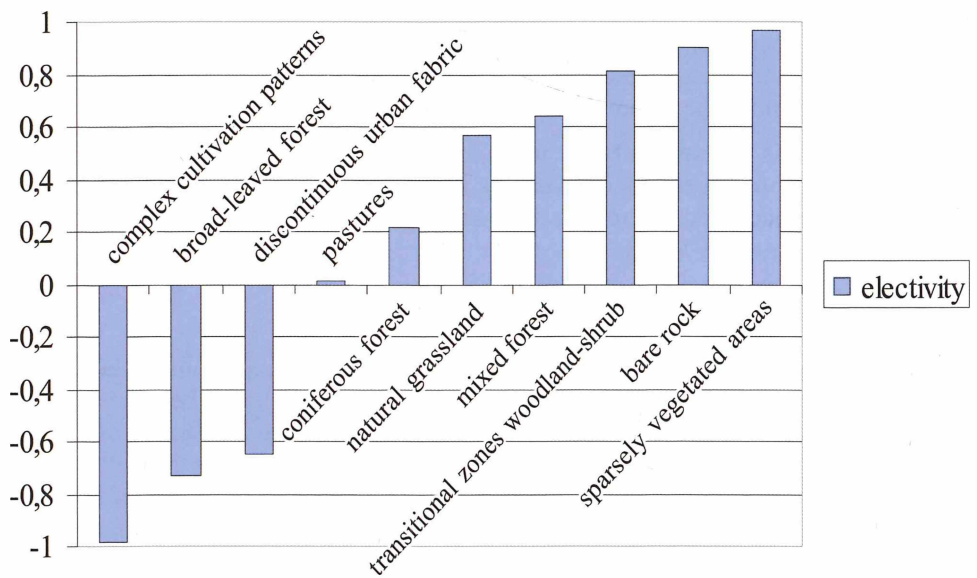

Fig. 5: Electivity of habitat by golden eagles in Lower Austria (n = 25).
Abb. 5: Elektivität der Habitate von Steinadlern in Niederösterreich (n = 25).

Eagles can range over large areas (up to 24,000 ha, see McGRADY 1997). Work in Scotland has shown most ranging occurs within 6 km of the range center (McGRADY et al. 1997, HAWORTH et al. in press). Our use of data only within the range of known nesting of eagles may mean that our analyses reveal electivity of nesting areas, and may not reflect the electivity of areas important for foraging.

Eagle nest location data is on a coarse scale. We only knew whether a square was occupied or not. We did not know the location of the nest within the square. So, in squares that included a wide range of elevations, the precision of measuring habitats may have been compromised.

CORINE data are manually derived from satellite images on a nominal scale of 1:100.000. Boundaries between habitats may be inaccurate or may not be accurately characterized. The area of the smallest unit mapped is 25 ha, and the minimal width of oblong elements to be mapped is 100 m (AUBRECHT 1996). Consequently, the heterogeneity of a landscape may not be represented properly. Habitats can change over time, especially in areas of extensive forestry activity, with open areas being created from clear-felling, and eventually closing as planting and successional changes occur.

The demarcation of regions is somewhat arbitrary, and apart from the fact that Lower Austria is indeed lower than the other regions we examined, regions in Austria do not conform to ecological zones. Analyses at the regional scale are justified from a conservation standpoint. Many conservation and wildlife management responsibilities are in the hands of regional governments, who are interested in the situation within their region. Future analyses will also examine habitat composition around eagle nest relative to availability of habitats within the ecological zone in which they occur.

The 'importance' of water bodies in eagle squares in Upper Austria and in the country as a whole is probably misleading. It is more likely that water bodies in Upper Austria are associated with preferred alpine and subalpine landcover types or good nesting habitat, and that the relatively large proportion of known nests that occur in Upper Austria influences its importance on a national scale. Further analyses will likely help understand how water bodies are correlated with other habitat types and eagle occurrence.

The occurrence of transitional forest-shrub habitat in Lower Austria probably reflects the generally lower elevation found there, but may also be related to it having more extensive harvesting of forest.

Overall, this first analysis of the habitats that might be important to eagles is promising. It has shown the facility of using CORINE landcover and digital elevation models within a GIS for Austria. It has also shown the need for more precise data on eagle nest location. We aim to undertake further analyses that will include data from all of Austria, and use more precise locations of range centers. Interim analyses will be performed and we will examine the accuracy of the CORINE data for selected study areas. It appears likely that these analyses will be useful to regional governments within Austria in their role of managing natural resources, including eagles.

Acknowledgement

We thank BirdLife Austria for providing the nest site data of golden eagle.

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