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Radiotracking of Bearded Vultures *Gypaetus barbatus* and Griffon Vultures *Gyps fulvus* in the Alps

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INTRODUCTION

Two WWF projects on vultures are underway in the Alps (Walter 1983). The aim of one project is to support the northern Yugoslavian colony of Griffon Vultures, a number of which spend the summer in the Alps. The other deals with the reintroduction of the Bearded Vulture into the Alps, where this species was exterminated about 100 years ago. This paper concerns the development of radio-tracking techniques for these birds in a high alpine environment, using receivers and automatic stations, with tests on a free-ranging group of Griffons at Salzburg Zoo.

RESEARCH AREA

Most of the Griffon Vulture data were obtained near Salzburg Zoo, on the northern slope of the Austrian Alps, where a free-ranging group of these birds has depended since 1961 on food from the zoo (Lacchini 1982). These birds roost several kilometres from the zoo, but can be kept under regular observation.

Further data were obtained from a second area in the central Alps, where some Griffon Vultures from Yugoslavia spend the summer but do not breed or overwinter. The central Alps are also a former habitat of the Bearded Vulture, with occasional recent reports of young (Tratz 1953; Hummel 1982). Following a census of favourable areas for the reintroduction project, this area, together with two others, was selected as the most preferable (Buchli & Müller 1982). The valleys are cultivated, but the alpine pastures are used for summer grazing of sheep and cattle, which are unsupervised and often meet with accidents, so that there are many livestock carcasses available as food for vultures. During winter, a number of Red Deer (*Cervus elaphus*) and Chamois (*Rupicapra rupicapra*) are killed by avalanches or other factors, and so provide a good food resource.

METHODS

Radio-tracking has become a standard tool in wildlife research (Long 1977; Long 1979; Amlaner & MacDonald 1980; Pincock 1983; Week & Long 1985). Automatic tracking systems have been used since 1964 (Cochran *et al.* 1965), but are mostly restricted to areas with gentle topography and to species with limited mobility (Deat *et al.* 1980; Lemnell *et al.* 1980). An exception is tracking by satellite, but the high power required of such tags has required a large cell capacity and mainly restricted their use to large animals (Kolz *et al.* 1980). The birds in our project were tracked with mobile receivers and by an automatic station.

Equipment

1) VHF receiver (No. 287078)	B+R Ingenieurgesellschaft mbH.
2) Antenna (Yagi AN 8 V)	Telecommunications Ltd.
3) Rotation system (RC 5-3)	Creative Design Co Ltd
4) Microprocessor	Development by T. Babsch, Rechenzentrum der Universität Ulm
5) Computers	Commodore VC 64 & VC 1541

The automatic system (Fig. 1) was designed to exclude as much RF interference as possible (Bögel 1987), and only 0.3% of the signals were distorted in this way. However, the bearing angle accuracy, which is also a function of other system limitations and of transmitter movement, was only +/- 12° (p=0.05), and fixes were therefore relatively inexact (Fig. 2). Data were interpreted according to their quality, previous and subsequent fixes, and a knowledge of the terrain (topographical factors were very important). Accurate fixes usually depended on additional mobile tracking.

The potting of the transmitter packages for Griffon Vultures was contoured to a single tail feather shaft, and glued to the feather with additional plastic binding and adhesive tape. The Bearded Vulture tags were fixed using the method of Brown (1983).

RESULTS

Introduction of captive-bred Griffons to the free-ranging group at Salzburg Zoo.

Four birds were added in autumn to the zoo group, from Innsbruck Alpenzoo and Rotterdam Zoo. Individuals differed considerably in their behaviour. Two became part of the zoo group within one or two weeks, although their flight was initially too poor for the longer flights.

Two birds did not immediately join the group. One, released in 1983, probably lost contact with the group when it tried to follow them to roost. During the following weeks it crossed the Alps (Fig. 3). It tended to follow valleys and avoid ridges, except for crossing the central Alpine ridge, and followed valleys again on the south slope. This bird was eventually caught on the brink of starvation, and successfully joined the zoo group the following year.

The other Griffon which failed to join the zoo group spent a couple of weeks near the zoo (Fig.4). To begin with, the bird only moved short distances, sometimes perching in the same tree for several days. The next stage involved several flights in the company of birds from the zoo, although it was never seen to remain with them for long. Finally, it took to making flights over larger distances, but always returned to the central area. After four weeks it was recaptured, because of its strange habit of landing in meadows with browsing cows, which attacked it on several occasions. After three weeks, it was released again among the wild birds in the central Alps. About one week later, this bird was observed feeding, perching and taking long flights with others along the north slope of the central Alps. The last signals from its tag were detected in this area after 40 days, at the time when vultures from the area were migrating back to the Yugoslavian coast. After a week of searching its probable flight path, signals were again detected near the Yugoslav border, near Koper.

Reintroduction of the Bearded Vulture in the Alps

Four young radio-tagged birds were released at an artificial nest site in May 1986 (Fig. 5). They left the nest between their 117th and 126th day after hatching. About two weeks later, they began to fly at high altitudes and to cross ridges, first roosting away from the nest site after the 17th day. Since signals could not reach the automatic system by line of sight from the nest, data registration increased sharply when the birds gained height during August (Fig. 6). There was a corresponding reduction in the registration of signals in December, when the first heavy snow fell and the birds returned into the valleys, reducing their high altitude flights.

The abrupt alpine topography, with few opportunities for mains power to the system, produced many areas from which signals could not be received (Fig. 7). This could be turned to advantage, however; with a good knowledge of the local topography and the signal quality, we could usually decide whether a bird was on the north or south slopes, or was soaring high above the mountains. Long-distance flights were random and always made singly, leading to absences of several days. One bird departed on October 2nd in a southerly direction (Fig. 8), and remained on the south slope of the Alps for almost a week, in an area about 10 km from the nest. It then headed west and even a search from the air failed to locate it. After an absence of seventeen days, the bird returned to its original range, where it spent four weeks without contacting the other vultures, and finally returned to the nest area after December 7th.

DISCUSSION

The work with these radio-tagged birds has not only proved the release method (Frey 1986), and shown that such birds will join migration routes (Genero 1985), but also made clear the value of the radio-tracking. Radio-tagging also enables the detailed study of individual behaviour, which is vital for providing rapid answers to questions about release locations, release techniques, and the most appropriate age and origin for the birds.

The comparison of Griffon and Bearded Vultures has shown how different monitoring techniques can be used for different species. The Griffon Vulture is relatively easy to track because it typically flies high above the ground. The automatic system was particularly valuable for the Bearded Vulture, a contour flier. If one of these was low down in a valley, the system would detect signals only if the bird moved up over a ridge, and thus warn of a possible long-distance movement.

Table 1 summarises the advantages and disadvantages of automatic tracking as opposed to mobile tracking, as shown by the work on Bearded Vultures. One further problem with the automatic system is the need to transport data to a central base, to increase the efficiency of detecting when birds move away.

Since the vultures could not be tracked from roads, and aircraft are seldom available, the combination of automatic stations with some mobile tracking seems to be a good way of monitoring them.

These techniques can hardly be compared with tracking from satellites, especially where large areas are to be covered. Satellite tags are now available for large birds (Fuller *et al.* 1984). However, ground-based tracking can provide much more detailed behavioural data, and rapid recovery of birds in difficulties: it is probably the best approach for reintroduction projects.

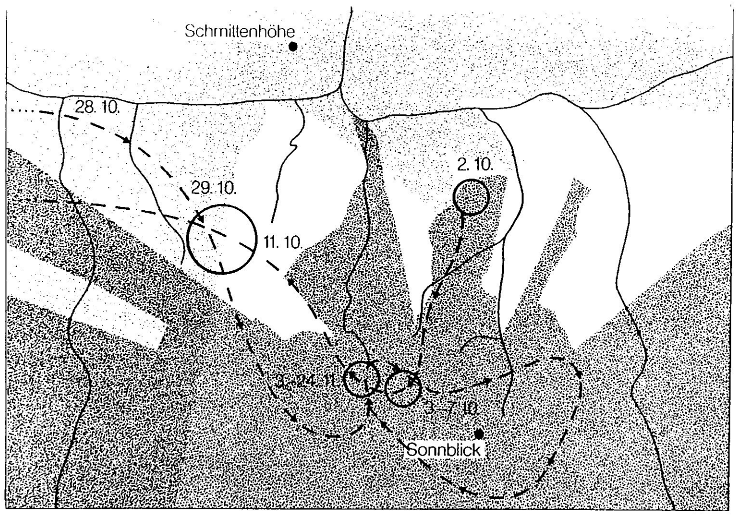

FIGURE 8 Long-range flight of a Bearded Vulture reconstructed by automatic and hand-tracked data.
0 = Resting areas
--- = Disappearing/returning within range of the automatic device.

TABLE 1. **Advantages and disadvantages of mobile and fixed receiving stations for radio-tracking vultures in the Alps.**

Mobile Tracking - Advantages	Disadvantages
Very accurate (close approach)	Difficulty with cross bearings
Flexible and transportable	Search difficulties in bad terrain
Rapid checking of plausibility	Time consuming
Behavioural observations possible	Usually only 1 animal at a time
Fixed-Station - Advantages	**Disadvantages**
Long detection range	Topographic radio shadows
Permanent point of reference	Little flexibility
Large amounts of data	Plausibility checks delayed
Several individuals at a time	No visual observations

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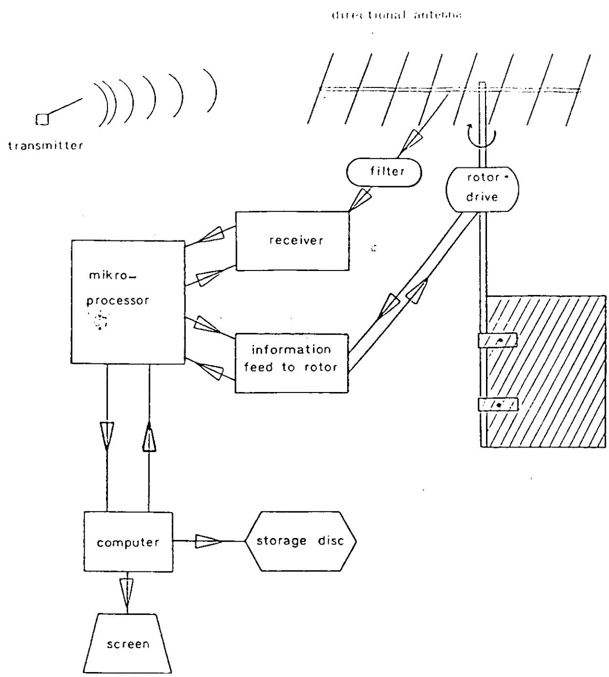

FIGURE 1 Schematic diagram of the automatic tracking system.

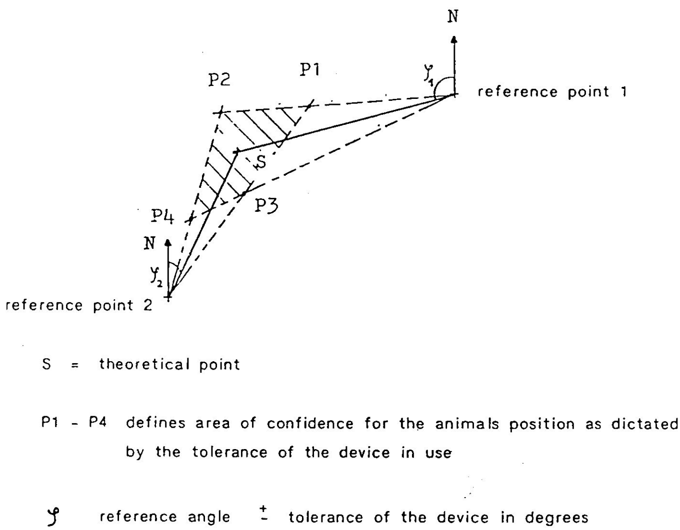

FIGURE 2 Radio fixing: cross-bearing.

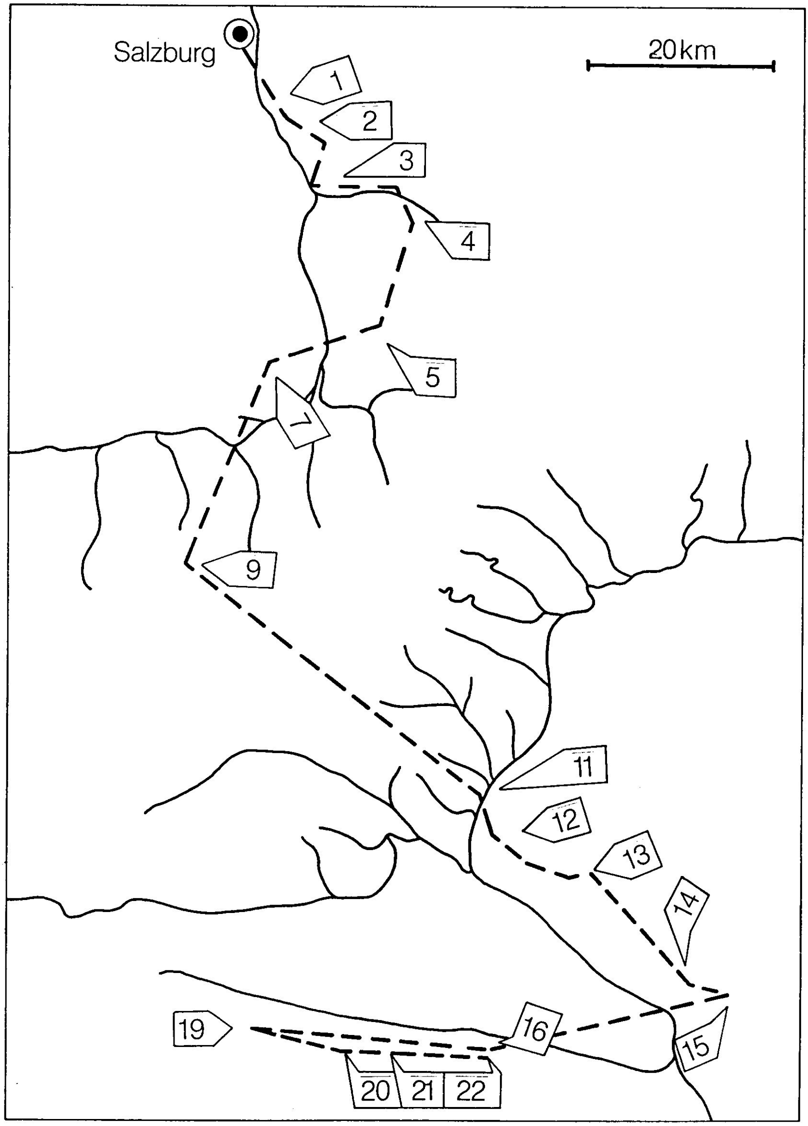

FIGURE 3 Movements of a zoo-bred Griffon Vulture after failed introduction to the zoo-group. The river systems indicate the north and south slopes of the Alps. Numbers indicate days of travel.

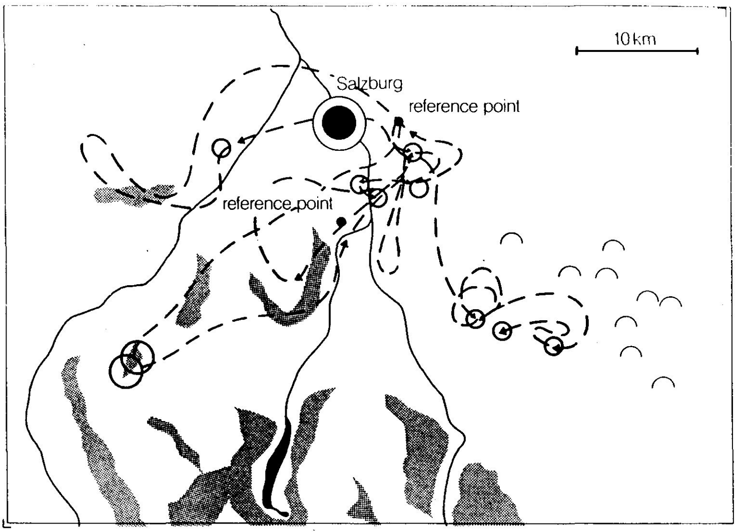

FIGURE 4 Movements of a zoo-bred Griffon Vulture after introduction to the Salzburg zoo-group. The bird failed to integrate. The rivers and higher ranges are shown.

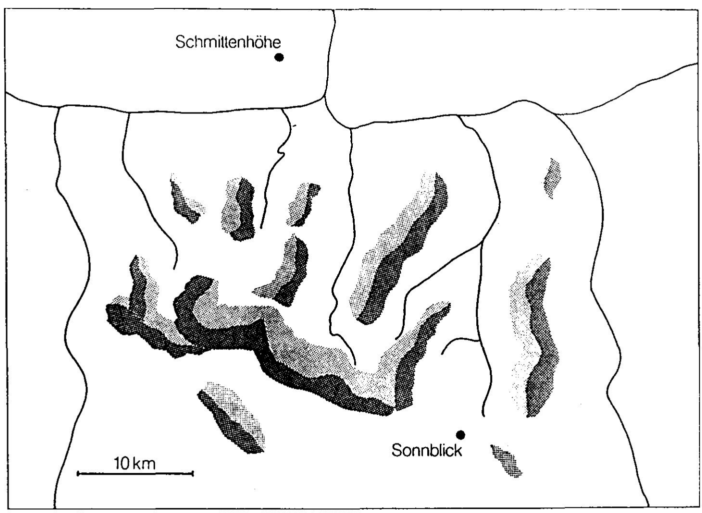

FIGURE 5 Area of reintroduction of the Bearded Vulture in the central Alps. The two reference points, the river system and the main ridges, are symbolised.

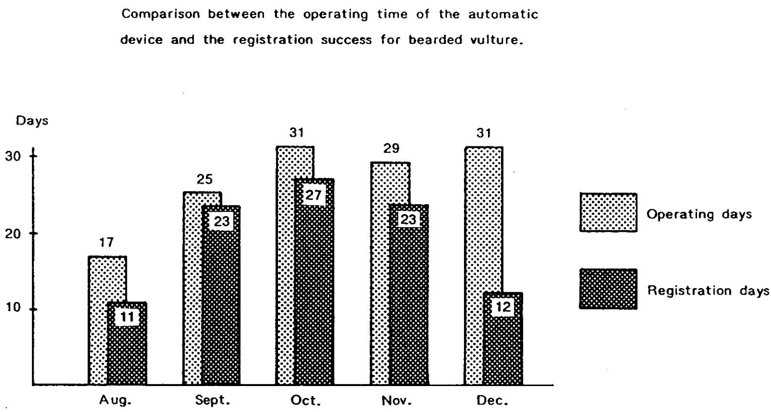

FIGURE 6 Comparison between the operating time of the automatic system and the registration success for Bearded Vulture.

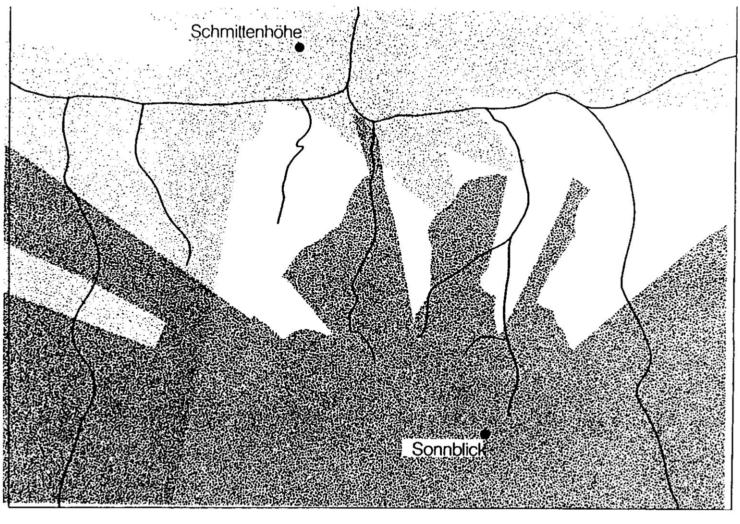

FIGURE 7 The area as in Fig. 5. The shaded spaces show the limited registration possibilities of automatic systems due to the topography.