

Migration and Wintering of the Lesser Spotted Eagle

Aquila pomarina :

A Study by Means of Satellite Telemetry*

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Abstract

An account is given of the satellite tracking of the movements of four adult and three juvenile individuals. For the first time a migratory bird was successfully tracked all the way from its breeding grounds in Europe to its wintering quarters in southern Africa and back to Europe. Its outward and return migrations both took about 7½ weeks. Both routes were practically identical, with the bird covering a total distance of 19,400 km, including its movements in its winter quarters in Zambia. On average 166 km were covered per day during migration. Its wintering quarters, where the bird stayed from the end of October until the end of February, extended over an area of ca. 25,000 km². The autumn migration of all individuals within Africa followed a relatively narrow corridor between longitudes 31° and 36° E from Suez south to Lake Tanganyika from where the birds dispersed. The greatest migration speed was reached by a young bird on the stage from Turkey to the Sudan, flying an average of 289 km per day.

Key words : *Aquila pomarina*, Lesser Spotted Eagle, Migration, Satellite telemetry, Wintering

1. Introduction

Because of the small number of ring recoveries, very little is known about the migration of the Lesser Spotted Eagle (LSE, Fig. 1), a typical long-distance migrant which spends over half of the year outside its breeding territory. Still less is known about its pattern of movements in space and time, its ecology, habitat requirements, etc. in its wintering grounds (Meyburg 1991, 1994).

Since 1992, when satellite transmitters (PTTs = platform transmitter terminals) first became available which were small and light enough to be fitted to this species, we have adopted satellite telemetry (ST) as a vital component in an extensive, long-term LSE Project in Mecklenburg-Vorpommern (Germany). The tracking in 1992 of the first young eagle, which took an unexpected migration route, has already been described (Meyburg *et al.* 1993). In 1993 and 1994 we equipped 7 more Lesser Spotted Eagles in Europe and tracked them over total distances of between 2,900 and 19,400 km.

2. Materials and Methods

In 1992 small, relatively reliable transmitters were made available by Microwave Telemetry Inc. (USA), weighing 50 g and thus suitable for fitting to female LSE. A further reduction to 28-30 g after the autumn



Fig. 1 Adult female Lesser Spotted Eagle *Aquila pomarina* with half-grown nestling

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of 1993 made it possible also to equip the smaller males.

In 1993 we equipped two female nestlings in Mecklenburg-Vorpommern and one more in Latvia. In 1994 four adult males were trapped in their breeding territories in Mecklenburg-Vorpommern and Slovakia by the Dho-gaza method (Bloom 1987) and fitted with transmitters. Attempts to capture for the same purpose passage migrants and wintering LSEs in Israel and South Africa with the help of Bal-chatris (Bloom 1987) were unsuccessful. However, as will later be reported elsewhere, one immature and one subadult wintering in Namibia were caught and equipped.

For further details regarding the methodics, reference should be made to Berthold *et al.* (1992) and Meyburg *et al.* (1993). The tracing of the migration route and calculation of the distances between each Argos location were done with the help of a computer programme based on a Mercator's projection. All given distances are the minimum calculated between consecutive locations. The true distances covered must hence have often been greater.

In addition to the ongoing field studies in the European breeding range, we have been able to carry out field observations on LSEs on migration and in their wintering grounds, particularly in Namibia, South Africa and Zambia.

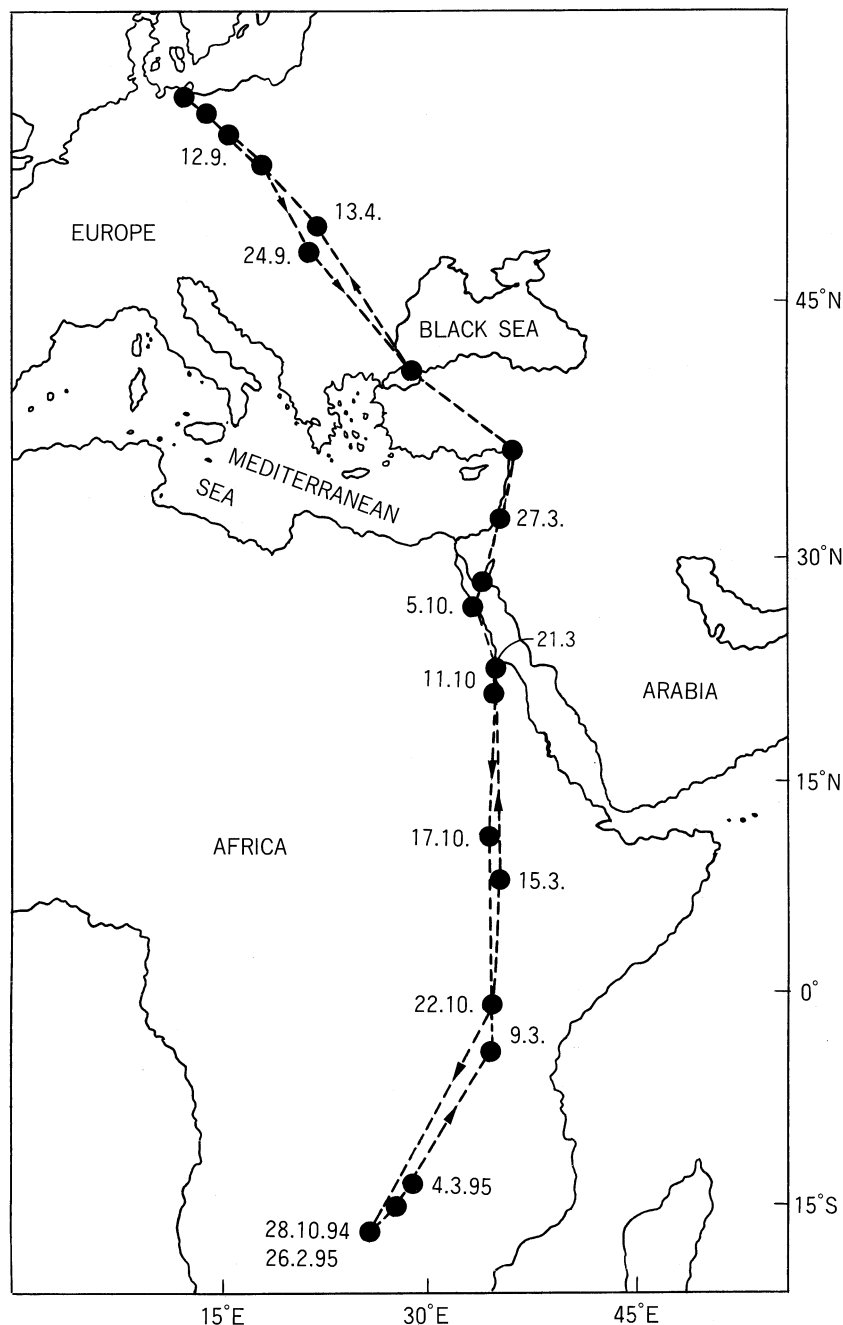


Fig. 2 To-and-fro migration of adult Lesser Spotted Eagle with PTT 22691 between its breeding grounds in northern Germany and its wintering quarters in Zambia, showing dates of arrival at selected points en route.

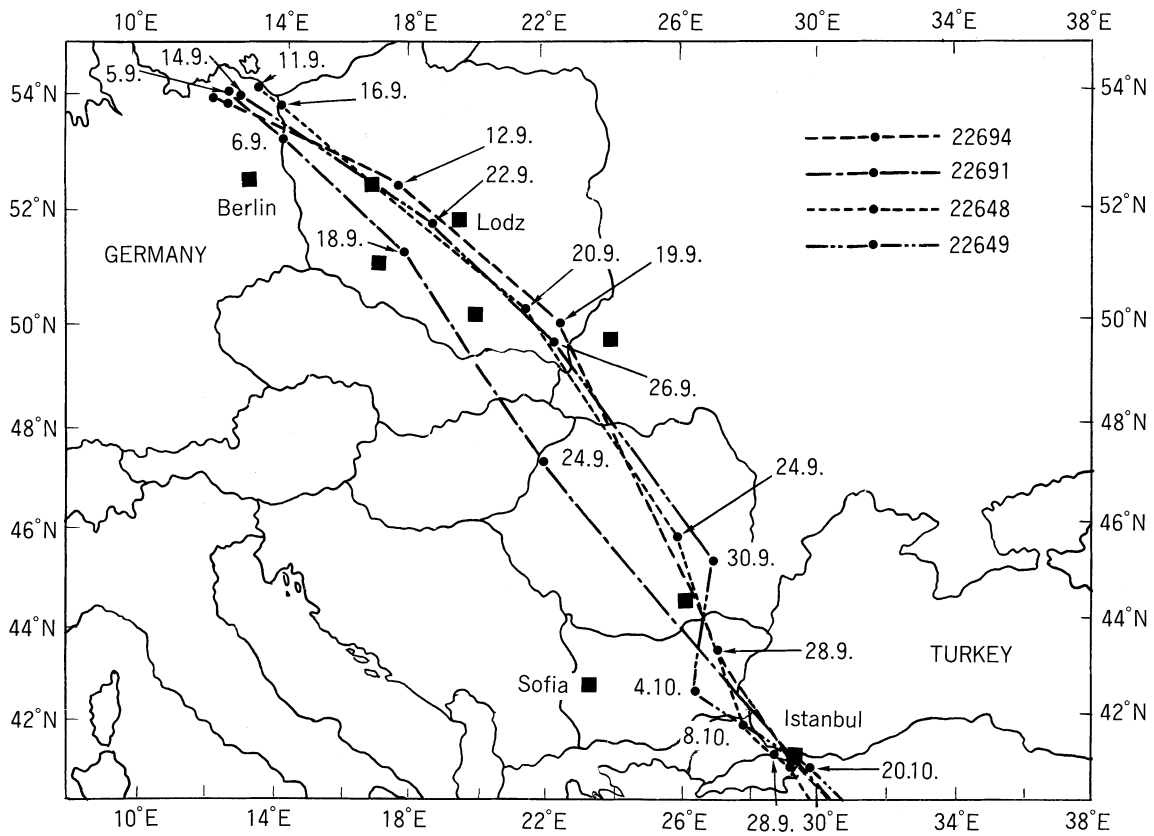


Fig. 3 Routes to the Bosphorus followed by 4 German Lesser Spotted Eagles.

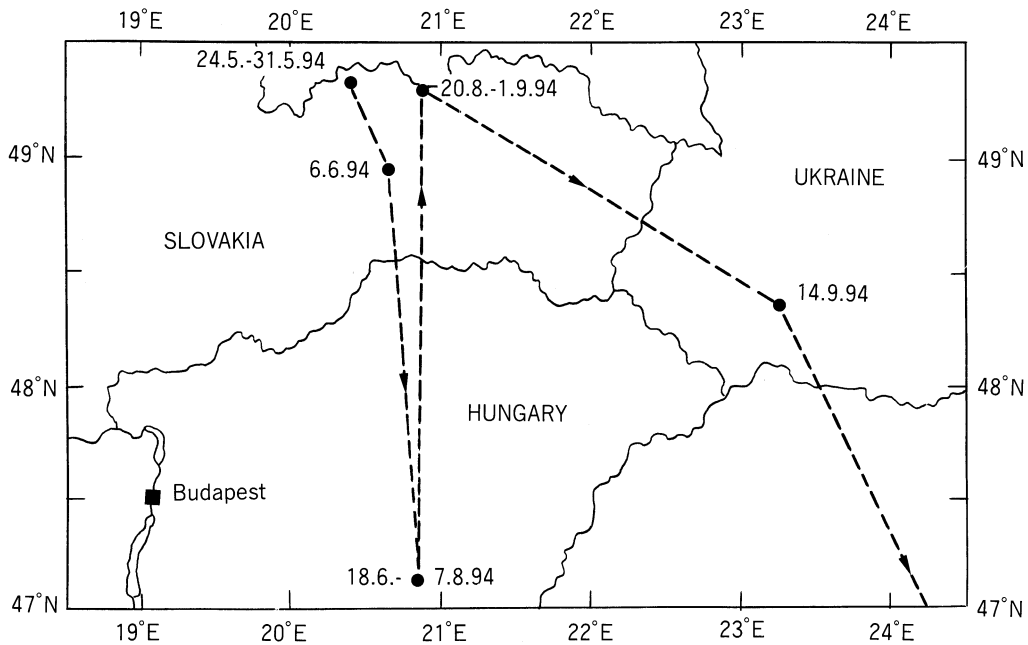


Fig. 4 Movements of non-breeding adult eagle with PTT 21821 in Slovakia and Hungary during the breeding season.

3. Results

All transmitters functioned perfectly on those birds that survived until failure of the batteries, which occurred after very variable lengths of time, (from 3 to almost 11 months, average of 7.6) and which could be determined from the data previously transmitted.

From all seven eagles between 44 and 126 Argos locations (average of 70) were received. In total we plotted 494 positions.

Both young birds from Germany perished in Lebanon, one of them being confirmed shot. Both transmitters gave out signals a few times thereafter, albeit irregularly. All the remaining birds were tracked to south of the equator (see Figs. 2, 3, 5 and 8). In

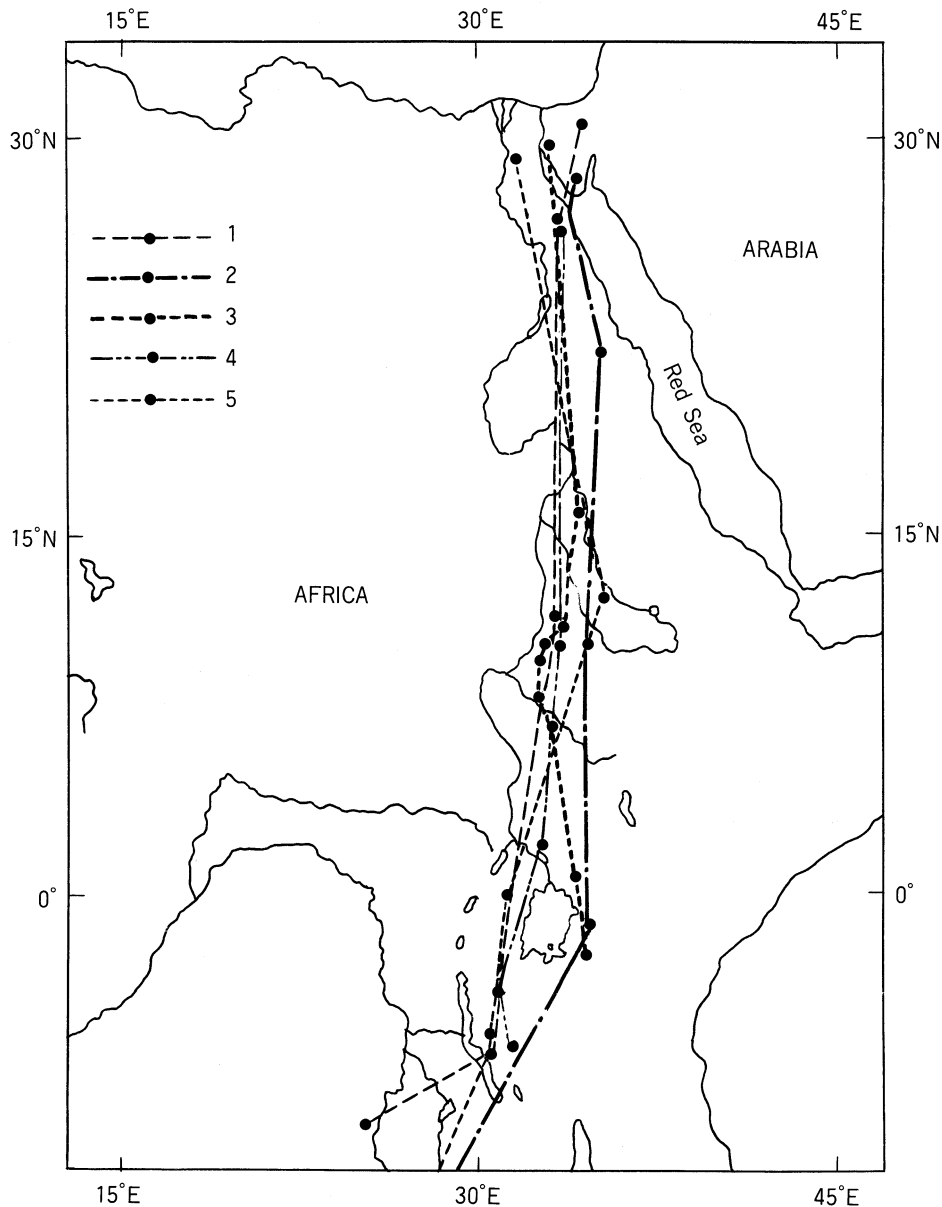


Fig. 5 Migration route in Africa of 5 Lesser Spotted Eagles from Suez to Lake Tanganyika tracked by satellite.

contrast to the first bird tracked in 1992, they all followed the typical eastern route over the Bosphorus, Israel and Suez. For the first time their movements within Africa could be followed—something completely impossible by direct observation. Equally successful was the documentation received from the wintering grounds in southern Africa, south of latitude 15.

In one case, using telemetry, we succeeded for the first time in tracking a migrant from Europe through its year-round migrations from its breeding territory to southern Africa and back (see Fig. 2). This adult male from Mecklenburg-Vorpommern was followed for almost eleven months and over a total of 19,403 km.

3.1 Adults

Adult LSE with transmitter N° 22691

Caught and equipped on 27 June 1994 in the former Teterow district (Mecklenburg-Vorpommern). The bird (weight 1,518 g) was at the same time fitted with

a conventional telemetry transmitter and kept under close observation for 121 hours before its departure. It showed no reaction to the two transmitters. It was a territorial bird its mate had not laid eggs or had lost them at a very early stage. We received 126 Argos locations from this eagle.

The eagle remained in the nesting territory until 5 September. On its journey to its wintering grounds in southern Zambia it covered 8,986 km. On the homeward journey it could be tracked all the way back to its breeding territory, where it arrived on around 22 April, some 10 days later than in other years, as did all other LSEs controlled by us, doubtless due to weather conditions. For outward and return journeys it took 7½ weeks in each case (see Fig. 2). In the 1995 breeding season it was again studied with the help of conventional telemetry.

In its wintering grounds (see Fig. 6), which covered a total of about 25,000 km², it remained for four

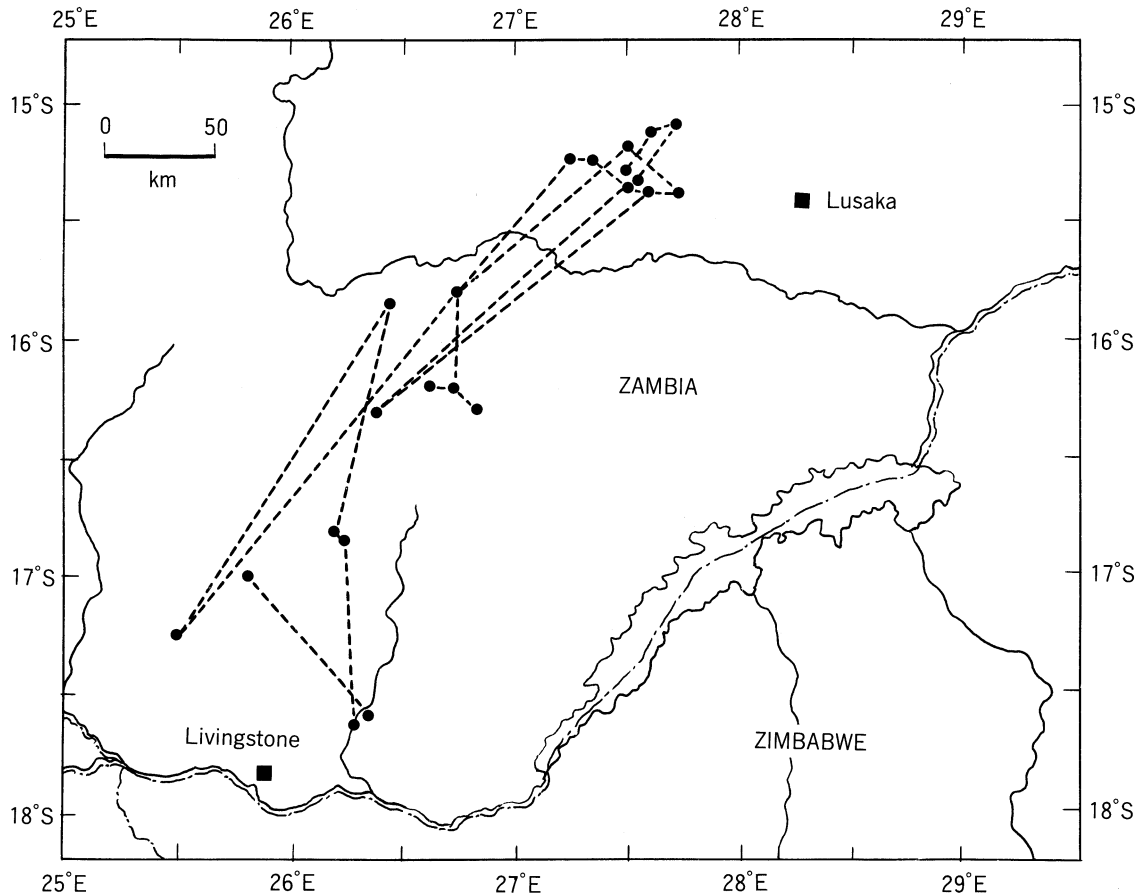


Fig. 6 Wintering range of adult Lesser Spotted Eagle with PTT 22691 in Zambia between 28 October 1994 and 26 February 1995.

months, from the end of October to the end of February. The locations here covered a total distance of 1,554 km. One month after arriving in southern Zambia, near the Victoria Falls, the bird concentrated on an area of ca. 1,800 km², 60 km west of Lusaka and just north of the Kafue river plain. Here it spent three separate spells of about two weeks each (26.11.-7.12., 19.12.-5.1 and 14.2.-26.2). In between it made two excursions to the southwest, to an area about 164 km distant.

The following principal stages outline this adult eagle's migration route (see Figs. 2, 3 and 5) :

- 5-6 Sep.94 128 km Departure south-west to the Oder near Schwedt (53° 18' N 14° 23' E)
- 6-12 Sep. 121 km further south-east to a place west of Poznan (52°32'N 15°40'E)
- 12-18 Sep. 215 km to a region east of Wroclaw (51°12'N 17°56'E)
- 18-24 Sep. 532 km continuing through Poland, central Slovakia and east Hungary to Oradea in NW Rumania (47°13'N 21°59'E)
- 24 Sep.- 5 Oct. 2,634 km through Rumania, Bulgaria, Turkey, Syria, Lebanon and Israel to the southern tip of the Sinai Peninsula (28°24'N 34°14'E)
- 5-11 Oct. 743 km along the Red Sea coast to the Egypt-Sudan border (22° 15'N 35°12'E)
- 11-17 Oct. 1,290 km southwards east of and roughly parallel to the Nile to the Sudan-Ethiopia border on the Blue Nile (10°43'N 34°34'E)
- 17-22 Oct. 1,333 km further south to the eastern shore of Lake Victoria on the border between Kenya and Tanzania (1°18'S 34°37'E)
- 22-28 Oct. 1,990 km through Tanzania and Zambia to an area north of the Victoria Falls (17°1'S 25°48'E)
- 28 Oct. 94-26 Feb. 95 sojourn in the wintering grounds in southern Zambia (see Fig. 6)

The principal stages on the return migration were :

- 26 Feb.- 4 Mar. 95 187 km northwest through Zambia to the upper reaches of the Kafue River (13°47'S 28°36'E)
- 4-9 Mar. 1,220 km through north-east Zambia to the wetland depression of the Wembere River in Central Tanzania (4°25'S 34°19'E)
- 9-15 Mar. 1,399 km north through Kenya and the western part of Ethiopia to the Ethiopia-Sudan border (8°6' N 35°12' E)
- 15-21 Mar. 1,614 km north through the Sudan to the Egyptian border 70 km from the coast (22°43'N 35°2'E)
- 21-27 Mar. 1,281 km across Suez to northern Israel (32°20'N 35°23'E)
- 27 Mar.-13 Apr. 2,265 km along the usual route to the Mediterranean, through Turkey, over the Bosphorus, through Bulgaria and Rumania to NE Hungary near the Slovakia-Ukraine border (48°19'N 22°4'E)
- 13.-ca. 22 Apr. 897 km northwest through Slovakia

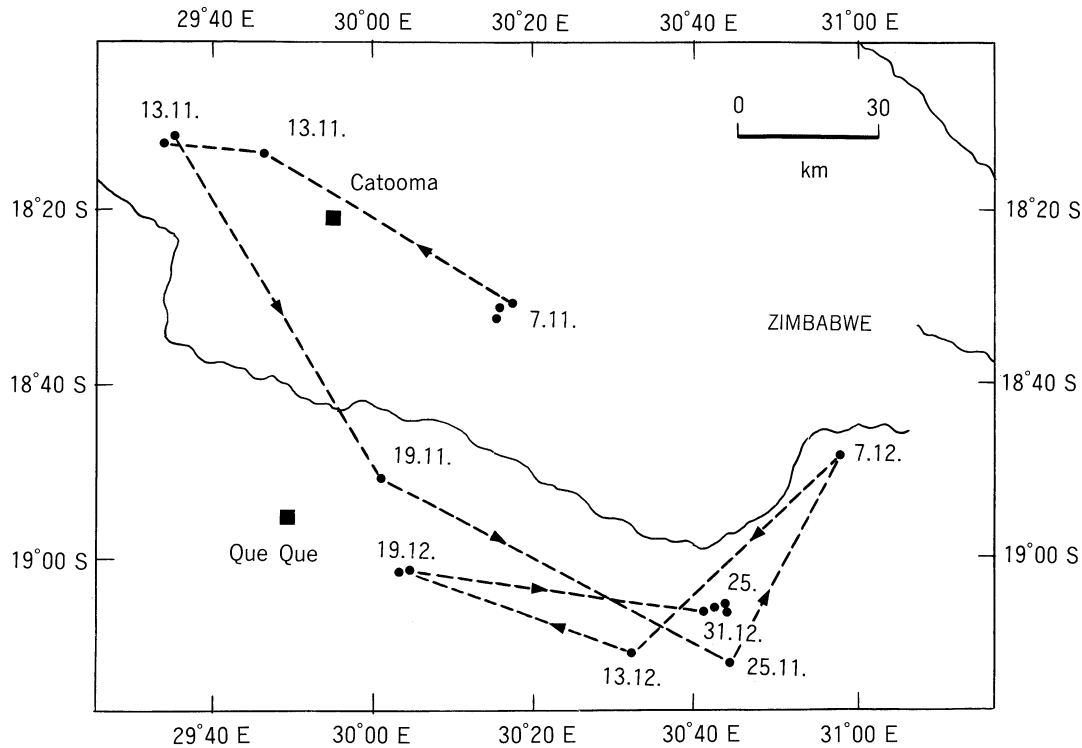


Fig. 7 Range in Zimbabwe from 7 November to 31 December 1994 of adult Lesser Spotted Eagle with PTT 22692 prior to flying on to Mozambique.

and Poland to the nesting territory, under direct observation.

Adult LSE with transmitter N° 22692

Captured and fitted on 26 May 1994, 40 km north-east of Poprad (Slovakia). This bird (1,380 g) had already been caught and ringed two years earlier at the same nest site. After being equipped it successfully reared one young and remained in the breeding territory up to 21 September. This eagle was tracked over a period of 7½ months and a total distance of 9,744 km, with a total of 95 locations on its migration to southern Mozambique.

After a stay of nearly two months at wintering grounds in central Zimbabwe on the Umniati River (see Fig. 7), extending over ca. 12,000 km² and within which the bird covered at least 472 km, it moved a further 768 km south during the first half of January, after which locations ceased due to failure of the battery.

In May and July 1995 this eagle was again observed feeding its brooding female and chick at the nest site. The chick subsequently fledged. Attempts to recapture the adult bird failed.

Adult LSE with transmitter N° 21821

Caught and equipped on 24 May 1994, 40 km NE of Poprad (Slovakia). This was the only unmated individual (weight 1,375 g) which, shortly before capture, had indulged in a spectacular aerial battle with the territory-holder, during which both birds spun earthwards with interlocked talons for 80–100 m.

This bird was tracked over a period of 10½ months and a total of 16,074 km, during which 74 locations were analysed. On its outward journey from Slovakia to the southernmost point of its migration in

Mozambique it covered 9,977 km.

To begin with, the eagle remained in northern Slovakia up to 31 May and then flew 247 km further south to the neighbourhood of Turkeve in Hungary (47°6'N 20°50'E). Here, in an area of some 35 km², it spent nearly two months, from 18 June to 7 August. It then returned to northern Slovakia, to the area in which it had been captured, where it remained up to at least 1 September (see Fig. 4).

This bird first reached its true winter quarters, which covered ca. 11,000 km² in the Kruger Park (South Africa) and neighbouring Mozambique, on 15 January 1995, before which it had roamed over various countries in southern Africa (see Fig. 8). The leisurely return journey, arriving in Upper Egypt only on 12 April, pointed to another non-breeding season in 1995. This was also indicated by the relatively low speed of migration, averaging only 128 km per day as far as Egypt, when contact was lost due to weakening of the batteries.

Adult LSE with transmitter N° 22694

This bird (weight 1,525 g) was equipped on 15 July 1994 in the former district of Malchin in Mecklenburg-Vorpommern (Northern Germany). Its offspring was killed shortly before fledging, probably by a pine marten. This eagle was tracked for 3½ months and over a distance of 7,726 km. After 39 locations the battery gave out prematurely at the beginning of November in Tanzania, probably before the bird reached its wintering grounds. In 1995 this bird's nest site was occupied by a new male.

3.2 Young birds

Juvenile LSE with transmitter N° 20643

This bird (weight 1,420 g) was equipped in the nest

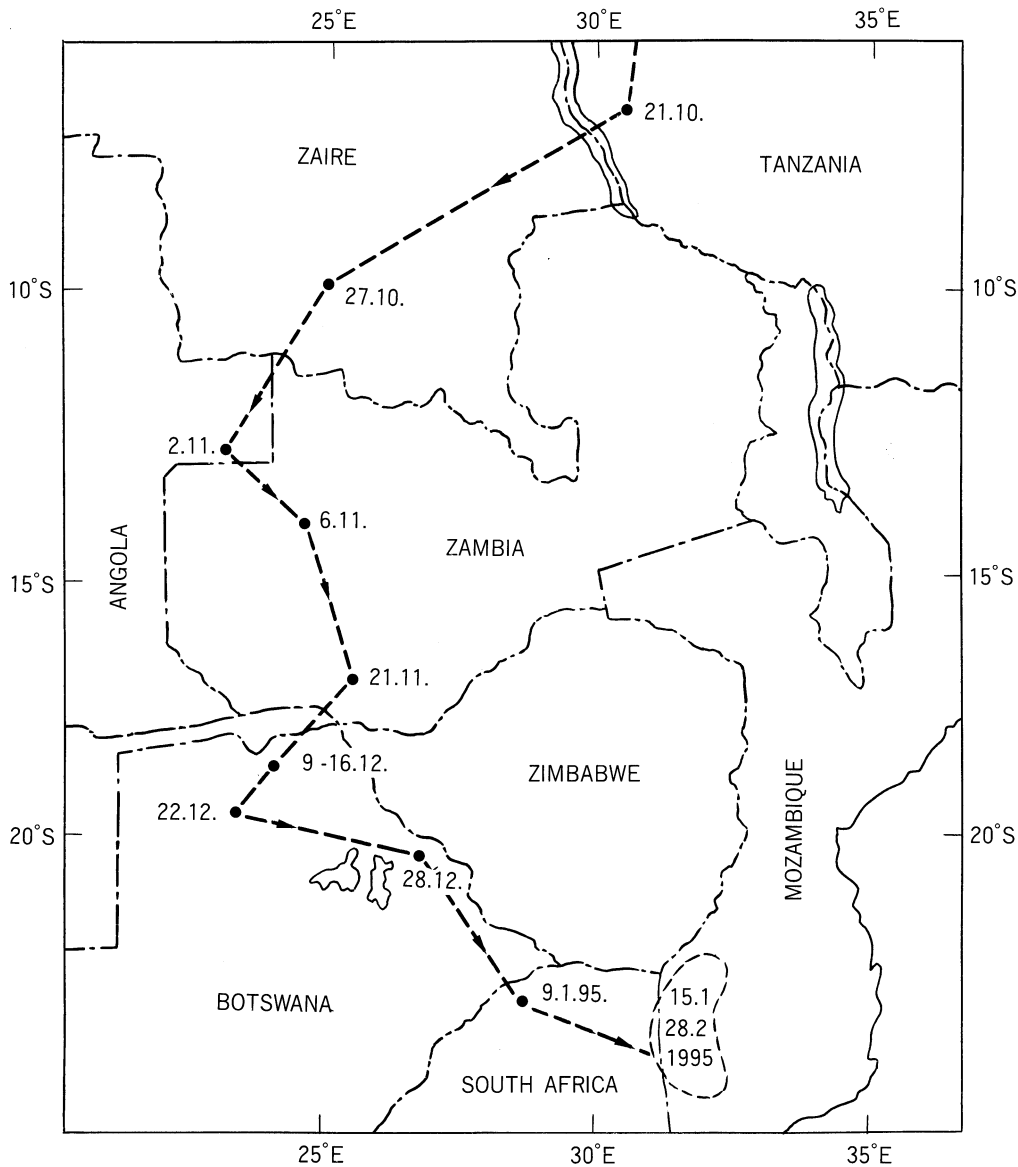


Fig. 8 Nomadic movements of adult Lesser Spotted Eagle with PTT 21821 during its passage south of Lake Tanganyika to the southernmost point of its migration.

at the edge of the Teici upland moor in Latvia on 25 July 1993 and tracked for a total of 7,178 km as far as Tanzania, where the batteries became prematurely too weak after 4½ months. 55 locations were received.

The following principal stages outline the migration route of this young eagle:

- 9-13 Sep. 93 156 km Departure southwest from the nest territory to East Lithuania near Panevezys (55°29'N 25°6'E)
- 13-17 Sep. 64 km heading south-east (55°N 25°39'E)
- 17-21 Sep. 723 km southwards through Belarus and Ukraine to a point near the Rumanian border (48°26'N 25°57'E)
- 21-26 Sep. 708 km south through Rumania and Bulgaria to the Turkish border (42°4'N 26°35'E)
- 26-30 Sep. 905 km southeast over the Bosphorus and through Turkey to the Mediterranean coast 25 km SW of Mersin (36°40'N 34°23'E)
- 30 Sep.-4 Oct. 991 km through Syria, Lebanon and Israel to the Gulf of Suez 22 km SE of Suez (29°49'N 32°42'E)

4-8 Oct. 1,575 km almost due south through Egypt and Sudan along the Nile valley to a point 180 km E of Khartoum (15°56'N 34°15'E)

8-12 Oct. 371 km further SSW over Wadi Medani in the region between the White and Blue Niles at 12°42'N 33°27'E

12 Oct.-26 Nov. 621 km short stages further south through Sudan to south of Akobo on the Ethiopian border (7°23'N 33°10'E)

26-30 Nov. 743 km on south through Uganda to the border with Kenya (0°19'S 34°48'E)

4-12 Dec. 75 km further on to the Serengeti plain (1°56'S 34°31'E)

Juvenile LSE with transmitter N° 20648

A nestling (weight 1,800 g) fledged in the nest in the former Teterow district of Mecklenburg-Vorpommern, at the western edge of the species' range on 30 July 1993 and recorded for the last time in the breeding territory on 7 September. This young eagle was tracked for 2,921 km, with 44 locations received. On 7 October shortly after its arrival in

northern Lebanon, the bird was shot. Four further locations were received from this area up to the beginning of March 1994, followed by five more from the neighbourhood of Beirut. In May 1994 we were sent the transmitter and ring with a covering letter from a Lebanese doctor confirming the shooting. There was a bullet lodged in the transmitter.

Juvenile LSE with transmitter N° 20649

A nestling (weight 1,570 g) fitted on 30 July 1993 on the nest in the former Ribnitz-Damgarten district at the NW limit of the species' range in Mecklenburg-Vorpommern. This young eagle was tracked for around 2,995 km. 61 locations were plotted. Most probably it was similarly shot in northern Lebanon, as was further substantiated by locations received in December from this area together with temperature and activity readings.

4. Discussion and Conclusions

4.1 Methodics

The smallest American transmitter so far available has proved reliable except for the battery. Since it requires a comparatively high level of power for the NASA satellite to receive the electromagnetic waves it emits, the lifespan of the battery is at present the basic weakness of the system. In order to economise power, the transmitter must be programmed in such a way that it functions for only a few hours at intervals of several days. As a result, locations on the migration route are inevitably widely spaced.

Important details regarding route, speed, resting places etc. could be obtained with permanently transmitting PTTs but this is not possible with conventional batteries over a long period of time. The solution might possibly be to use solar power. However, solar-powered transmitters are at present only available weighing 70 g. A solar transmitter which we fitted to a White-tailed Sea Eagle and which transmitted uninterruptedly, could be located daily up to 10 times (Meyburg *et al.* 1994). Three more similar transmitters are currently operative on other large eagles. This would also greatly increase the chances of conducting direct observations of the bird in its wintering grounds with the additional help of a conventional transmitter, since the satellite locations, with only a few hours' delay, can be relayed to the observer in the field. The ecology during this long phase within the annual cycle is still virtually uncharted and this technique could give a vital boost to its study.

It is to be hoped that relatively soon Solar PTTs weighing only 40-50 g may become available so that LSEs can be thus equipped. This would also open up the possibility of tracking both adult and young birds over a period of several years.

4.2 Departure

According to our visual observations in the breeding territory, made largely with the help of conventional telemetry, the young eagles as a rule leave their birthplace alone, before the adults which up to that time have cared for them. In isolated cases, however,

an adult bird can also leave earlier. The departure of the two young birds from Germany, between 8 and 10 and 10 and 13 September respectively, was markedly early as compared with other young eagles tracked by conventional telemetry. As also with adult birds, the speed of travel was relatively low, especially in Germany and also in Poland, only increasing from Ukraine onwards.

The three adult birds with no young to care for left 10-14 days earlier than the eagle which had bred successfully which, however, travelled much faster, reaching the Black Sea at about the same time.

4.3 Migration route

Through observation at concentration points (Burgas in Bulgaria, Bosphorus, Belen Pass, Iskenderun Gulf in Turkey, Israel, Suez and Hurghada in Egypt, as summarised in Bijlsma 1987), the route round the eastern Mediterranean is relatively well known and studied. Beyond this point the routes taken are virtually unknown (van de Weghe 1978 : Meyburg 1991).

The four birds from Germany all followed a similar route as far as the Bulgarian Black Sea coast, leading in practice over Poznan to south-east Poland, through eastern Slovakia or western Ukraine and finally diagonally through Rumania over Bucharest to the Black Sea near Burgas (see Fig. 3).

The eastern Mediterranean was flown round. One eagle at least crossed the Gulf of Suez from the southern tip of the Sinai Peninsula, while two others flew round the north of it (see Fig. 2).

From here on the hitherto unknown route in Africa proved to be a quite narrow flight path running almost due south between longitudes 31° and 36° through Sudan to the southern end of Lake Tanganyika in SW Tanzania. From this region the LSEs appeared to fan out and disperse to scattered wintering grounds south of latitude 10° S. On the outward migration three eagles passed west and two east of Lake Victoria.

What was striking was the precision with which the routes taken by the eagle fitted with PTT 21691 coincided on both outward and return journeys, so far as could be judged from the Argos locations. The slight, possibly only apparent, deviation between Lake Tanganyika and the wintering grounds was perhaps due to inaccurate plotting of the location in Tanzania, where a distinct change of direction at the southern end of the aforesaid flight path occurred, conditioned in each case by a gap of several days between locations.

4.4 Speed of migration

The autumn migration began slowly (4.2.) but gathered considerable speed already in south-east Europe. The stretch from the Bulgarian-Turkish border, over the Bosphorus, through Turkey, the Middle East, Suez and Egypt to the resting-place in the Sudan (4.5.) was covered with the greatest speed. South of Sudan the rate decreased.

In Israel, by observing migrating LSEs we were able to tackle the question of the amount of time daily available for travel : the first examples arrived at their roosting place around 15.20 hrs. By 17.00 hrs.,

with darkness beginning to fall, most of the tree roosts had been occupied. Thermals had already ceased by 16.00 hrs. The next morning the roosts were abandoned by 7.30 hrs. This gave a maximum of 8-9 hours available for travel. Based on this evaluation, the young eagle from Latvia flew at an average speed of between 32 and 36 km per hour.

Attempts at capture in Israel were unsuccessful, since the birds showed no interest in either food or drink. Possibly no food was taken during this whole stage of the migration.

The stage between the Bosphorus and Sudan was covered by all birds in 12-14 days. Here the young Latvian eagle attained its highest average speed of 289 km per day. Three adult eagles covered averages of 244, 250 and 282 km per day respectively. Only the young eagle (PTT 20649) which subsequently perished in Lebanon lingered for a whole week in the neighbourhood of the Bulgarian-Turkish border. A similar speed of migration was recorded for the closely related Greater Spotted Eagle. One adult of this species migrating through Iraq and Iran covered a daily average of 280 km (Meyburg *et al.* 1995).

The adult eagle with PTT 22691 travelled an average of 166 km per day on both outward and return journeys. On two days during the homeward journey the average speed in Ethiopia and Sudan could be determined thanks to two good locations with only a few hours between them. In each case this amounted to 30 km per hour. This, however, should be taken as a minimum value, since in both instances the bird was probably not in continuous flight during the measured time-lapse. On this basis the eagle would have spent an average of five hours per day travelling.

The widespread view that the return migration is distinctly faster than the outward one (Berthold 1990) was not borne out by this bird. With the first raptora Wahlberg's Eagle (*Aquila wahlbergi*) ever to be tracked through a complete annual cycle, the return migration took around two weeks longer than the outward one (Meyburg *et al.* 1995).

4.5 Resting places

One important resting area on the outward migration is clearly East Sudan, between the Ethiopian border and the White Nile, between latitudes 7° and 13°. It is more than surprising that up to now there have been no autumn sightings from Sudan or Ethiopia (Hogg *et al.* 1984 ; Nikolaus 1987 and pers. comm.). Particularly favoured was the region running between the Blue Nile with its tributaries and the Sobat River. Four of the tracked eagles arrived here between 12 and 17 October, one of them already on 2 October. The young bird spent a particularly long time (six weeks) in this area. This stretch of land, originally acacia savannah, is today given over to the cultivation of millet, in which the eagles find an ideal supply of food. At this time of the year, after harvest, various rat species are especially easy to catch (G. Nikolaus, pers. comm.).

4.6 Winter range

Data in the literature on the wintering grounds are quite inexact. The size of the area depends basically

on how it is defined: the wintering of the LSE, according to the results presented here, turns out to be a rather dynamic proceeding. Certainly the winter range in East Africa given by Cramp and Simmons (1980) is incorrect, stretching according to them from northern Sudan south to the Indian Ocean in Somalia and then down the coast to South Africa. This omits the whole western part of the range and it appears questionable whether LSEs in the north (Somalia, Kenya, Tanzania) in fact regularly overwinter so far east. According to our findings the winter distribution given by Brown *et al.* (1982) is, in the main, correct. This, however, overlooks the region in northern Namibia and southern Angola.

Christensen and Sorensen (1989) made a detailed analysis of the literature. The LSEs tracked by us frequented two countries (Angola and Zaire), for which, according to these authors, no evidence has hitherto been found. Based on the literature combined with the results from satellite telemetry we drew up a map of the winter range (Meyburg 1994). This included all occurrences from around the beginning of November to the beginning of March. If, however, one defines the winter range as the extent of the birds' preliminary resting grounds (winter quarters) then it would probably be merely defined as Africa south of latitude 15°S.

4.7 Influence of rain fronts

Ornithologists, especially in Southern but also in Eastern Africa, have presumed that wintering LSEs, far from being sedentary, follow the rain fronts so as to feed on the swarming termites (Brooke *et al.* 1972, Pearson and Meadows 1979, Steyn 1982). In the Kruger Park at the end of December 1994 we observed individual LSEs in the company of other species fly down to feed on termites. On 15 and 16 January 1995 there was heavy rainfall in this region. Between 17 and 20 January hundreds of eagles were observed here (A. Kemp pers. comm.) - many more than at the end of December. The fact that both eagles fitted with PTTs 21821 and 22692 were in this area at the same time can be taken as confirmation of this theory but further research is required.

4.8 Orientation

All German and Slovakian LSEs initially set out in the same general direction from their breeding territories, both young and adult birds heading in a somewhat too easterly direction. Both adults from Germany changed direction when still in Poland, taking an almost straight line to the Bosphorus. Further slight corrections were made by the young birds. The fact that these birds from Central Europe travelled too far east must explain to some extent why in autumn relatively many eagles are counted on the Black Sea coast near Burgas (Bulgaria) while in spring the number is much smaller (summarised in Bijlsma 1987). A deviation rather too far east is, however, relatively harmless, since the Black Sea coast serves as a leading line straight to the Bosphorus. Too wide a deviation to the west can, on the other hand, lead to straying into Greece, as happened with the first eagle tracked in 1992

(Meyburg *et al.* 1993). Subsequently, we learned that in that same year two more young eagles from Slovakia had lost their bearings and strayed into Greece, where they were probably shot (S. Danko, pers. comm.). Certainly, individual LSEs on autumn migration are regularly observed in Crete (M. Wink, pers. comm.).

During the crossing of Anatolia the birds showed a tendency to diverge westward from the obvious shortest stretch to the Gulf of Iskenderun. At least five of the birds arrived at the Mediterranean coast north of Cyprus. The satellite data did not reveal whether they then flew along the coast or took the shortest route across Cyprus to the Lebanon. As on the Black Sea, it is here clearly less dangerous to reach the coast slightly earlier and use this as a leading line, than to miss this and then possibly completely lose the direction.

4.9 Threats during migration

Very little is still known about the causes of death during migration and on the wintering grounds. The greatest danger is clearly the passage through Lebanon and Syria, particularly for young birds which risk being shot there. The relentless shooting in both countries is well documented (Hatsofe 1981, Leshem 1985, Baumgart 1991 a & b). Resolution N° 15 adopted at the IV World Conference on Birds of Prey and submitted to the President of Syria (Meyburg and Chancellor 1994) resulted in the latter's passing a law (N° 41/T) for the first time on 23 Oct. 1994 decreeing a five-year ban on hunting which is evidently being widely upheld (Baumgart 1995).

Every opportunity for improving the situation in Lebanon must be seized on, since this probably presents the gravest threat to the species.

4.10 Prospects

The use of ST as an aid to ornithological study is still only in its infancy and will in the future play a significant part which has not as yet been sufficiently appreciated.

The work on LSEs will be continued. Should solar transmitters weighing around 40 g actually become available in the foreseeable future, it will be possible, not only to study in close detail the preconditions, routes, resting and wintering places, times of passage and arrival, etc., but also to compare the same birds in different years. In addition we will obtain the answer to the still open question as to where the young birds spend their first year of life. Finally we must try to ascertain the degree of dependence on weather conditions during migration and on the wintering grounds.

Solar transmitters sending continuous signals, in combination with conventional transmitters, would greatly increase the chances of locating wintering eagles in the field and keeping them under direct observation. This would smooth the way to closer knowledge of the ecology of the eagles during this phase of the annual cycle.

5. Conclusion

Seven Lesser Spotted Eagles were tracked by satellite over distances ranging from 2,900 to 19,400 km

and over periods from 3½ to almost 11 months. An adult from Germany tracked for just under 11 months spent the northern winter in the south of Zambia, where it stayed from the end of October to the end of February. Its outward migration covered a distance of almost 9,000 km. On two occasions a migration speed of at least 30 km per hour was calculated from two locations obtained on the same day.

Two other adults from Slovakia were tracked to their wintering grounds in south Mozambique, and one of these was also tracked on its return migration as far as Egypt. Whereas the bird from Germany performed a typical to-and-fro migration between its breeding area and winter quarters, another adult, after a six-week sojourn in central Zimbabwe, where it had a range of about 12,000 km², suddenly flew on further south into southern Mozambique at the beginning of January. The third adult wandered slowly through Zaire, Angola, Zambia, Botswana and South Africa, to settle eventually likewise in southern Mozambique, at the furthest point of its migration, from mid-January to the end of February.

Both the juvenile eagles from Germany were, in one case demonstrably and in the other presumably, shot in Lebanon. A young Latvian bird reached the southern Sudan within a month; it stayed there for six weeks, in what is clearly an important resting area for the species, before proceeding on to Tanzania.

The speed during outward migration was slow at the beginning and highest during the stage from Turkey to Sudan. Since only 8 to 9 hours per day are available for migration here, the young bird from Latvia must have travelled at a speed of at least 32 to 36 km per hour.

A non-breeding adult caught in Slovakia at the end of May spent almost two months 250 km further south in Hungary before returning to Slovakia again in August. In Hungary it occupied a home range of about 35 km² in a very open area not used for breeding by this species.

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