

Meyburg, B.-U. & C. Meyburg (2009): Hohe Mortalität bei Jung- und Altvögeln: Todesursachen von Schreiadlern. Falke 56: 382-388.

Translation:

High mortality rate in juvenile and adult birds: Causes of death in Lesser Spotted Eagles

The Lesser Spotted Eagle (*Aquila pomarina*) is the most endangered of the remaining four German indigenous eagle species. The population has declined slowly but continuously for decades. In addition, the size of the breeding range has shrunk more and more. The main reasons for the decline are considered to be habitat deterioration in the breeding area and human persecution on the migration routes. Other causes, such as the natural mortality of juvenile and adult birds, have scarcely been taken into consideration to date. This article, based on the studies conducted by Bernd und Christiane Meyburg, reports on the appalling losses of juvenile and adult birds

The mortality rate is a very important parameter for calculating the population structure and dynamics of wildlife populations. Unfortunately there are practically no reliable data in this respect for adult Lesser Spotted Eagles or other eagle species. Estimates give the mortality rate after the third year as under 10 %. We have already published some results on the mortality of juvenile eagles and further information, based on the fitting of a large number of nestlings with satellite transmitters, can be expected shortly. Up to the present day the mortality rate of Lesser Spotted Eagles and other eagle species has been based on estimates only. Such estimates are normally based on ring recoveries and other identification markings (wing tags, colour rings) as well as DNA analysis of moult feathers. All these methods are however imprecise in respect of a true calculation of the mortality rate. Ring recovery rate is only a few percent, birds usually lose their wing tags after only a few years and identification rings are often difficult to read. Moulting feathers, particularly from male Lesser Spotted Eagles, are rarely found. The most common cause of mortality recorded to date for all age groups is shooting. The mortality rate of adult birds on migration was extremely high. Natural losses, as incurred for example crossing the Mediterranean - established in the meantime in the case of juvenile Lesser Spotted Eagles - cannot be detected with the methods mentioned above.

Mortality rates und satellite telemetry

The most effective method for gaining as accurate as possible information on the annual mortality of adult birds and individuals of other age groups is satellite telemetry (ST). In the framework of a long term World Working Group on Birds of Prey project, B.-U. Meyburg has fitted Lesser Spotted Eagles with satellite transmitters (PTTs) since 1992. When no more signals are received from a bird fitted with a PTT the possible reasons for the failure are:

1. The bird has lost, destroyed or removed the transmitter,
2. The transmitter has failed for technical reasons, or
3. The bird is dead.

Some Lesser Spotted Eagles bite through the bands with which the PTT is fastened like a small rucksack to the birds back. Other individuals are unaffected by the transmitter and carry it for many years. Until a few years ago PTTs were not as reliable as they are today and often failed for unknown technical reasons. When signals ceased, it was difficult for the researcher to decide whether the PTT had been removed from the bird, it had developed a technical failure and the bird was still alive, or if the bird was dead. In the meantime the transmitters are much more reliable and there have been no technical failures in recent years. Following long term studies on Lesser Spotted Eagles in captivity a harness for the PTT has been developed that to a great extent rules out the possibility of the bird removing it. In this paper we therefore only take account of the results of the past 3 years. Older data have to be separately evaluated because of the problems described above.

Eleven adult eagles, two females and nine males, were carrying functioning PTTs in August 2008. These birds had been fitted with transmitters in different years, the first in 2002, and one more each year in 2004, 2005 and 2007. In 2006 two birds and in 2008 six adult Lesser Spotted Eagles were fitted with PTTs. Only the transmitter fitted in 2002 could merely send Doppler and not the very more precise GPS fixes. Included in the calculations was also a further female which had been fitted with a PTT in 1996. This transmitter was no longer functioning in August 2008, but the bird returned to its breeding site in Mecklenburg-Western-Pomerania every year including 2009 and was easily identifiable from its antenna. All twelve eagles migrated on the normal route from the Bosphorous around the eastern Mediterranean to Suez. From there they continued their migration within a relatively narrow corridor through Egypt, Sudan, Uganda and Tanzania to their wintering areas in southern Africa. This route was also tracked by ST before 2008 for the female with the transmitter fitted in 1999. Up to this time, and also during wintering 2008/2009, there were no losses. Then two adult eagles were lost on spring migration in 2009 and a further two in their German breeding grounds. In evaluating the data we must restrict ourselves to a description of the individual cases as, due to the small number of cases studied, the statistic analysis only permits limited conclusions as far as the population as a whole is concerned. We present the fate of the four adult eagles as an example below.

(BOX 1)

The male with PTT No. 36021

This bird was fitted with its transmitter at its breeding site in Mecklenburg-Western Pomerania on 28.07.2002, to which it thereafter returned annually. In winter the eagle migrated very far to the south. The most southerly fix (28° 34' 22" S/ 31° 41' 42" E) was from KwaZulu-Natal Province, South Africa, near Richards Bay, some 9,350 km in a direct line from its nest site. The first fix at the nest site in 2009 was on 11.04. The last fix was on 22.05 only 900 m west of the nest site. In the intervening period, for a transmitter that had been operating for seven years, we received many good quality Doppler Argos fixes from the nest site area. The eagle was sighted on 09.05, 01.06 and 03.06.2009, and it was confirmed that the PTT was still sitting in the correct position. To date this is the Lesser Spotted Eagle with the longest record of carrying a PTT still sending signals.

On 27.06.2009 the bird was caught, severely injured but still capable of flight. Following a detailed veterinary examination it was decided to have the bird put down. The autopsy showed that the lower jaw was broken on both sides. The complete lower beak hung loosely to one side. The bird was not capable of either eating or drinking. As a result it was emaciated and weighed only 905 g. Males normally weigh some 1,300 to 1,500 g. The injury was most probably caused by a collision with a power cable.

The x-ray pictures showed two pieces of lead shot. One of these was located directly under the skin over a muscle 12 mm above the left thigh. The other piece of shot was on the right tarsometatarsus (lower leg) between the ankle and the intertarsal joint. The shot had become deformed on impact with the bone. It was clearly an old injury as both pieces of shot were encapsulated in tissue and the skin had completely closed over the wounds. The bird had probably not been shot in Germany, but in the Near East or elsewhere, as the pieces of shot were conspicuously square in shape and were therefore not industrially manufactured. The adult bird had however not only survived these injuries. In addition it had an old fracture of the tibiotarsus (shinbone) and the left fibula (calf bone). The bone fractures had knitted together. It is amazing that the bird had survived the consequences of such bone fractures.

A few days before its accident the bird had been observed carrying prey into the woods. As it was feared that the female would not be able to feed the young nestling, the nest was searched for, found, and checked with permission of the authorities on 05.07.2009. In the nest was a some 35 day old, very underweight (650 g) young eagle. Its crop was empty, it appeared weak and its begging calls could be heard from some distance away. There was no prey in the nest. Young birds of this age normally weigh 50 - 100 % more. As the dietary requirement increases with age it could not be assumed that the female could cope adequately with the feeding. Female Lesser Spotted Eagles normally forage only sporadically during the nestling period. This is the task of the male. In 2009 the mice population was evidently so low that many species had problems rearing a brood. Its constant begging, and the absence of the female on foraging trips, clearly increased the risk of the young eagle being found and killed by predators. Even if it had managed to survive until fledging, which could be more or less ruled out, its condition for the long migration to Africa would have been extremely poor. The young eagle was therefore taken from the nest and taken to the Woblitz nature protection station. Sadly an infection led to the bird becoming blind in one eye so that it could not be released into the wild.

(BOX 2)

The male with PTT No. 84373

This male, which had successfully reared young, was fitted with a PTT on 12.07.2008 in the state of Brandenburg. From 30.11.2008 to 23.2.2009 it wintered in Botswana and Zimbabwe. A total of 1,503 GPS fixes were received from the wintering area. Its winter quarters extended 550 km from east to west and 160 km from north to south. The male bird began its spring migration on the morning of the 23.02 and was last located on 30.03.2009 in Israel. This indicates that the bird was shot down shortly afterwards in the Lebanon, Syria or

southern Turkey. In terms of human persecution these regions are the most dangerous along the whole migration route.

(BOX 3)

The male with PTT No. 84374

This eagle from the state of Brandenburg was last located on 03.02.2009 in Zambia on spring migration. It was caught on 02.08.2008 at its nest site together with its female partner. The eagle reached its winter quarters on 15.11.2008 and departed on 10.01.2009. Some 1,022 GPS fixes were received in this time frame. The wintering area extended a maximum of 500 km from east to west and a maximum of 630 km from north to south. It included parts of southern Zambia, the eastern part of the Caprivi Strip (Namibia), the north-east of Botswana and the western part of Zimbabwe. From 18.01.2009 it rested on spring migration in an area in north-east Zambia and north-west Malawi. From 30.01 to 03.02.2009 51 GPS fixes were received from the same wooded area in Zambia, some 137 km east of Chinsali (1,790 m ASL).

This indicates that the bird was lying dead on the ground with the solar array and antenna well exposed. We had experienced similar cases of finds of poisoned Red Kites (*Milvus milvus*) in Spain and Portugal. The cause of the eagle's mortality cannot be stated. It is however unlikely that it died at human hands as the transmitter would probably have been removed. The transmitter would then either have ceased sending or have continued to transmit from the finder's home. In similar cases with Ospreys (*Pandion haliaetus*) it was very clear from the fixes up to which stage the bird was in its natural biotope and when the transmitter was taken to a village. We are usually informed immediately when a transmitter is found, as the finder hopes to receive a reward. In this way we recover not a few transmitters from African countries, often with the assistance of the local German Embassy. It is also unlikely that the eagle was killed by another animal. In such cases the transmitter does not remain in the correct position, the solar panels are not recharged, and such a large number of GPS fixes are not transmitted over such a long period. The antenna must protrude vertically and should not for instance lie on the ground.

In April 2009 the Lesser Spotted Eagle, in contrast to the female of the pair, did not return to the old breeding site, another sure indication that it had died. The female paired with a new male partner. The new male, in contrast to the male that had been fitted with a PTT and could have either lost or removed it, could not be mistaken for the old bird as it had neither a ring from a ringing station nor a colour ring. Adult Lesser Spotted Eagles are extremely philopatric (site fidelity). The possibility that the bird resettled in another territory can be excluded, as all breeding pairs in the near vicinity or further distant are all monitored, and the bird with its transmitter and yellow colour ring would have been noticed immediately.

(BOX 4)

The male with PTT No. 83269

The loss of the fourth eagle in Brandenburg is mysterious. This bird was fitted with a PTT at its breeding site on 27.07.2008, on the western edge of the Lesser Spotted Eagle distribution range. It remained in its wintering area which, based on 1,105 GPS fixes, extended 756 km from east to west and 210 km from north to south, from 03.11.2008 to 23.01.2009. In spring 2009 the bird returned belatedly to its old nest site on 26.04.2009. From at least 04.04 to 08.04.2009 it remained in the far south of Turkey near the Mediterranean coast at an altitude of some 1200 m ASL. During this period the fixes showed the bird sitting and not flying at any time. The region around the town of Samandağ is considered a hot spot of bird of prey persecution in Turkey. This most southerly town in the country is located directly on the Mediterranean coast not far from the Syrian border. Could it be that the bird was shot and injured here and needed some days to recover? Climatic reasons for the stopover can be excluded. The flight onwards was markedly slow. An adult female, which migrated through this area at the same time, flew on without stopping and reached its breeding site in Brandenburg on 15.04.2009. At this point in time the male had only just reached the Bosphorus.

The eagle was first located directly at the nest on 26.04.2009, as also two days later, whereby the second fix was less precise. Before this time a new unmarked male had arrived and paired with the female present. Subsequent to the arrival of the male with the PTT, despite intensive observation, sightings were made of the unmarked male only and there was no sign of the male with the transmitter. No more fixes were received after 28.04. The single egg of the clutch turned out later to be unfertilised. There are two possible explanations for the situation. Either a confrontation between the two male birds ending in death for one of them, or the death of the male from other causes (e.g. collision with one of the nearby wind turbines). The possibility of the transmitter failing or being lost just as the eagle arrived at the nest site appears unlikely. A similar phenomenon was recorded with a male Lesser Spotted Eagle with PTT in Slovakia in 2002, which had been monitored since 1992. It arrived at the breeding site on 12.04 after which date signals ceased. In June the breeding site was found unoccupied. We have ourselves observed fights between males, although a fatal end in the case of this species is not known from the relevant literature, personal experience or reports from other ornithologists. With other species such as the White-tailed Eagle (*Haliaeetus albicilla*) such confrontations can indeed end fatally.

Mortality in other years

When the years 2006 to 2008 are taken into account the situation looks markedly better. In autumn 2006 six adult eagles with PTTs left their German breeding areas. They all returned the following year, as did the seven adult eagles that migrated in 2007. No bird with a PTT fitted died in the time frame 2006 to 2008. The total mortality over the three year period is therefore 14.8 % (95 % confidence interval: 4.2 - 33 %). Even without a detailed evaluation it can be stated that for the time frame 1994 to 2005 there were quite a lot of losses of adult eagles with PTTs, which can only be explained by the death of the birds concerned. Using DNA analysis it could be proved that, at a breeding site in north-east Brandenburg, both adult eagles were replaced by new birds. Based on DNA analysis, the longest period of time recorded for the return of both partners to a breeding site was in one case three years.

Dead birds found in Germany

To date there have only been very few known finds of dead Lesser Spotted Eagles in Germany. On 06.08.1971 a 17 year old Lesser Spotted Eagle was found as a road kill near Falkenthal (Brandenburg), only 12 km from its birthplace. In 2001 G. Heise found the remains of a Lesser Spotted Eagle, consisting of feathers, the skull and some bone remnants, in a former breeding wood in the northern Uckermark (Brandenburg). The time of death was estimated as being in mid-May but the cause of mortality remained unclear. A five year old Lesser Spotted Eagle was found as a road kill in September 2007 on the new Autobahn 20 (Baltic Freeway) near Strasburg, only 7.5 km from its birthplace. For the first time on 12.09.2008, an adult male Lesser Spotted Eagle was found dead after collision with a wind turbine. The bird had been ringed as a nestling in Mecklenburg-Western Pomerania eight years earlier. The find was made in the north-east of the Uckermark district some 32 km from where the bird had been ringed. The collision with the rotor blades resulted in fractures of the skull, two cervical vertebrae and various other bones.

Wind turbines - a new permanent danger

The number of victims at wind farms is undoubtedly higher than officially known. The plans to greatly increase the numbers of these installations in Brandenburg and elsewhere can only be viewed with the greatest concern as far as the Lesser Spotted Eagle is concerned. Wind farms in the USA claim thousands of victims annually. As with the help of ST studies it is now known that the birds have a much greater home range than previously believed, the protective belt around known nest sites of 3 or 6 km only partly helps to solve the problem. Moreover, even these minimum stand-off distances are often not respected. The only direct observation of a dramatic near-accident to date (by C. Rohde) is briefly described here. On 09.05.2009 at 10.10 am, a Lesser Spotted Eagle, probably the male of a nearby breeding pair, riding a thermal together with other birds of prey (a Red Kite and Common Buzzard (*Buteo buteo*)), was observed drifting towards a new wind farm in the north-east of Brandenburg. At 10.25 am the eagle was attacked by a Red Kite that had its breeding site on a slope in a nearby small valley. At 10.30 am the eagle suddenly appeared in the zone of the rotor blades of a wind turbine. Turbulence in the eagle's flight was observed at the height of the turbine hub. Suddenly the bird listed to one side, lost control and came into contact with the hub. That the bird then managed to escape unscathed from the approaching rotor blades was no less than a miracle. It lost some height but then regained control and remained capable of flight. The turbine where the collision occurred is only 2,800 m from the Lesser Spotted Eagle's nest.

Significantly higher mortality in juvenile eagles

As is to be expected, ST shows that mortality is particularly high in the course of the first year of a Lesser Spotted Eagle's life. The routes of the first autumn migration often differ significantly from the route of the adult eagle around the eastern Mediterranean described in 1995, which it has used without exception since. The first young eagle from Mecklenburg-Western Pomerania fitted by us with a transmitter in 1992 migrated to the southern tip of the Peloponnese (Greece). The contact broke off at this point. Whether it was shot down in this region of high persecution activity, or failed to survive the crossing to Crete, remains

unknown. In 1993 two German and one Latvian juvenile eagle were fitted with PTTs. Both German birds were shot on autumn migration over the Lebanon. We were sent one of the transmitters with a piece of lead shot lodged in it. The bird had been found dead by a Lebanese doctor in the north of the country who informed us of the find by letter. The second juvenile eagle was also definitely shot in Lebanon. First of all the signals ceased abruptly, and then fixes came for a long period of time from the capital Beirut. Only the Latvian eagle made it as far as Tanzania where the transmitter's batteries became too weak to send.

From 2007 onwards, thanks to a project funded by the Deutschen Bundesstiftung Umwelt (DBU - German Federal Environment Foundation) and the Deutschen Wildtier Stiftung (DeWiSt - German Wildlife Foundation), more young eagles could be fitted with PTTs. In 2007 six juveniles were fitted with PTTs. One of them collided with a vehicle in the Sudan and died in an animal clinic. As with the first young eagle to be fitted with a transmitter in 1992, one juvenile reached the southern tip of the Peloponnese where again contact was lost. Again it remains unclear whether it was shot or failed to complete the crossing to Crete. A further bird could only be tracked as far as Bosnia.

One bird wintered in the Sudan, very far north of the known wintering areas to date of the Lesser Spotted Eagle in Central and South Africa. Over 1,700 GPS fixes were recorded during wintering, providing a good basis for more detailed behavioural studies. Subsequently the first spring migration of a just one year old bird could be partly studied. The bird left its winter quarters on 08.05.2008 and followed the usual migration route via Suez and close to the coast of the eastern Mediterranean. The last signal from this bird was on 12.06.2008, 130 km west of Istanbul. The transmitter probably failed at this point.

Another juvenile Lesser Spotted Eagle was tracked as far as the southern tip of the Sinai Peninsula (Egypt). It remains unclear whether it then failed to complete the crossing over the Gulf of Suez to Africa or possibly died of poisoning at the Sharm El Sheikh sewage works.

The last juvenile eagle was tracked to Mozambique and it then wintered in Zambia where contact was lost for unknown reasons. An unmarked juvenile in the project was shot on Malta. 'Sigmar' as the bird was named in the press received a great deal of media attention, was flown back to Germany, but the injuries incurred meant that it had to be put down later.

In 2008 17 juvenile eagles were fitted with PTTs. Contact with four individuals broke off for no apparent reason. Four birds were found in an exhausted state. Two of these were rehabilitated and were released without transmitter, the other two died. Three other eagles without PTTs also died from lack of nutrition, including two Latvian birds which made it as far as the Ukraine and the Sudan. A fourth probably died in the breeding area for the same reason.

The cause of mortality of a juvenile eagle in West Africa remains unknown, although a search was made when it stopped migrating. Two birds died as a result of collision with power lines and a road kill accounted for another bird. One juvenile obviously died of poisoning in the south of the Sinai Peninsula. Two young eagles attempted unsuccessfully to cross the Mediterranean at a very wide point.

The furthest distance covered was by a juvenile eagle with PTT No. 84371. It wintered in Zambia and was last located on 04.06 in Syria on spring migration. Four days later two precise fixes were received from the outskirts of Baghdad (Iraq) after which signals ceased. This indicates that the young bird was shot in either Syria or the Lebanon and was then transported to Iraq. In 2009 a total of twenty young eagles were fitted with transmitters.

A comparison with Golden Eagle and Red Kite

Comparative ST study data are up until now only available for young Golden Eagles from Alaska in the years 1997 and 1999. The survival rate of the young eagles in the first eleven months of their life was only some 0.34 - 0.19. For lack of other published results we are only able to compare Lesser Spotted Eagle results with those of the Red Kite, which is similar in size. Between 2002 and 2005 we fitted a total of nine Red Kites with PTTs. Seven of these birds probably died by spring 2009, two males and a female in the breeding area, a male on migration, as well as two juveniles and a female in winter quarters. At present (autumn 2009) one female still has a transmitter and, since it was fitted at the age of 3 years, has annually (to date seven times) successfully reared young. A transmitter was removed from an adult bird on recapture.

Bernd-Ulrich Meyburg, Christiane Meyburg

(BOX 5)

Prof. Dr. Bernd-Ulrich Meyburg, Chairman of the World Working Group on Birds of Prey (WWGBP) and Head of the German Federal Working Group for Bird of Prey Protection in NABU, has been involved with the fitting of satellite transmitters to many Lesser Spotted Eagles and other birds of prey, most of them in Germany, since 1992. Together with his wife Christiane Meyburg, who manages the comprehensive database, he has published to date only a small part of the results of on-going studies. The articles already published are available online at www.raptor-research.de

Illustrations

Fig. 1: Adult male Lesser Spotted Eagle with a 30 g GPS solar satellite transmitter a few seconds after release. Photo: B.U. Meyburg. Mecklenburg-Western Pomerania, 12.08.2009.

Fig. 2: One of the pieces of shot above the left thigh can be seen on the X-ray.

Fig. 3: The adult bird survived a fracture of the left shin. Photos: O. Krone.

Fig. 4: Movements of the male Lesser Spotted Eagle with PTT No. 84373 during wintering.

Fig. 5: Autumn (red) and spring (black) migration of the male with PTT No. 84373 from Brandenburg. Departure from the breeding area on 15.09.2008. Green: winter quarters. The crossing of the Bosphorus took place on 07.10.2008, the bird passed through Israel on 13/14.10.2008 and it was at Suez on 16.10.2008 and 29.03.2009.

Fig. 6: Movements of the male Lesser Spotted Eagle with PTT No. 84374 during wintering in southern Africa.

Fig. 7: Autumn (red) and spring (black) migration of the male with PTT No. 84374 from Brandenburg. Departure from the breeding area on 15.09.2008. The crossing of the Bosphorus took place on 02.10.2008, the bird passed through Israel on 8.10.2008 and it was at Suez on 09.10.2008.

Fig. 8: The first Lesser Spotted Eagle confirmed as victim of a wind turbine. Photos: M. Götttsche. Uckermark, Brandenburg, 12.09.2008.

Fig. 9: In September 2009 ST fixes led to the location of this young Lesser Spotted Eagle in St. Gallen (Switzerland), where it could be observed thoroughly for several days. Photo: U. Büchler

Fig. 10: The antenna and transmitter are very useful for identification of adult birds. In this way a female eagle was positively identified at its nest site every year from 1996 to 2009 inclusive. The photo is of an adult male Lesser Spotted Eagle with visible antenna. Photo B.-U. Meyburg. Mecklenburg-Western Pomerania, 12.08.2009.

(BOX 6)

Relevant literature:

Böhner, J. & T. Langgemach (2005): Warum kommt es auf jeden einzelnen Schreiadler *Aquila pomarina* in Brandenburg an? Ergebnisse einer Populationsmodellierung. Vogelwelt 125: 271–281.

Danko, S., B.-U. Meyburg, T. Belka & D. Karaska (1996): Individuelle Kennzeichnung von Schreiadlern *Aquila pomarina*: Methoden, bisherige Erfahrungen und Ergebnisse. S. 209-243. In: Meyburg, B.-U. & R. D. Chancellor (Hrsg.): Eagle Studies. Berlin, London & Paris: WWG on Birds of Prey.

Mc Intyre, C., M. Collopy & M. Lindberg (2006): Survival Probability and Mortality of migratory juvenile Golden Eagles from Interior Alaska, J. Wildlife Mgmt. 70: 717-722.

Meyburg, B.-U. (2005): Zug und Verfolgung der Greifvögel in der südlichen Türkei. Orn. Mitt. 57: 12-16. www.Raptor-Research.de

Meyburg, B.-U. & C. Meyburg (2009): Wanderung mit Rucksack – Satellitentelemetrie bei Vögeln. Falke 56: 256-263. www.Raptor-Research.de

Meyburg, B.-U., T. Belka, Š. Danko, J. Wójciak, G. Heise, T. Blohm & H. Matthes (2005): Geschlechtsreife, Ansiedlungsentfernung, Alter und Todesursachen beim Schreiadler (*Aquila pomarina*). Limicola 19: 153-179. www.Raptor-Research.de

Meyburg, B.-U., K. Graszynski, T. Langgemach, P. Sömmer & U. Bergmanis

(2008): Cainism, nestling management in Germany in 2004–2007 and satellite tracking of juveniles in the Lesser Spotted Eagle (*Aquila pomarina*). Slovak Raptor Journal 2: 53–72. www.Raptor-Research.de

Meyburg, B.-U., C. Meyburg, T. Belka, O. Sreibr & J. Vrana (2004) : Migration, wintering and breeding of a Lesser Spotted Eagle (*Aquila pomarina*) from Slovakia tracked by Satellite. J. Ornithol. 145: 1-7. www.Raptor-Research.de

Meyburg. B.-U., W. Scheller & C. Meyburg (1995): Zug und Überwinterung des Schreiadlers *Aquila pomarina*: Satellitentelemetrische Untersuchungen. J. Ornithol. 136: 401-422. www.Raptor-Research.de

Pfeiffer, T. & B.-U. Meyburg (2009): Satellitentelemetrische Untersuchungen zum Zug- und Überwinterungsverhalten thüringischer Rotmilane *Milvus milvus*. Vogelwarte 47: 171-187. www.Raptor-Research.de

Smallwood a, K. S., L. Ruge b & M. L. Morrison c (2009): Influence of Behavior on Bird Mortality in Wind Energy Developments. J. Wildlife Management 73:1082-1098.

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