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First Results of the Tracking of an Eastern Imperial Eagle (*Aquila heliaca*) Tagged with a GPS / GSM Transmitter in Bulgaria

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Abstract: The article presents the results of the first tagging of a young Eastern Imperial Eagle (*Aquila heliaca* Savigny 1809) with a GPS / GSM transmitter in Bulgaria. The device was a prototype of the Spanish company EagleEye®. The transmitter was fitted on a young Imperial Eagle successfully treated in the Wildlife Rescue Centre of Green Balkans. The bird was released back into the wild at 150 days of age in the end of November 2007. The eagle started migrating to the South after the release. During this intensive movement, the tagged Imperial Eagle flew over two continents – Europe and Asia and crossed the borders of three countries – Bulgaria, Turkey and Greece. The behavior of this bird was completely different from that of the other two Imperial Eagles of the same age, studied at the same time through radio-tracking. They stayed to winter in Bulgaria, while the GPS / GSM tagged bird was obviously heading for Africa, flying over wide marine areas. An area on the north coast of the Marmara Sea, where the bird remained for a while, was located during the study. A total of 869 positions with the exact location of the bird were received during the study period. Data on the duration of the daily passage and the height of the flight was also gathered.

Key words: Imperial Eagle tracking, GPS/GSM transmitter, Eastern Imperial Eagle

Introduction

Studying birds through various types of marking and further tracking is a widespread technique. Ringing with standard and/or specialized ornithological rings is the most used and at the same time the most accessible method. This method was introduced in Bulgaria as early as 1928 (Nankinov 1988, 1997). For the past few decades various types of transmitters – radio-, satellite (PTTs), GPS/GSM transmitters for marking and tagging of birds have been gaining popularity on a global scale.

Despite the fact that for the past 20 years different institutions and organizations in Bulgaria have been working for the preservation and studying of birds, the use of transmitters has been introduced fairly recently. The German researcher B. Meyburg was the first to report an Egyptian Vulture (*Neophron percnopterus Linnaeus* 1758) tagged with a satellite transmitter in Bulgaria. The bird migrated to Africa (Chad and Nigeria) (Meyburg *et al*. 2004). The next time this method was used was back in 2005 when Green Balkans Federation and the Bulgarian Society for the Protection of Birds started radio-telemetry tracking of Black Vultures (*Aegypius monachus* Linnaeus 1766).

In the summer of 2007 the team of Green Balkans Federation marked two young Eastern Imperial Eagles with radio-transmitters for the first time in Bulgaria (Gradev *et al.* 2011). Later that year the same team tagged another young Imperial Eagle with a GPS/GSM transmitter. This paper presents the results of the tracking of the latter bird. This was the first time such transmitters were used for studying Imperial Eagles in Bulgaria and for studying birds in general. In 2008 the tagging of Imperial Eagles with transmitters continued, as Green Balkans marked a young bird with a radio-transmitter (Gradev *et al.* 2011). In the same year another young individual was tagged with a GPS/satellite transmitter by a team of the Bulgarian Society for the Protection of Birds (Stoycho Stoychev, Dimitar Demerdzhiev, pers. comm.). Again in 2008, the Fund for Wild Flora and Fauna tagged several Griffon vultures (*Gyps fulvus* Hablizl 1783) with low-range radio-transmitters to track the vultures, which were experimentally released from an acclimatization aviary as a part of the programme for reintroduction of the species in the Balkan Mountains.

Since the first tagging of Imperial Eagles with radio- and GPS/GSM tags in Bulgaria carried out by Green Balkans Federation in 2007, the use of transmitters for marking and tracking of birds has been applied more intensively.

Material and Methods

The young Eastern Imperial Eagle tagged had been treated in the Wildlife Rehabilitation and Rescue Centre of Green Balkans Federation in 2007. It hatched the same year with a pair nesting in the area to the north of the Dervent Heights. During the breeding season of 2007 the pair had only this single chick.The bird arrived in the Rescue Centre on July 23rd, 2007, at an age of about 60-65 days, weighing 2290 g. After rehabilitation and training to hunt on live prey, and having reached suitable age, on October 29th 2007 the Imperial eagle was released back into the wild in the nesting area. By that time the eagle was already about 150 days old, reaching a weigh of 3855 g. The selection of the release site was based on its proximity to the hatching nest as well as the results of the telemetry tracking of the other two young Eastern Imperial Eagles tagged with radio-transmitters that year (Gradev *et al*. 2011). These findings indicated that there was a temporary settlement area of Imperial Eagles in the area of the release site. Probably the reason for concentration of eagles in that area was the abundance of voles (*Microtus* sp. Schrank 1798). Considering the presence of suitable prey and the occurrence of several individuals from the same species at a close age, that particular area was selected for releasing the tagged bird. It was expected that the released eagle could join the group already formed. The young eagle was tagged with a GPS/GSM transmitter in order to study the migration, wintering, pair formation and other significant stages of the life of the juvenile eagles, as well as to follow the process of adaptation and survival of the birds which have undergone treatment in the Rescue Centre. The device was a prototype designed by the Spanish company EagleEye® and was granted for the purpose of this study by Luis Escribano and Víctor García Matarranz who had developed the technology. The fixing of this 70g device equipped with a solar battery was done under the standard "backpack" method (Garcelón 1985). The device records the geographic coordinates of the location of the bird through a GPS system, activated once every 30 minutes between 08:30 am and 09:30 pm, while the first location for the day is taken at about 08:25 am. Thus a maximum of 28 positions with the exact location of the marked individual can be recorded on a daily basis. The device does not work during the rest of the day to allow for saving the battery and extend its operational life. The saved information is sent through the network of a GSM operator, using the GPRS service. The transmitter used within the current study was programmed to work with the network of a Bulgarian GSM provider, using roaming services to transfer data once the bird leaves the territory of the country. The data is sent once every 48 hours at a certain hour when the GSM device turns on and searches for connection with the Bulgarian or other foreign mobile operators. In case of zero coverage, the recorded positions are saved on the memory of the transmitter until the next time, 48 hours later, when the device starts searching for network connection again. This action can be repeated multiple times as the device can save up to 30 000 positions if there is no mobile network coverage. The processing of the data received from the transmitter was done through the Location of a

Signal (LOAs) software. The visualization and the analysis of the data obtained through the GPS/GSM transmitter was done using the ESRI ArcMap software. Shape files with in-built altitude of Greece, Turkey and Bulgaria from the ESRI libraries were used for the compilation of the maps. The WGS 84 coordinate system was used. In addition to the location of the bird, the transmitter can provide data on the bird's activity – flying or resting, height, speed and direction of flight. The data received from the transmitter covered the period 29.10-04.12.2007.

The device sent a total of 869 positions and there were signals providing exact data on the location of the eagle for each of the 37 days of study. An average of 24 locations per day was recorded. The maximum number of signals per day (28) was achieved six times. The least amount of signals was received on November 5th, 2007 – 8 (the eagle was still in Bulgaria), December 1st, 2007 – 14 (from the south-eastern coast of the Island of Rhodes), November 24th, 2007 – 19 (from the coast of the Aegean Sea, across the Island of Lesvos).

Results and Discussion

On the release day (October 29th) the young bird flew well and was observed hunting successfully on voles immediately after the release. In the beginning, the bird made short-distance flights and stayed in the area for several days after the release (until November 3rd). The distance and the speed of the flights gradually increased, as in the period November 3rd-5th the bird moved 7 km southwards. This was not the real distance covered by the bird but the distances along a straight line between the first and the last locations of the eagle sent for that day. Although it was released in an area harboring concentrations of young Eastern Imperial Eagles, the tagged bird did not stay in the region and left immediately, while other birds at the same age stayed there longer. During the following two days the eagle flew to Turkey, moving 65 km further away, crossing the breeding areas of two neighboring pairs of Imperial Eagles that nested on both sides of the Bulgarian-Turkish border. On November 7th the bird was located in Greece, in the area of the Maritsa river valley. On that day the eagle moved further 60 km towards the Aegean Sea above the Turkish territory, continuing its migration to the South. For the period November 9th-22nd the eagle stayed in an area along the North coast of the Aegean Sea (the area of Tekirdag), flying over a region covering a total area of 1580 m^2 and altitude between 0-2000 m. At that time the eagle had already moved about 180 km away from the release site and its natal area. Probably the bird stayed in that area either because of the availability of suitable habitats or because it was looking for a place to cross the sea. On November 23rd the eagle crossed the Dardanelles in the south-eastern part of the strait over a section 7,4 km wide. Having crossed to Asia, the eagle continued moving southwards, following the Western Turkish coast of the Aegean Sea. In 2008 another juvenile Imperial Eagle marked in Bulgaria by BSPB with a satellite transmitter, provided with GPS (Stoycho Stoychev, Dimitar Demerdzhiev, pers. comm.) migrated crossing the Daradanelles and the Turkish coast of the Aegean Sea. There is additional data from approximately the same area for the migration of another young Imperial Eagle marked by the team of Raptor protection of Slovakia with a PTT in Slovakia in 2005. In the spring of 2006 the Slovakian individual moved along the north-western Turkish coastline from the south to the north and also crossed the Dardanelles (Chavko *et al*. 2008).

After crossing the Dardanelles the young eagle subject to this study crossed wide aquatories 15-20 km wide. On November 29th the eagle left continental Asia flying over the Aegean Sea and reached the island of Rhodes. The bird stayed on the island until December 3rd, when it made an attempt to cross the sea towards the Karpathos Island, located about 50 km to the south-west, probably in the direction of the Island of Crete. This assumption is based on the existing observations of migrating juvenile and immature Imperial eagles on some islands in southern Greece and Crete in particular (Handrinos, Akriotis 1997, Sakoulis 2001). There is obviously a functional migratory route as 19 out of 315 Imperial eagles ringed in the Carpathian basin were recovered in Greece until 1993 (Sakoulis 2001). In addition, wintering of first-winter individuals on Crete was also proven (Sakoulis 2001).

Having flown 34 km towards the island and having only 14 km more to reach it, the eagle turned back and returned to Rhodes (Fig. 1 – Map of the migration of the young eagle). Probably the reason was

strong contrary wind as, according to the transmitted data, the bird was flying very low. Speed between 10-40 km/h was recorded during the attempt of the eagle to reach Karpathos, while during its return back to Rhodes the bird was recorded to fly at over 58,6 km/h. This also confirms the assumption that the weather conditions caused the sudden change of the flight direction. On the morning of December 4th, the eagle was wandering over Rhodes, and this is where the transmitter sent the last signal at 10:31 am. No more data was sent by the transmitter and the reason is still unclear – the device might have stopped working or the bird might have died. The probability of the bird being still alive is supported by some evidence of an adult Eastern Imperial Eagle that has managed to somehow remove a battery-powered PTT transmitter in two years after the fitting as well as the suggestion that other birds of prey are also capable of removing the Teflon ribbons of the tags (Meyburg, Meyburg 1998). There are also documented cases of a solar-powered tag fitted on an Eastern Imperial Eagle that ceased sending signals and was later recovered without obvious damages and seven more cases of solar-powered transmitters that failed to send signals in 1997 for unknown reasons (Meyburg, Meyburg 1998).

During its migration to the South, this young Eastern Imperial Eagle obviously headed for Africa and its behaviour was completely different from that of two other Eastern Imperial Eagles at the same age marked with radio-transmitters in Bulgaria and studied in the same period. Those eagles with radio-transmitters wintered in temporary settlement areas in the country close to their natal areas (Gradev *et al*. 2011). On the other hand the GPS/GSM tagged eagle migrated along the same route (the Dardanelles and the Aegean coastline) as the described two cases of eagles marked by BSPB and Raptor protection of Slovakia. The presented information shows that the studied eagle, which had been treated in the Rescue Centre of Green Balkans Federation, used the same migratory routes as the Eastern Imperial Eagles at the same age, raised in their natural environment. Despite the fact that it did not have the chance to be trained by its parents to hunt, use hunting areas, migrate, etc., the young eagle demonstrated behaviour similar to that of young birds of the same species raised naturally in the wild.

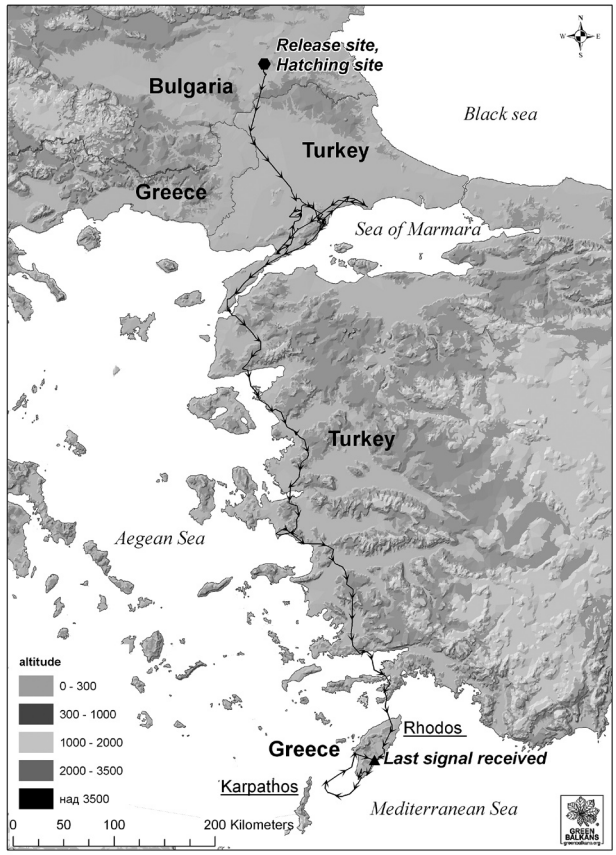

Fig. 1. Map of the migration of the young eagle

It had moved 720 km away from the natal and release site. This was the distance following a straight line between the first and the last localized positions. Considering the fact that the movement of the bird was not following a straight line, the distance covered must have been much larger. The total covered distance, following each of the localized positions, was 1530 km. It is important to note that the real distance covered by the bird was much larger as there was no data about the bird's location in certain hours of particular days, so a straight line is assumed to run between the last position sent that day and the first position of the following day. The results also show that the first location sent at 08:30 am is often tens of meters away from the last position sent the previous day when the eagle settled down to roost. Therefore the bird must have started its active movement before 08:30 am. According to the data obtained, the tagged eagle was covering an average of 41.5 km per day while moving, hunting and settling down. The maximum distance passed for a single day was 130 km. This distance was recorded on November 21st 2008, when the bird crossed the Dardanelles. Data

on the diurnal activity and rest of the bird was also obtained through the transmitter (Table 1)

Table 1. Activity of the tagged eagle during different parts of the day

Hour / activity	Rest	Movement
8,00 am – 01,00 pm	154	185
01,00 pm – 09,30 pm	352	178
Total	506	363

During rest, when the bird must have been perched close to the surface, the recorded positions were at an altitude of 0-1000 m. The results show almost twice more positions of rest in the afternoon hours (after 01:00 pm) in comparison to mornings (until 01:00 pm), conditionally accepting 01:00 pm as an average value for the middle of the light part of the day. The average overall speed of flight during migration was about 16 km/h, though the speed of movement in the mornings and afternoons differed. In the hours before 13:00 h the average traveling speed recorded was about 25 km/h. The maximum speed of flight reported in this part of the day was 81.69 km/h, reached on November 27th, 2007 in the area of the Aegean Sea coastline, to the south of Izmir. As a whole, in the pre-noon hours the bird made longer and more targeted flights. In the afternoon hours the bird traveled more slowly at an average speed of about 6 km/h. The maximum speed reported after 01:00 pm was about 83 km/h on December 2nd, 2007, while the bird was on the Island of Rhodes.

Limitations of the method

The use of the EagleEye® GPS/GSM transmitter allows for a relatively precise tracing of the route of the eagle but is as yet subject to certain limitations. For example, the data on the altitude of the bird is not reliable for the purpose of this study and is therefore not commented in the current paper. In addition, due to the limited range of the GSM operators the system cannot always achieve a full coverage of 28 signals per day, thus losing information on a part of the daily movement of the bird. The method is very convenient for tracking long-distance migrations, allowing for precise identification of the direction of flight and the distance covered. For the periods of short-distance flights the method allows for the identification of the areas to which the birds are generally attached, as well as potential temporary settlement areas, while the intervals between the signals make it difficult to calculate the overall distance covered. Similar assumptions are made by Meyburg, Meyburg (1998) for the use of PTT for identification of daily flight distances and cross-country speed.

Conclusions

Marking a young Eastern Imperial Eagle with a GPS/GSM transmitter for the first time in Bulgaria made it possible to obtain previously non-confirmed data on the life of young Eastern Imperial Eagles.

The young Eastern Imperial Eagles from the Bulgarian population can either migrate to the South during their very first calendar year, or stay and winter in the country.

One of the possible migratory routes for the young Eastern Imperial Eagles from Europe to Asia is across the Dardanelles and along the Turkish coastline of the Aegean Sea.

The movement of the studied eagle was more active in the morning hours during migration and could reach speeds of more than 80 km/h.

The migrating young Eastern Imperial Eagles cross aquatories of various widths.

The method of treatment of the young bird in the Wildlife Rescue Centre was a success. This was also proven by the post-release adaptation and the successful migration.

The young bird treated in the Wildlife Rescue Centre migrated like birds of the same age naturally raised in the wild.

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Първи резултати от проследяването на Източния Царски орел (*Aquila heliaca*) маркиран с GPS/GSM предавател в България

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(Резюме)

Статията представя резултатите от първото за страната маркиране на млад Източен Царски орел (*Aquila heliaca* Savigny 1809) с GPS / GSM предавател. Устройството е прототип на испанската фирма EagleEye®. Предавателят е поставен на млад царски орел, рехабилитиран в Спасителния център на диви животни към Зелени Балкани. Птицата е върната отново в природата на около 150-дневна възраст в края на месец ноември, 2007. След освобождаването й в природата, птицата активно се придвижва на юг, следвайки особеностите на релефа. По време на интензивното си придвижване, маркираният царски орел е преминал през територията на три държави – България, Гърция и Европейска и Азиатски Турция . Поведението на тази птица е коренно различно от това на други два царски орела на тази възраст, проучвани по същото време с радиопредаватели. Те остават да зимуват в България, докато маркираният с GPS / GSM предавател царски орел вероятно се отправя към Африка. Регистриран е район по северното крайбрежие на Мраморно море, в който птицата се задържа продължително по време на проучването. Получени са общо 869 позиции с точното местоположение на птицата. Събрани са данни за дневната активност и скоростта на полета.