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Data on the postbreeding migration of marked Romanian Great White Pelicans (*Pelecanus onocrotalus* Linnaeus, 1758)

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Abstract Between 1931 and 2018 in the Danube Delta, 1,171 Great White Pelican (*Pelecanus onocrotalus* Linnaeus 1758) were ringed (731 with metal rings, 440 with coloured plastic rings) at breeding sites. The majority of the captured birds were flightless young individuals. From the ringed birds, 25 (2.13%) were reported as recaptured. Most were reported from Israel (28%), and the rest from 8 other countries. Recovery distance varied between 50 and 3,000 km. 19 birds (76%) were reported within half year after ringing, 2 birds (8%) within a year, and further 4 individuals (16%) were reported after a year. With the exception of a single photographed individual, all the others perished: they were shot or fell victims to accidents. These cases suggest high mortality in the young age cohort. Very little knowledge is available about the African wintering grounds; there are only two reports from Egypt and one from Southern Sudan. Traditional ringing yields little information for this species. Considerably more exact data could be expected from satellite tracking, use of other modern locating techniques and use of genetic methods. The ringing of nestlings is only possible if we can apply less aggressive methods then used to date. Besides its scientific value, the intense research on the still numerous Great White Pelican population would be justified by the outstanding faunistic, economic and cultural importance of this species.

Keywords: Great White Pelican, Romania, ringing, reported ringing recoveries, *Pelecanus onocrotalus*

Összefoglalás A Duna-deltában 1931 és 2018 között 1171 rózsás gödényt (*Pelecanus onocrotalus* Linnaeus 1758) (fémgyűrűvel 731 példány, színes műanyag gyűrűvel 440 példány) jelöltek meg fészektelepen, csekély kivétellel röpképtelen fiatalokat. Közülük 25 madárról (2,13%) érkezett megkerülési adat. A legtöbbet (28%) Izraelből jelentettek vissza, a többit nyolc másik országból. A megkerülési távolságok 50 és 3000 km között változtak. A gyűrűzés utáni első félévben 19 madár (76%), félév-egy év között két madár (8%), egy éven felül 4 (16%) példány került meg. Egy lefényképezett egyed kivételével a többi elpusztult, lelőtték, vagy baleset áldozatává vált. Mindez nagy fiatalkori mortalitásra utal. Az afrikai telelőhelyekről keveset tudunk, csupán két egyiptomi és egy dél-szudáni visszajelentésünk van. E faj esetében a hagyományos gyűrűzés kevés adatot szolgáltat. Lényegesen több és pontosabb eredmények várhatók a műholdas követés és más *hightech* eszközök alkalmazásától, valamint a faj genetikai kutatásától. A fiókagyűrűzés akkor jöhet számításba, ha kevésbé agresszív technikát alkalmaznánk, mint eddig. A Duna-delta még nagyszámú gödény állományának vizsgálatát – a tudományos eredmények mellett – kiemelt faunisztikai, gazdasági és kulturális értéke is indokolja.

Kulcsszavak: színes gyűrű, Románia, gyűrűzés, rózsás gödény, visszajelentett gyűrű

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Introduction

The world populations of Great White Pelicans (*Pelecanus onocrotalus* Linnaeus 1758) (further referred to as GWP) are divided into two separated stocks. One of them nests in Southeast Europe and Western Asia, while the other in Central Africa. The populations breeding in the Palearctic are long-distance migrants, while the Africans are residents, though they disperse widely in Africa (Crivelli & Schreiber 1984, Crivelli *et al.* 1991a, del Hoyo *et al.* 1992).

Our knowledge of the size of the Palearctic GWP populations is limited, and contradictory data are available. Smaller populations breed around the Mediterranean Sea in Turkey and Greece (Crivelli *et al.* 2000). Around half of the Palearctic populations breed in the territory of the former USSR. At the end of the 20th century, the number of breeding pairs was estimated at 3,120–6,550 (Krivenko *et al*. 1994), or 3,070–4,300 (Crivelli *et al*. 1994). Later their number was changed to 2,553–31,124 pairs (Crivelli *et al.* 1997). The world population was estimated at 7,345–10,500 pairs (Crivelli 1994, Crivelli *et al*. 1991, 2000, del Hoyo *et al*. 1992). From the start of the 21st century, a positive trend was described: the estimated number grew to 6,790–11,300 pairs (IUCN 2001). Based on the census and estimations carried out in 2011–2012, the number of breeding pairs was 4,702–5,175 in the populations breeding at the colonies in Southeast Europe and Turkey (Catsadorakis *et al*. 2015, Catsadorakis 2016), and a year later the Red List quoted 4,900–5,600 pairs (IUCN 2018). At the end of the 20th century, their number in Romania was estimated to be 3,500 pairs (Crivelli 1997), and at the beginning of the 21st century still 3,500 pairs are mentioned (Plattheeuw *et al.* 2001). Then 460–3,500 pairs were given by Schogolev *et al*. (2005) and 3,650–4,000 pairs were estimated by Kiss *et al*. (2015) and 4,100–4,500 by Petrovici (2015), The BirdLife International (2018) mentions 4,100–4,480 pairs, which is 82% of the European population, and the tendency of change is stable. All these data probably seriously underestimated the real number of GWPs, as with the use of drone technology from 2016 at a single large colony located in the Danube Delta, the number of breeding pairs was estimated to 16,000–19,000 (17,000 GWP on average) (Marinov e*t al*. 2016, Kiss *et al.* 2019b).

The migration, and especially the wintering grounds, of this species are even less studied (Crivelli *et al*. 1991a, del Hoyo *et al*. 1992, Izhaki *et al*. 1994, 2002, Catsadorakis 2002). As there have not been intense GWP ringing efforts in the Danube Delta since 1996, and it hinders the chance of reports of recaptured birds, this paper aims to summarise and elaborate the recovery data of ringed GWPs. Here, we should emphasize that we use the term 'recovery report' for both the rings found on corpses, or the visual observation and report of marked birds, or any other information source, such as newspaper / press announcements (Kiss 2018).

Materials and Methods

With two exceptions – when we ringed two pelicans outside the colony – we ringed flightless nestlings at the strictly protected Roşca-Buhaiova Area. This is the largest GWP colony in Europe. This area is one of the most valuable parts of the Danube Delta Biosphere Reserve of UNESCO's list of World Heritage Sites. The strictly protected area is located at the

north-eastern part of the Delta consisting of 9,625 hectares open water surface and reed beds that form floating islands. These islands follow the water level changes and are not linked to dry land. Woody vegetation is represented by grey willow *(Salix cinerea)* bushes. The area is dissected by several old canals that have silted up. The GWP colony *(Figure 1)* is located on the two adjacent lakes named Buhaiova-Hrecisca (Andone *et al*. 1969, Kiss 2002, Ceico 2003, Platteuw *et al*. 2004, Kiss *et al.* 2019b).

To catch the flightless nestlings we applied two methods, both of them were technically and ethically approved then. Both of these methods are based on utilizing the short time window, when the nestlings reach maximum size and aggregate into nurseries, when they swim around in groups, but do not fly at all, or their flight is very weak. As breeding is highly synchronised in the whole colony, the nestlings are more or less the same age. In the Danube Delta, the beginning and (to a lesser degree) the middle of August seem to be the most appropriate for ringing. The first method was the following: the targeted individual was followed with a light fishing boat, with a low number of crew on board, and the nestling was captured with a long-handled lifting fishing net. The other method was to create a large 'V'-shaped seine net tunnel fixed to long poles pushed into the lake bottom, and the nestlings were driven by boats into the tunnel. The capture boats were waiting for the GWP nestlings at the narrow throat of the tunnel. The advantage of this method is the relatively short duration of disturbance and more efficient ringing, but it requires the coordinated work of at least 4–5 boats and 10–12 skilled persons.

Up to the date of writing our paper, from the 731 metal and 440 colour ringed GWPs only 25 were reported, and part of these reports were data deficient or inaccurate. Two of them were rings from bird corpses found by the national park rangers. The highest number of

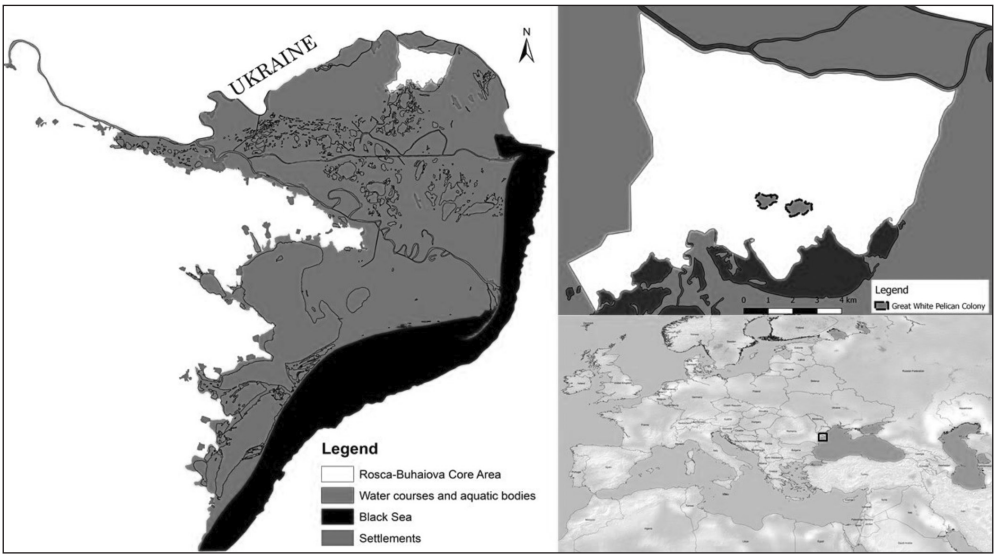

Figure 1. The lakes Buhaiova and Hrecisca in the strictly protected Roşca-Buhaiova Reserve in the Danube Delta, Romania (Graphic: Doroşencu C. Alexandru)

1. ábra A Buhaiova és Hrecisca tavak a romániai Duna-deltában, a Roşca-Buhaiova szigorúan védett rezervátumban

reports were published in the reports of the Romanian Ornithological Centre (Kiss 1992, Kiss & Condac 1992, Radu 1994, Cătuneanu 1999, Akriotis & Handrinos 2004). From the metal ringed birds, 9 (1.23%) recovery reports were published (Crivelli *et al*. 1991, Cătuneanu 1999), and later an additional 4 reports arrived, so the sum grew to 1.78%. From the 440 coloured plastic rings used from 1989 (2.72%), 12 were reported. The cumulative recovery report of all metal and plastic ringed birds is 2.14%. Only a single colour ring was observed in the field, and reported. The rest of the cases were recovered from dead or shot birds.

If the recovery report was not precise regarding the date of ringing, we used the middle of August for the given ringing year as a starting point. If the original ringing report did not specify the location, or only Danube Delta or the city of Tulcea is given, we gave the coordinates of the largest colony of the Delta (it is specified from 1934 as a location). If the data on ringing date was missing, we calculated the time spans from the middle of August based on our experience and literature data.

Results

With the exception of three individuals, all the Danube Delta GWP recoveries were reported from the southward migration period. Seven (28%) reached Israel, from where they were

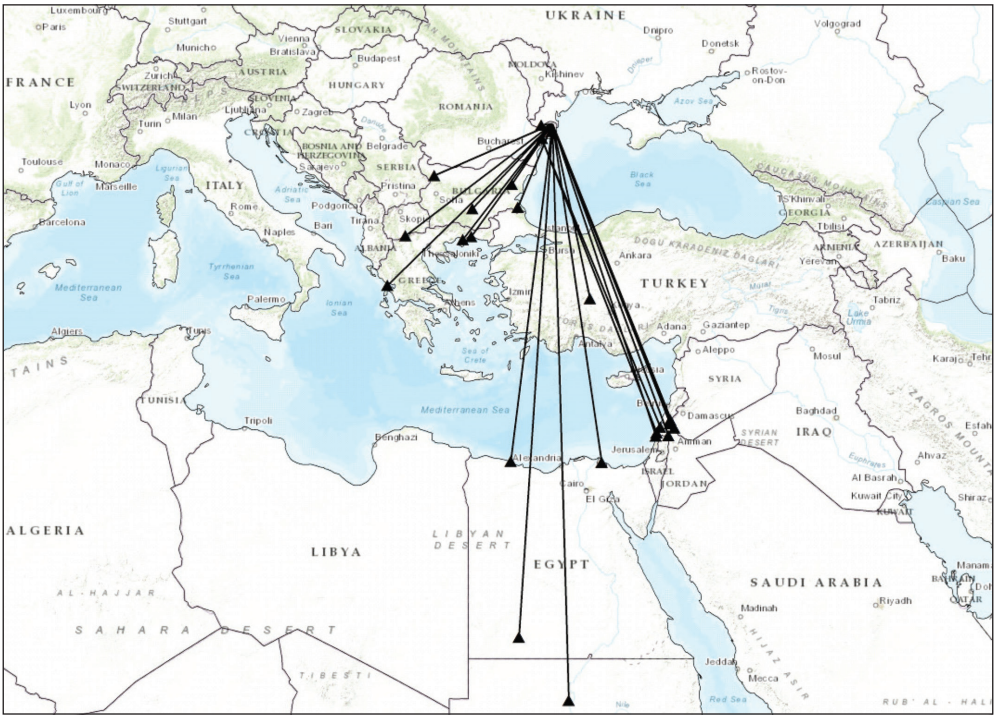

Figure 2. Recapture locations of Great White Pelicans *Pelecanus onocrotalus* (n = 25) ringed in the Danube Delta (Romania)

2. ábra A Duna-deltában megjelölt rózsás gödények (n = 25) megkerülései

reported, and the rest from 8 countries on 3 continents *(Figure 2)*. The exceptions are: one bird turned back and was reported from Ukraine, one was collected in Greece at the middle of March, most probably on its return passage from the wintering ground, and one individual was found in May in Israel.

Although few data are available, it seems that birds start both southeast and southwest from the Danube Delta (Fülöp *et al*. 2018). This is further supported by the spatial pattern of later recoveries. Birds using the southeastern flyway were recovered from Turkey, Syria, Israel, Egypt and Sudan, while the birds heading to the other (southwestern) flyway were recovered in Bulgaria and Greece. The Ukrainian data cannot be clearly assigned to either route.

The majority of recoveries were within a short period of time. Juvenile mortality is high. Within half a year after ringing, 19 GWPs (76%) were either shot or fall victim to accidents. Between half a year and one year, a further 2 individuals (8%) were reported, and recoveries more than a year after ringing amounted to 4 individuals (16%).

Discussion

The method of bird ringing, invented by the Danish ornithologist H. Ch. Mortensen in 1899 for the study of migration, still yields remarkable results, especially when using plastic colour ring combinations that can be identified from a long distance with a scope. The application of modern technologies, such as the solar- or battery-powered satellite tracking, opened a new era of bird migration research. In Romania, with the exception of a single satellite transmitter study of GWP migration that was initiated to follow the movement of birds around the breeding colonies planned for three month duration (Kiss & Nichersu 2002), only ringing yielded data on the spatial and temporal pattern of GWP migration, a strictly protected bird of outstanding faunistic and economic importance.

The first GWP ringed in Romania was recovered in 1935 in Egypt, and then, until the 1940s, there were no data from Romania on GWP ringing. Between 1940 and 1970, a total of 731 metal rings were put on flightless nestlings (Crivelli *et al*. 1991a, Cătuneanu 1999). Blue plastic colour rings with 4–5 characters were used from 1989. Until today, our working group marked 440 birds with these plastic rings, and the overwhelming majority (99.6%) of them were also flightless young birds at breeding colonies. Only two individuals were caught outside the colonies, and both of them were recovered later.

During the autumn migration, GWPs fly towards the African wintering grounds along the Eastern shores of Europe and Asia Minor in the Eastern Mediterranean Sea region. Thus following the *Via Pontica*, between 1979 and 2003 on average 20,946 and maximum 37,703 individuals flew through Bulgaria. The number of birds observed shows an increasing trend (Michev *et al.* 2004, 2011, 2012, 2018, Iankov 2014). In the last years of the 20th century, a similar increasing trend was reported from Israel, where autumn records were between 70,000–80,000 observed individuals (Crivelli *et al*. 1991b, Izhaki 1994), while the average was 71,421 per year (Leshem & Yom-Tov 1996, Shmueli *et al*. 2000a, 2000b). In the last decade of the 20th century on average 36,923 overflying GWPs were calculated (Alon *et al*. 2004). Later, these numbers were raised to 40,000±9,000 GWPs (Hadzofe 2014).

According to the Israel Nature & Parks Authority (INPA), between 1999 and 2013, on average 39,395±8,201 GWPs per year were estimated (Labinger & Hadzoffe 2015). It is worth mentioning that according to the IUCN Red List the Wetlands International – Waterbird Population Estimates, the total number of GWPs in 2015 was 265,000–295,000 individuals in the world (BirdLife International 2018).

The fact that the majority (28%) of GWPs ringed in Romania were recovered in Israel can be explained, first of all, by the location of the country. Several important passage routes transect Israel, among them many of piscivorous species. These seriously impact the intensely managed fisheries of Israel, and hence are an important factor in the fish industry.

GWPs not only migrate through these countries but due to global climate change (Doxa *et al.* 2012), overwintering of some individuals or even groups becomes more and more common, which has economic, epidemiological and other consequences. This phenomenon results in more intense applied ornithological research, and more effort and financial funds invested into GWP research (Crivelli *et al*. 1991b, Izhaki 1994, Leshem & Yom Tov 1996, Smueli *et al*. 2000a, 2014, Izhaki *et al*. 2002, Alon *et al.* 2004, Artzi & Oron 2014). At the same time, intense fishery production necessitates the use of advanced infrastructure and fish stock protection measures. These measures significantly increase GWP mortality, and at the same time result in more ringing recovery reports (Shmueli *et al.* 2000a, 2000b).

GWPs are large soaring birds, and therefore, when flying around the Mediterranean Sea, they follow the shorelines using the uplift of thermals. It is less likely that some flocks would directly cross the Mediterranean Sea. There is a migration route that starts to the southeast from Greece, by which GWP flocks from the western part of the Balkan Peninsula can join the circumpontic flocks (Crivelli *et al*. 1991a, Izhaki & Dagan-Shmueli 1994, Catsadorakis 2002).

It is already known that the migration of GWPs follow the Nile from Egypt (Crivelli *et al*. 1991a, del Hoyo *et al*. 1992, Izhaki *et al*. 2002, Chege 2014, Shmueli *et al*. 2014). The most faraway point (2,820 air kilometres from the site of capture) reached by any GWP ringed in Romania is located at Arduan (El Dean) in the valley of the White Nile, coordinates: 19°56' N, 30°25' (Cătuneanu 1991, Crivelli *et al*. 1991a).

In the last decades, it has been proven that some GWP populations do not migrate to the classic wintering grounds in Africa. This phenomenon is more characteristic for immature GWPs that disperse in the Balkan and the eastern part of the Mediterranean in Turkey, and especially in Israel, where they overwinter and hence can shorten their autumn migration (Crivelli *et al.* 1991a, Izhaki *et al*. 1994, 2002, Leshem & Yom-Tov 1996, Shmueli *et al.* 2000a, 2000b, 2014, Arzi & Oron 2014, Onmuş 2014). For example, a bird equipped with a satellite transmitter in Israel spent the winter in Israel, from where it returned to Europe in the spring in two consecutive years (Izhaki *et al*. 1994, 2002).

The African wintering grounds of the GWP are not exactly identified, but there are confirmed data that at least 5% of the European population cross the Red Sea at Gebel El Zeit (Hilgerloh *et al*. 2011), reach South Sudan, and then follow the water way of the White Nile and later, along the lake system of the Great Rift Valley, get to the equatorial part of Africa (Crivelli *et al*. 1991a, del Hoyo *et al*. 1992, Izhaki *et al*. 2002, Chege 2014, Shmueli *et al*. 2014). Location data from birds tagged in Israel with satellite transmitters arrived from the water bodies of Nasser and Jebel Aula Dam on the White Nile, and from the Sudd Swamp

in South Sudan, from Lake Rosaires on the Blue Nile, and through the lakes of the Rift Valley to Kenya to Lake Turkana. Only a single Danube Delta GWP's data fits into this pattern, recovered in South Sudan (Cătuneanu 1991, Crivelli *et al*. 1991).

Compared to other large water birds ringed by us, the recovery rate of GWPs ringed in the Danube Delta is very low: only 2.13%. These differences are mainly due to the different anatomy and behaviour of the ringed species (del Hoyo *et al.* 1992). From the 215 ringed Great Cormorant *(Phalacrocorax carbo)*, 32 (14.89%), from the 219 ringed Eurasian Spoonbill *(Platalea leucorodia)*, 35 (15.99%) were recovered (Kiss *et al*. 2007, Sándor *et al*. 2011, Kiss *et al.* 2019a). The rings can be easily observed on the long tarsus of the Spoonbills when they are feeding in the shallow water or rest on trees. Great Cormorants often bask on prominent points. But the tarsus of the pelicans is relatively short, and they most often stand in shallow water, and hence it is impossible to observe and photograph the colour rings.

Ringing recoveries are similarly low for the GWPs marked in other countries. For example, between 1925 and 1989 in the Soviet Republic of Dagestan, 256 GWP were ringed, and only juveniles (1.56%) were recovered, and from the approximately 2,000 ringed juveniles at Lake Balhas, only 7 (0.35%) were recovered. From the 2,116 individuals ringed in Iran, only 30 were recovered (1.42%). Based on the period when these birds were marked, we can safely assume that only metal rings were used. From the 731 GWPs marked with metal rings in Romania, 8 individuals were recovered: this constitutes 1.09% (using the data from Crivelli *et al*. 2001). With recoveries in later years, the ratio grew to 1.78%. The use of coloured plastic rings by which the bird can be identified from a greater distance has considerably improved the recovery rate: from the 440 colour ringed birds, the recovery of 12 (2.13%) was reported.

There is another explanation for the low recovery in the case of the GWP. Ringing recovery rate, or the returned information, does not only depend on the size of the bird and the ringing effort, but also on the human population density, (research) infrastructural, cultural and economic properties of the countries along the migration route, and also on the presence (or lack) and density of scavenger animals, and other factors (Underhill *et al.* 1999). The GWPs ringed in the Danube Delta migrate through the Balkan towards Asia Minor, from where the main source of recovery data is Israel. Afterwards, they disappear almost without any trace in Africa.

As classic ringing did not yield enough data on the migratory routes and the exact locations of the wintering grounds of GWPs, the use of other, technologically more advanced methods seems more promising. The results from Israel show that the use of battery-powered satellite transmitter techniques is especially promising. These develop very fast and provide data with a resolution and exactness formerly not possible. To achieve a similar amount of information through conventional ringing, the marking of birds in numbers at a higher magnitude would be necessary. The related costs and required time invested would be considerably higher and, even worse, the capture and ringing of birds becomes more problematic. We should stress here that during the one and a half century long ornithological research in the Danube Delta, there has never been a project fully dedicated to the marking of GWPs and research into their migration. Our knowledge mainly comes from collateral

sources. If we take into account the positive population dynamic trends of this species, this in itself should be the topic of research projects. For example, the application of drone technology in the census showed a four times higher number of breeding pairs than conventional techniques (Marinov *et al*. 2016, Kiss *et al*. 2019b). A population increase of such magnitude would cause problems in several countries on three continents. GWPs have outstanding importance not only in terms of biological diversity, but also in terms of culture, fisheries and tourism. Therefore it is inevitable that their research deserves special attention. It is also clear that our knowledge regarding the exact mapping of their migration routes and localising their wintering grounds can only be achieved through an international large-scale project. It must also involve African countries that based on our present knowledge are part of the migration routes from Southeast Europe to equatorial Africa. The project should prioritise satellite tracking and long-term monitoring of GWPs belonging to different age cohorts.

Genetic analyses of moulted feathers could yield similarly valuable data, and could shed light on the reasons of the sharp decline in population numbers detected in recent years. As we cannot rule out that African migrants might mix among the GWPs migrating towards Europe (Crivelli *et al.* 1991a, Kiss 1992, Kiss & Condac 1992, Michev *et al.* 2018), this method can only work if moulted feathers are collected both at the starting points and wintering grounds. It could also give evidence on the genetic origin of these birds. The classic ringing at breeding areas gives only data on the last location of the given individual, and other marking techniques prove only useful for gaining results if the birds were captured accidentally. It would be advantageous to use modern capture techniques in the course of organised capture campaigns both at the breeding grounds and African wintering grounds. Preferably, the feeding and roosting areas of GWP should be used for the capture. If the lack of other methods would necessitate the capture of flightless young individuals, one of the smaller water bodies in the Danube Delta in their present state would be a possible site, but a capture technique should be used which would cause the least disturbance for the whole population. Besides leg rings, wing tags with colour letter and character codes could also be a good solution.

Special attention must be paid in the project to set up a framework of disseminating information on the migration of GWP along the whole migration route. It should also facilitate the sharing of information on the migration and wintering of GWPs. Based on the outstanding importance of GWP in biodiversity, but also its key role in the fish industry, tourism and culture, organising an international project dedicated to the research and conservation of the GWP would be especially timely and reasonable.

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