Safeguarding the Lesser White-fronted Goose Fennoscandian population at key staging and wintering sites within the European flyway

Special publication of the LIFE+10 NAT/GR/000638 Project

Editors: Manolia Vougioukalou, Savas Kazantzidis & Tomas Aarvak

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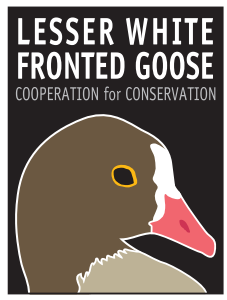

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Contents

The Lesser White-fronted Goose - a part of European biodiversity history or here to stay?

Morten Ekker & Terje Bø

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Lesser White-fronted Geese in flight - Kerkini Lake. © Theodoros Naziridis

The Fennoscandian Lesser White-fronted Goose population seems to be back on track, inching its way back from the very verge of extinction. Decades of systematic and comprehensive flyway conservation and management are gradually showing positive results. However, "the flock of geese" is still tiny and thus extremely vulnerable to a diversity of stressors and threats – from direct human persecution to unsound management practices.

Around the 1900's the Lesser White-fronted Goose was a numerous species in the Northern Fennoscandian mountains (Norway, Sweden and Finland), but just 50 years later, conservationists sounded the alarm with regard to its critically low population levels. This warning was, after some years, taken seriously and in the mid-1980's, several initiatives were initiated in order to improve the conservation status of the Lesser White-fronted Goose and quite literally to save the species from extinction in Europe.

Finland and Norway took the lead in organizing systematic monitoring and satellite tracking to document the status of the population and to improve the knowledge base, which led to increased international cooperation between the countries hosting the Fennoscandian population. Greece was shown to house the critically important wintering grounds for the Fennoscandian birds and has since been the focus of conservation action, as well as Hungary and Estonia, each holding key stopover sites along the migration route within Europe.

During 2005-2009 the first multi-national EU-LIFE project focused on monitoring and conservation in the breeding grounds, on migration, as well as in the wintering areas (Tolvanen et al. 2009). In 2011 this successful cooperation was continued through the ongoing project (LIFE10 NAT/GR/00638), which strived to safeguard the remaining Fennoscandian LWfG population in its wintering and staging sites along the European flyway. This project has implemented a variety of concrete conservation measures, including the training of 21 field teams from 15 countries in Lesser White-fronted Goose identification and monitoring, the implementation of novel smart patrol sys-

tems at the Greek and Bulgarian sites, training of local authorities in Greece and Bulgaria, habitat management in Greece and Hungary, extensive awareness raising and education, international networking and the development of National Action Plans for the conservation of the Lesser White-fronted Goose in Hungary, Bulgaria and Greece. In addition, fruitful collaboration with other key range states outside of Europe such as Russia and Kazakhstan has played an important role, both for the conservation of the Fennoscandian population, as well as the neighboring Western Main population.

Important work has also been accomplished in order to formally anchor and commit the range state governments in the flyway. In 1996 the first International Action Plan for the species was published by BirdLife International on behalf of the Council of Europe (Madsen 1996). Subsequently in 2005, a workshop was organized in Finland to collect the basic information needed for the development of a flyway plan for the species in the Western Palearctic, the AEWA International Single Species Action Plan for the Conservation of the LWfG (ISSAP). The ISSAP was adopted under the African Eurasian Waterbird Agreement (AEWA) in 2008 and has since provided the agreed international framework for all conservation activities and cooperation for the species within the AEWA region (Africa – Eurasia) (Jones et al. 2008). The ISSAP therefore includes both the Western Main population (breeding in Russia) and the Fennoscandian population, while the Eastern Main population, breeding in Russian Far East and wintering in China, is still not part of any multilateral plan.

The value of international cooperation - flyway conservation

More than twenty years of spring and autumn monitoring of the Lesser White-fronted Goose in the key staging grounds in the Porsangen Fjord – close to the main breeding grounds in Northern Norway – has revealed a vulnerable but also remarkably staunch and robust population – with less than 40 potential breeding pairs that count for the annual recruitment into the population. Colour-ringing and satellite tracking of birds have documented patterns and key locations of significant value for the understanding of the migration and on how to prioritize actions and subsequently implement mitigating measures throughout the flyway.

For many years, illegal shooting has been regarded as the most significant mortality factor – especially during autumn migration (along the eastern route). As we learned that breeding failure may increase the proportion of birds using the eastern route (Øien et al. 2009), sound management of the breeding habitats has become a crucial measure and a key element in the population restoration. By safeguarding the breeding conditions (e.g. predator control), more birds reproduce successfully and both recruitment of chicks and especially, adult survival are being enhanced.

After many years at a critically low level, there are now indications of a slow but steady increase of the Fennoscandian population. From 2011 onwards, the population size has increased and the 2015 breeding season had an all-time high record with respect to chick production and recruitment, with an autumn population size (in the Porsangen Fjord) of 137 individuals (including 21 broods). At the most, 144 geese were observed in Greece on 15th February 2016 (114 in Kerkini Lake and 30 in the Evros Delta). This last breeding season (2016) was characterized by poor environmental conditions in the breeding areas, but even this year the production was surprisingly good - most probably due to reduced predation by the Red Fox population which has been controlled actively in recent years. However, the flock is still so small and vulnerable that any minor extra stress in any part of the flyway may have fatal consequences at the population level.

The foundation for all the conservation initiatives throughout the flyway lies in the dedicated network of skilled and enthusiastic people. This network – part of which has now been involved in the completion of two major EU-LIFE projects - is of crucial importance for the continued survival of the species. The continued monitoring and presence in the field, fact-finding missions/site documentation based on new tracking plots, awareness raising campaigns, education and training, habitat restoration as well as action-planning and implementation in national and international arenas, have all been possible due to the serious commitment and hard work of many people.

For a migratory species like the Lesser White-fronted Goose, it is the value of every small as well as large action along its complex migratory pathways that eventually sums up to a successful total.

Additional challenges

In addition to the "traditional" stressors and threats to the Fennoscandian population mentioned above, we have become increasingly aware of the possible threats from human activities related to the re-introduction of Lesser White-fronted Geese.

As stated in the ISSAP, the re-introduced birds ("Swedish population") present a potential threat to the Fennoscandian Lesser White-fronted Goose population due to their genetic make-up. In addition, their potential to disrupt the original migratory routes of the Fennoscandian birds is now seen as an increasing threat. Observations in recent years demonstrate that some of the released individuals have already appeared in the core staging areas of the Fennoscandian Lesser White-fronted Geese in Norway (Porsangen Fjord) leading to a fear of a mixing of the two populations (Aarvak et al. 2016). Considering the potential consequences such interactions could have for the Fennoscandian population at the flyway level, this is not only an issue of concern for Norway but also for the other countries hosting the Fennoscandian population as well, as it may potentially lead to serious changes in all the range states.

The ongoing and planned re-introduction initiatives represent valuable experiments showing that captive breeding, re-introduction and human modification of the migratory routes of Lesser White-fronted Geese is possible. Such actions could therefore be considered as a conservation option in the future, should there be a time when the original wild Fennoscandian population has become extinct and there is an international agreement amongst all range states to move ahead with such an initiative for the species based on internationally agreed principles and methodologies. However, as the original wild population is still present in its traditional flyway and conservation actions are bearing fruit, these ongoing release activities represent an unresolved threat to the original wild population in its current precarious state.

Lesser White-fronted Geese in Norway. © Tomas Aarvak

Remaining challenges and future perspectives

The future of the Lesser White-fronted Goose in Europe is still uncertain, but the outlook is not as bleak as it once was. To reach the common, ambitious conservation goals, we need to keep up the good work throughout the flyway and focus on finding sound solutions to the significant and complex challenges present in key areas with real conflicts. The remaining threats and stressors need to be continuously tackled on all levels by involving all stakeholders. Illegal killing remains a serious threat for the species, and a common practice at a number of important Lesser White-fronted Goose sites, whilst widespread agricultural practices also do not act in favor of the species. A revised and updated International Single Species Action Plan for the Lesser White-fronted Goose would serve as the best available tool for internationally coordinated conservation efforts.

The Lesser White-fronted Goose and the ongoing multifaceted conservation efforts to ensure its survival, have the capacity of serving as a European biodiversity conservation flagship and a symbol of how to successfully rescue a critically endangered migratory species. In May 2016, the LIFE project won the European Natura 2000 Award in the category "Cross-border cooperation and networking" – *thanks to the implementation of a successful "flyway approach" covering 15 countries* (European Commission 2016). The award is a great inspiration for all the range states, representing a momentum for continued, consensus-based conservation efforts. By continuing on this path, we are well on our way to making sure that the Lesser White-fronted Goose remains a fixture of European biodiversity.

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Six years of coordinated efforts result in an increasing trend for Europe's rarest waterbird: the Lesser White-fronted Goose LIFE + Project

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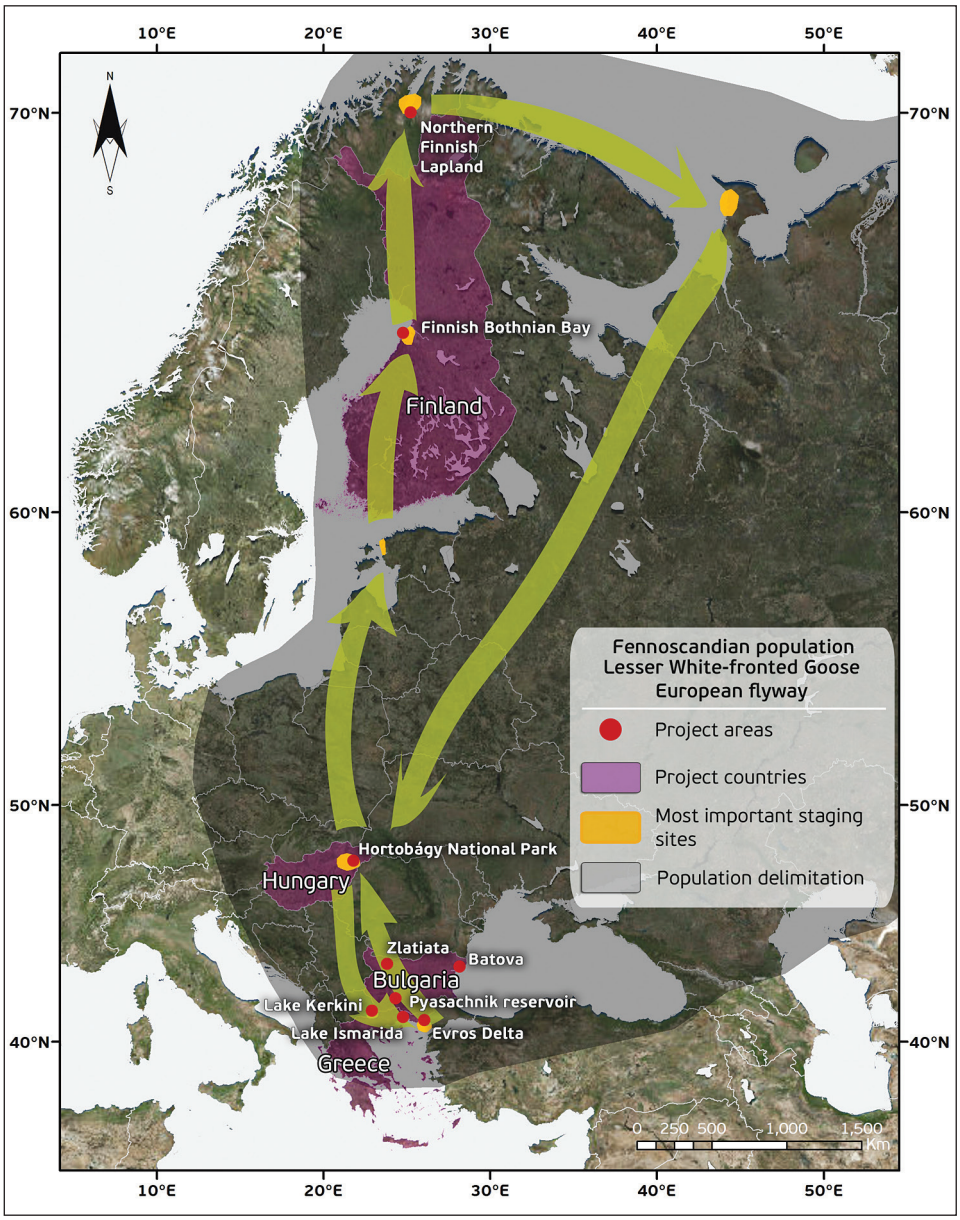
LWfG in Lake Kerkini, Greece. © Kostas Papadopoulos

1. Introduction

Over 20 years of research on the Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) can probably allow the LWfG the title of the rarest breeding waterbird in Europe. Once breeding in a vast and continuous area in the lower arctic that ranged from Northern Scandinavia all the way to eastern Siberia. Due to a severe drop in the global population, the LWfG breeding range is now fragmented in separate populations (Jones et al. 2008). Although the LWfG is globally classified as Vulnerable by the IUCN, the Fennoscandian LWfG population that was once the most common breeding goose species in the alpine region of Norway, Sweden and Finland is now ranked as Critically Endangered within the EU numbering only approximately 30-35 breeding pairs (Aarvak et al. 2017a). A number of conservation projects have been and are being implemented in order to ensure the survival of this iconic species. The EU LIFE+ Project "Safeguarding the Lesser White-fronted Goose Fennoscandian population at wintering and staging sites within the European flyway" (LIFE10 NAT/GR/0009638) began in September 2011 and ended in April 2017. Funded by the European Commission and the Norwegian Environment Agency, the project involved eight partners in four countries as well as the UN (Hellenic Ornithological Society, Greek Ministry of Environment and Energy, Forest Research Institute in Greece, Bulgarian Society for the Protection of Birds, Hortobágy National Park Directorate in Hungary, WWF Finland, Metsahallitus Parks and Wildlife Finland; and the African Eurasian Migratory Waterbird Agreement) and implemented conservation actions across the migration routes of the European LWfG.

Upon the completion of the preceding international project on the species in 2009, which was also funded by LIFE (LIFE05 NAT/FIN/000105), it was concluded that Greece was the bottleneck for the conservation of the species within the EU, that urgent international conservation actions needed to be carried out in countries along the eastern branch of the autumn migration of the Fennoscandian LWfG, that successful breeding is particularly important for the Fennoscandian LWfG population and that it is very important that national governments and international organizations start immediately to implement the existing action plans for the species and also allocate adequate financial resources for conservation work (Tolvanen et al. 2009). During the same period (in autumn 2008) the AEWA International Single Species Action Plan (ISSAP) for the Conservation of the LWfG was adopted by the AEWA Parties. The ISSAP identified hunting and illegal killing as the main threats for the species and described measures needed to be taken along the Western Palearctic range of the species (Jones et al. 2008).



All project areas within the western (European) Lesser White-fronted Goose flyway. Green arrows show the spring migration towards the north, and the autumn migration towards the south.

2. Project objectives

The project was designed following the flyway approach and aimed towards the development of a wide conservation network with the objective to implement urgent concrete conservation measures, as well as to be able to have a long lasting positive effect on the species. The project actions were selected based on the conclusions of the previous LIFE project, the international action plan for the species, and the National Action Plans for the LWfG where these existed. The project undertook concrete conservation actions in seven Natura 2000 sites in Greece, Bulgaria and Hungary and its main objectives were: to reduce mortality rates related to hunting along the European flyway, to provide suitable foraging and roosting habitats for the species in wintering and staging grounds, to increase knowledge and awareness and to maximize international cooperation and networking. The project focused on: 1) Reducing the threat from hunting and poaching in Greece and Bulgaria, 2) Habitat management in Greece and Hungary, 3) Preparation of National Action Plans in Greece, Bulgaria and Hungary, 4) Public awareness in Greece and Finland, and 5) Monitoring in Greece, Bulgaria and Hungary.

3. Results

3.1 Reducing the threat from hunting and poaching

Although the LWfG is a protected species whose hunting is not allowed, it is affected by poaching and hunting of other waterfowl and especially geese. Disturbance, lead poisoning and within the EU more rarely, direct shooting are considered the main impacts of hunting on the species. In Greece, the impact of hunting on the LWfG was assessed in the Evros Delta by the Forest Research Institute (Kazantzidis et al. 2015). The Evros Delta, a Natura 2000 as well as a Ramsar site, is the most popular goose hunting site in Greece. Possibly due to the recent economic recession in Greece and unfavorable weather conditions, hunting activity was relatively low during the research period. Although no LWFG were recorded in any of the hunting bags, hunting is still considered a threat to the LWfG since it takes place at the same time as the LWfG are wintering in the area (mostly in January) and at very close proximity to the LWfG roosting and feeding areas. Additionally, hunter awareness regarding the species was relatively low and other protected species of wildfowl were found within the hunting bag (Kazantzidis et al. 2017). To minimize the threat of hunting and illegal shooting in Greece, the

Smart Patrol System (SPS) was designed and operated by the Hellenic Ornithological Society (HOS) for five wintering seasons at the main LWfG sites in Greece, Kerkini Lake, Ismarida Lake and Evros Delta. Using infrared and daylight long-distance cameras, the main LWfG roosting and feeding areas were under surveillance and any potentially threatening events for the LWfG (or other wildfowl) were dealt with immediately (Demertzi et al. 2017b). No LWfG fatalities were recorded during the period during which the SPS operated, whereby at least 750 patrols took place during five LWfG wintering periods (2012-2013 until 2016-2017). The unique collaboration between the HOS and the local Forest Services significantly contributed to hunting law compliance (Demertzi et. al 2017c). To engage with stakeholders as well as the public, the HOS in collaboration with the Greek Ministry of Environment and Energy run a campaign against illegal killing in Northern Greek wetlands. The campaign included the production and broadcast of a TV and Radio spot, a full length documentary, the production of a Good Practice Guide for Hunting in Wetlands and the adoption of Local Actions Plans (LAPs) as Ministerial Decisions for the effective coordination of pertinent authorities in the enforcement of hunting legislation. Additionally, several training seminars were organized for wardens and hunters, in which emphasis was given to the identification of LWfG and other protected waterfowl, protected areas and hunting legislation and enforcement (Vougioukalou et al. 2017b).

In Bulgaria, combined patrols coordinated by the Bulgarian Society for the Protection of Birds (BSPB) took place in three Natura 2000 sites in which LWfG had been observed in the past (Batova, Pyasachnik Reservoir and Zlatiyata), and a permanent patrolling system in protected areas in Bulgaria was developed. Although the recorded hunting activity was very low and no significant hunting violations were recorded, the collabration between the BSPB and the state authorities responsible for hunting control was significant and was transferred to areas where intense goose hunting takes place (Shabla, Durankulak and the Burgas lakes) (Dobrev & Cheshmedzhiev 2017).

3.2 Habitat management

The LWfG is a habitat specialist which, unlike most other goose species in the Western Palearctic that have increased in numbers in recent decades, has not adapted to feed on agricultural fields. Staging and wintering sites for the species mainly include low-growth natural flood grasslands, and the sound management of those is essential for the conservation of this species. Food availability inside protected areas also safeguards the species from having to fly to potentially less safe habitats to feed. The LWfG diet was analyzed in Greece and Hungary and a series of habitat management actions were planned and subsequently implemented. In both countries, the preferred food source for the LWfG were grasses (Karmiris et al. 2017b, Bogyo & Tar 2017a), whereas they also consumed a variety of other plants (including halophytic vegetation) depending on their availability. In Hungary, high grazing pressure as well as the partial presence of shallow water areas was also a key factor influencing the feeding of the species. Analysis of the LWfG feeding behaviour also took place at Kerkini Lake, Greece, where the LWfG feed on the mudflats of the lake shore, and depart from the area only when the feeding area floods or when the relative cover of natural foods falls to a very low level (Karmiris et al. 2017b).

Habitat management actions took place at the Evros Delta in Greece and in the Hortobágy National Park in Hungary. To increase LWfG food availability inside the protected area of Evros Delta, mechanical removal of the dominant halophytic vegetation, which is favoured less by the LWfG was followed by seeding of grasses on selected plots. The results showed that food availability increased inside fenced selected plots in which geese fed and a series of actions were recommended to be followed by the area managers (Karmiris et al. 2017c). In Hortobágy, management mainly included water level and vegetation management at the fishpond system of the National Park. An overgrown pond of ca. 125 ha was restored by the removal of reed to provide a resting area for geese and a suitable habitat for many of other waterbirds. Additionally, appropriate water management in three fish ponds provided the LWfG and other geese with a mosaic habitat of mud banks that offered freshly grown vegetation, while mud islands and higher water level fishponds offered an optimal resting place (Bogyo & Tar 2017b).

3.3 Coordinating international and national conservation action

The project contributed directly to the implementation of the International Single Species Action Plan (ISSAP) for the LWfG (Jones et al. 2008) and was a major driving force behind the further development of the conservation of the species within the EU and beyond. In the framework of the LIFE+ Project, two meetings of the AEWA Lesser White-fronted Goose International Working Group were co-financed by the project and organised by the Secretariat to the African-Eurasian Migratory Waterbird Agreement (UNEP/AEWA Secretariat). The 2nd Meeting of the AEWA Lesser White-fronted Goose International Working Group took place in Kerkini Lake Greece in November 2012. The main outcomes of the meeting included the agreement for the establishment of critical sites for the LWfG and a common monitoring scheme that was developed in the framework of the LIFE project, and the agreement for the extension of the working group membership to include the Eastern population of the LWfG. The 3rd Meeting took place in Trondheim Norway in April 2016 and its main outcomes included the selection of nine critical sites for the LWfG for which urgent concrete conservation actions will be implemented. The group also concluded on the main steps to be taken regarding the pending revision of the ISSAP for the LWfG and agreed on a concrete workplan for 2016-2019 (Mikander 2017).

National Action Plans (NAPs) for the LWfG were drafted by the project team for Greece, Bulgaria and Hungary (Vasiliadis et al. 2016, Bogyo et al. 2014, Yankov & Dobrev 2015) according to international and national guidelines and obligations, to ensure effective, coordinated, long-term and legally binding conservation of the species on national level (Vougioukalou et. al 2017a). Similar national action-planning processes were followed in all three countries and included the establishment of a national working group, drafting the status report and the NAP for the species using all available knowledge, stakeholder consultation of the NAP document and adoption by the relevant ministry. As also identified by the International Single Species Plan for the LWfG, hunting, illegal killing and habitat loss were identified as major threats for the species in Greece, Bulgaria and Hungary. All the three NAPs include a list of threats for the species, corresponding actions and authorities responsible for the implementation. Even though all three NAP processes were initiated in 2012 only the Hungarian NAP has been adopted and been implemented so far. Lengthy administrational procedures in

Project signboard in Evros Delta, January 2016. © Panayiotis Ioannidis/Evros Delta Management Authority

Greece and Bulgaria highlight the difficulty of the transition of international as well as NGO-driven nature conservation activities into the national biodiversity agenda.

3.4 Public awareness

Significant efforts were put into public awareness and the engagement of the public to LWfG conservation – particularly around the key project sites in Greece. Two websites were developed and operated for the project (international **www.wwf.fi/lwfg** and Greek **www.ornithologiki.gr/nanoxina**), where all project material is available. Similar websites have been launched by project partners (ie. **www.fri.gr**). A number of attractive communication materials were produced in all project partner languages (Greek, English, Bulgarian, Hungarian, and Finnish) as well as in Norwegian and Sami languages, and distributed to relevant stakeholders and national authorities. Materials included a project leaflet, poster, sticker and calendar, special issues for the member's magazine for the HOS and the BSPB, signboards and a Layman's report. Additionally, the project was presented in a number of international and national workshops, conferences and events reaching an audience of more than 20,000 persons.

During the project, a comprehensive Environmental Education Programme was developed and launched in Greece. The Programme included the production of two educational kits for primary and secondary school level, including a teacher's guide, a story, a memory game, colour book, poster and floor game. The material was evaluated by the teachers as well as the pupils and distributed to ca. 600 schools and other educational establishments (libraries, National Park information centres etc.). In total ca. 5,500 school children participated in the Programme through field trips, open events and the school network (Panoriou 2017). The Programme was designed to be implemented by the teachers themselves and to be incorporated into the school curriculum and will as a result continue to contribute to LWfG conservation long after the end of the LIFE+ Project.

LWfG seminar in Kerkini Lake, November 2015. © HOS

LWfG LIFE Project team, February 2014. © HOS

3.5 Monitoring

A comprehensive monitoring plan for the LWfG was developed along its European migration routes, including the publication of standard monitoring instructions and a field guide. Three LWfG identification and monitoring training seminars were organized in Hortobágy National Park by WWF Finland where 36 birdwatchers and ornithologists from 15 countries along the LWfG migration routes attended. Trained participants formed new field teams on the ground and the most significant results included the first confirmed observation of a larger LWfG flock in Lithuania, large number of LWfG observations in north-eastern and south-western Poland and in southern Hungary and the first records of live LWfG in Serbia for decades (Tolvanen et al. 2017).

Regular monitoring of LWfG was conducted in all project sites where concrete conservation actions were implemented in the framework of the LIFE+ Project, to monitor their effectiveness. In Hungary LWfG monitoring at the Hortobágy National Park has been conducted since 1990. Since the beginning of the LIFE+ Project the LWfG Fennoscandian population has shown an increasing trend in numbers especially during spring staging, whereas during autumn it remained more or less stable (even though a slight increase is apparent), supporting the LWfG "loop migration theory" (Øien et al. 2009). A significant monitoring result was the observed reduction in the amount of time the LWfG spend in the Hortobágy National Park especially in autumn, possibly due to an observed temperature rise as result of climate change (Szabo et al. 2017). Monitoring also took place in the Tisza Lake region (ca. 25 km west from Hortobágy National Park). LWfG of most likely Western Main population were observed in the area (1-10 individuals annually) between 2013-2016, while hunting was identified as a significant threat for the species in this area. The analyses revealed that the site (the second biggest wetland of the country) is less suitable for the Fennoscandian LWfG population than the sites in Central and Northern Hortobágy (Hortobágy Environmental Association 2016). In Bulgaria no LWfG were observed in any of the project sites (Batova, Zlatiyata and Pyasachnik reservoir) and as a result monitoring was extended to adjacent regions. LWfG individuals were observed in the Burgas Lakes as well as the Shabla and Durankulak Lakes in north-eastern Bulgaria, most likely belonging to the Western Main population. The LWfG arrived in January-February amongst the enormous flocks of wintering geese (over 450,000 individuals), which do not allow precise LWfG observations to be made (Dobrev et al. 2017). In Greece, LWfG monitoring was conducted between October and March from 2011 until 2017, and showed a slowly increasing trend in the development of the Fennoscandian LWfG population, with a maximum count of 144 individuals in Greece in 2016. LWfG were mainly observed in Kerkini Lake and Evros Delta as expected, but two individuals were observed also at Koronia Lake (Demertzi et al. 2017a). Monitoring also covered Ismarida Lake, but no LWfG were observed there. The arrival date of the LWfG in Greece showed a shift towards earlier dates, whereas the departure dates remained more or less the same, resulting in an increase in the overall time the LWfG spent in Greece with the 2016-2017 season being the longest (188 days). The LWfG spent more time wintering in Kerkini Lake while the Evros Delta was increasingly less favoured by the LWfG. Disturbance caused by hunting was evident in the area, confirmed by the fact that LWfG and other geese spread out of the non-hunting area immediately after the end of the hunting season (Demertzi et al. 2017a). Overall, the Fennoscandian LWfG population spent more time in Greece than any other country along its flyway (Aarvak et al. 2017b). As a result, conservation efforts at the Greek wintering and staging sites and especially at the Evros Delta need to be continued and developed in order to ensure habitat availability and site connectivity.

4. Discussion

Following six years of project activities as well as Red Fox culling at the breeding sites and after experiencing a steady negative trend for decades, the Fennoscandian LWfG population is now showing signs of recovery and an annual increase of up to 15% (Aarvak et al. 2017a). The breeding success in 2015 was good and in the following winter and spring the population reached its highest count in Greece since the beginning of the 1970s and in Finland since 1962.

The main outcomes of the project can be summarized as follows:

- The LWfG clearly shows a shift in the timing of LWfG migration and in the relative importance of the traditional staging and wintering sites. There are still periods during the annual cycle during which the location of the main Fennoscandian flock is unknown. The effect of climate change on the conservation of the species needs to be examined and new conservation actions need to be planned. One of the recent changes in the migration pattern is that the time the LWfG spend in Greece has increased: they spend approximately six months of the year there, concentrated at only two very limited wintering sites. Thus, Greece is obviously the most significant country for the conservation of the Fennoscandian LWfG within EU, and additional conservation measures need to be developed and implemented to ensure effective control of poaching, site connectivity and suitable habitat management.
- Linking the conservation efforts along the European flyway to the wider international conservation efforts for the species within the Western Palearctic remains essential. During the project, the mutual benefits of the close coordination between the LIFE project partners and the AEWA LWfG International Working Group were very tangible. Not only do we know that parts of the Fennoscandian population migrate outside of the EU, but the long-term survival of the species is also dependent on the conservation status of the Western main population, which regularly provides the Fennoscandian population with an influx of genetic diversity through male mediated emigration. Going forward, efforts must be increased to expand the LWfG field network and to tackle threats to the species beyond the EU.
- Although no LWfG were recorded to have been shot in project sites within the project period, hunting is still a threat for the LWfG in many parts of their migration routes. From the countries involved in this project, this is especially the case in Greece, as hunting takes place in the immediate vicinity of (and also directly at) wintering and staging LWfG sites. As a result the suitability of the present protected areas for the LWfG needs to be examined and re-evaluated. Especially in Evros Delta, hunting takes place at the border of the core area for the LWfG, increasing the possibility of a LWfG being shot accidentally. Although, hunters' and national authorities' knowledge regarding LWfG has increased, more still needs to be done. Effective mechanisms and collaboration schemes have been developed to effectively diminish mortality risk and disturbance from poaching and hunting respectively in Greece and Bulgaria; however endorsement, support and implementation of those by national authorities needs to be reinforced.
- The Fennoscandian LWfG have been shown to depend largely on natural flood grasslands. A large number of plant species have been recorded in its diet at the wintering sites in Greece, but only four of them (especially graminoids) were preferentially selected by the LWfG. The LWfG presence could be considered as an indicator of wetland habitat quality and highlights the necessity and importance of natural grassland maintenance, management and restoration. Appropriate livestock grazing management is considered beneficial to LWfG by creating an attractive habitat for LWfG.
- The LWfG conservation network that has been developed in the project has been of great value for monitoring the species recovery, and has been instrumental for the identification of new LWfG sites and the increase in knowledge for the species. Extensive LWfG monitoring also highlighted the increasing importance of Europe for the Western Main population of LWfG. Maintenance and even expansion of an active network of field observers is essential to indentify still unknown sites along the LWfG flyway in Europe, especially as the migratory movements are changing due to climate change.
- A number of action plans exist for the LWfG that are in need for update and/or endorsement. The International Single Species Action Plan for the LWfG, although still valid (since 2008), would provide a more useful international framework if updated with the new developments for the species. Pending the revision, the detailed workplan adopted by the intergovernmental AEWA LWfG International Working Group, which reflects the current internationally agreed conservation priorities, is an essential tool for coordinating the overarching work for the species. Countries along the migration routes of the Fennoscandian LWfG need to step up their efforts regarding the LWfG National Action Plan adoption and implementation. Local Action Plans for the LWfG have been proven to be very useful in Greece and other LWfG site managers also beyond Greece are encouraged to also develop similar Plans.

The increasing numbers of the Fennoscandian LWfG allow us to consider the LWfG LIFE+ Project as a conservation success story and an important catalyst for further conservation projects and initiatives. Coordinated action along all the key sites of the species along the flyway is essential for the recovery of the population that is still critically endangered. Habitat management, ensuring adequate site protection and connectivity as well as identification of still unknown LWfG sites are essential actions that will allow the slow recovery of the Fennoscandian LWfG population. The collaborations and network that has been developed during the framework of the LIFE+ Project will be instrumental in the development of much-needed new and further LWfG conservation projects and initiatives.

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International Conservation Action for the Lesser White-fronted Goose

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1. Introduction

The Lesser White-fronted Goose *Anser erythropus* is a long-distance migrant, travelling vast distances between breeding grounds across Fennoscandia and the Russian Artic to wintering areas in South-Eastern Europe, Central Asia and the Middle East, as well as in China and Japan. Some 20 countries regularly host Lesser White-fronted Geese during their migrations within the Western Palearctic alone. As such, ensuring international cooperation across the entire range is an essential part of the efforts to halt the decline of the species and to bring the Lesser White-fronted Goose back to a favourable conservation status in the long term.

Although legally protected throughout most of its range, the Lesser White-fronted Goose remains globally threatened, being recognized as 'Vulnerable' by the IUCN and ranked by BirdLife International as 'SPEC 1' within Europe, denoting a European species of global conservation concern. The species is classified as Endangered in Europe and Critically Endangered within the European Union according to the 2015 European Red List Assessment. It is listed in Annex 1 of the European Council Directive on the Conservation of Wild Birds (79/409/EEC1979, 2009/147/EC 2009), in Column A of the Action Plan under the African-Eurasian Migratory Waterbird Agreement and in Annex II 'Strictly protected species' of the Bern Convention.

The global population of the species has declined rapidly since the middle of the 20th century. Although the most dramatic decline appears to have levelled off, there are still fears that the species may go extinct – particularly in Europe - following the fragmentation of its range and the continued threat posed mainly by illegal killing and habitat loss. The migration routes of all three global populations remain - to varying extents - only partially known.

The international conservation work for the species within the Western Palearctic takes place under the framework of the African-Eurasian Migratory Waterbird Agreement or AEWA, and is, in particular guided by the AEWA International Single Species Action Plan for the Lesser White-fronted Goose and by the AEWA Lesser White-fronted Goose International Working Group convened to drive its implementation.

One of many Lesser White-fronted Geese that live in captivity.
© Nicky Petkov/BSPB

The EU LIFE+ Project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway"[1] has directly contributed to the implementation of the International Action Plan – delivering against many of the results identified therein - and has also been a major driving force behind the further development of the conservation of the species within the European Union and beyond. The strong link between the project and the wider international Lesser White-fronted Goose agenda has thus proven to be extremely beneficial for the conservation of the species as a whole.

This article provides an overview of this international Lesser White-fronted Goose conservation framework and also provides examples of the contributions made by the EU LIFE+ Project, including the main activities carried out by the UNEP/AEWA Secretariat as a project partner. In addition, a brief overview of the main international projects implemented under the International Working Group is also given, as well as an outlook of things to come.

[1] *LIFE+10 NAT/GR/000638.* ***https://wwf.fi/en/lwfg/***

2. The International Conservation Framework

2.1 The African-Eurasian Migratory Waterbird Agreement (AEWA)

AEWA[2] is an independent legally-binding multilateral regional Agreement negotiated under the provisions of Article IV of the Convention on the Conservation of Migratory Species of Wild Animals (CMS or the so-called Bonn Convention)[3].

The foundation of AEWA lies in the flyway approach: the need to implement conservation measures for and sustainable use of migratory waterbirds along the entire length of their flyways. All AEWA species cross international boundaries during their migrations and require good quality habitat for breeding, as well as a network of suitable sites to support their annual journeys. International cooperation across their entire migratory range, as provided by AEWA, is therefore essential for the conservation and management of migratory waterbird populations and the habitats on which they depend.

AEWA covers 254 species of birds ecologically dependent on wetlands for at least part of their annual cycle, which are further divided into 554 populations allowing for the individual assessment of the conservation status of each population. The Agreement area stretches from the northern reaches of Canada and the Russian Federation to the southernmost tip of Africa, covering 119 Range States from Europe, parts of Asia and Canada, the Middle East and Africa. Currently 75 countries and the European Union (EU) have become Contracting Parties to AEWA (as of 1 April 2016)[4].

The Lesser White-fronted Goose is one of the waterbird species prioritized for international conservation action under the Agreement. Two populations of Lesser White-fronted Geese are covered by AEWA. These are the North-East European & Western Siberian/Black Sea & Caspian population (more commonly known as the Western main population) and the Fennoscandian population, both of which are listed on Column A of Table 1 of the AEWA Action Plan, thus granting them the highest level of protection under the Agreement[5].

As such, AEWA serves as the main international legal framework for the coordinated conservation efforts for the Lesser White-fronted Goose within the Western Palearctic, covering all range states of the species within its geographic remit.

2.2 AEWA International Single Species Action Plan

International Species Action and Management Plans are one of the key tools used to guide concerted action for species or groups of species which routinely cross international borders. The AEWA International Single Species Action Plan for the Conservation of the Lesser White-fronted Goose (Western Palearctic) was adopted at the 4th Session of the Meeting of the AEWA to Parties in 2008[6].
This Plan constitutes the internationally agreed conservation framework for the species within the AEWA range, with the long-term goal of returning both the Fennoscandian and Western main populations of the Lesser White-fronted Goose to a favourable conservation status. The Action Plan applies to the 22 Principal Range States identified as regularly hosting Lesser White-fronted Geese within the AEWA region.

Of the Range States covered by the Action Plan, twelve countries are Contracting Parties to AEWA at the time of writing, and are therefore obligated to implement the Plan. AEWA Species Action Plans adopted by the AEWA Meetings of the Parties are operative documents derived from the legal text of the Agreement[7], and although these species (or population) specific plans are not directly binding, Parties have an obligation to cooperate with a view to implementing them. Should a Party to which an Action Plan applies make no efforts towards implementing such plan, the Party would be in breach of its AEWA commitments[8].

Although most Lesser White-fronted Goose range states are currently engaged in the international conservation network (see 2.3. below) it continues to hamper progress in the implementation of the Action Plan that several key countries for the species such as Azerbaijan, Greece, Iran, Kazakhstan and Russia have not yet acceded to AEWA. As many of the core conservation activities such as changes to hunting legislation etc., can only be implemented by the national governments, their engagement is crucial for the long-term survival of the species.

For each identified threat and knowledge gap, the Action Plan outlines results and activities to be implemented in those range states to which they apply. Illegal killing and accidental shooting including disturbance caused by hunting as well as habitat loss and destruction are recognized as the foremost threats to the Lesser White-fronted Goose across its flyways in the Western Palearctic. Climate change is also increasingly thought to be affecting the migratory patterns of the species as well as the critical sites it depends on during migration.

In addition, gaps in crucial knowledge such as the location of several key sites along the flyways also continue to hinder conservation efforts, for example, the location of most of the wintering sites of the Western main population remain unknown.

[2] *For more information about AEWA, please visit the AEWA website:* ***www.unep-aewa.org/***

[3] *For more information about CMS, please visit the CMS website:* ***www.cms.int/***

[4] *AEWA geographic range and up-to-date list of Contracting Parties:* ***http://www.unep-aewa.org/en/parties-range-states***

[5] *AEWA Agreement Text as amended by MOP6 (2015), page 42:* ***https://goo.gl/HXyDzp***

[6] *Jones, T., Martin, K., Barov, B., Nagy, S. (Compilers). 2008. International Single Species Action Plan for the Conservation of the Western Palearctic Population of the Lesser White-fronted Goose Anser erythropus. AEWA Technical Series No.36. Bonn, Germany.* ***https://goo.gl/jrqaxJ***

[7] *Paragraphs 2.2.1 and 4.3.4 AEWA Action Plan.*

[8] *Mikander, N. 2015. Overview on the Status of Preparation and Implementation of AEWA ISSAPs, ISSMPs as well as Multi-Species Action Plans. Page 9-10.* ***https://goo.gl/JSFiAS***

2.3 AEWA Lesser White-fronted Goose International Working Group

To help guide and boost the implementation of the International Action Plan, the UNEP/AEWA Secretariat convened the inter-governmental AEWA Lesser White-fronted Goose International Working Group in 2009. As is the case for all AEWA Species Working Groups, members consist of designated national government representatives as well as national experts for the species[9]. In addition, several international conservation and hunting organizations are permanent observers to the Working Group , as they play a vital role in the development and implementation of conservation action for the species[10].

One of the main strengths of these AEWA International Working Groups is the involvement of the governments in the international conservation work, regardless of whether they are Contracting Parties to the Agreement or not[11]. Many species have highly functioning and dedicated international expert networks composed of scientists and conservation practitioners. In the longer term, however, government involvement is crucial to ensure national funding and implementation of certain types of conservation action.

Key tasks of the Working Group, as laid out in the generic Terms of Reference established for all AEWA Species Working Groups by the AEWA Technical Committee in 2009, include the coordination of the implementation of the Action Plan as well as offering range states implementation support and stimulus. In addition, it is the role of the Group to monitor and report back to the AEWA governing bodies on implementation progress and effectiveness of the Plan.

A core task of each designated government representative, in turn, is the responsibility to coordinate the national implementation of the Action Plan and to function as the link between the International Working Group and the relevant national organizations and stakeholders. The role of the national experts – beyond actively contributing to the work of the Group based on their expertise – is to strengthen and maintain the technical and expert network relevant for the species in question in their country. The experts are also expected to function as the link between the international and national expert networks.

Mandatory reporting on Action Plan implementation before each meeting was established by the Working Group in 2010. The Working Group also has a discreet website with a members-only intranet hosted by the UNEP/AEWA Secretariat[12]. The Working Group aims to hold face-to-face meetings every two-three years, with three meetings having taken place thus far and the next meeting foreseen for 2019.

A Chair country is elected at each meeting of the Working Group and the Chair is currently held by Estonia. An International Coordinator for the Lesser White-fronted Goose is situated at the UNEP/AEWA Secretariat courtesy of funding provided by the Norwegian Environment Agency, whose main task it is to facilitate the work of the Group including fundraising and providing the link to the wider international conservation community for migratory waterbirds.

3. Activities implemented by the UNEP/AEWA Secretariat within the EU LIFE+ Project

3.1 Establishing national conservation frameworks in key range states

Corresponding to the adoption of International Single Species Action Plans, which serve to unite range states and stakeholders in working towards a common agreed goal across a species' range, National Action Plans are instrumental in breaking these overarching activities down to national level. The establishment of inclusive National Species Working Groups as well as the adoption and subsequent implementation of National Action Plans in key range states are therefore considered to be priority steps towards ensuring the implementation of International Action Plans.

National Action Plans should be used as a tool for reaching agreement amongst national stakeholders on priorities for conservation action as well as for detailing the responsible actors for ensuring the implementation and funding of each activity[13]. As described above, the designated national representatives in the International Working Group should provide the link between these national structures and the wider international community, ensuring the flow of information between the various levels. Of the 22 range states to the Lesser White-fronted Goose International Action Plan, only ten have adopted or are in the process of developing National Action Plans to date[14].

Within the framework of the LIFE+ Project, the UNEP/AEWA Secretariat assisted Greece, Hungary and Bulgaria with the development of their National Action Plans to the degree requested by the respective national project beneficiaries. The need for support by the Secretariat differed greatly amongst the three countries committed to developing Plans within the framework of the project. Whilst Hungary already has an established procedure for the development of National Action Plans and thus only required very limited support, the Secretariat ran a national action-planning workshop for the species in Bulgaria and provided guidance on the establishment and implementation of an action-planning process in Greece. In addition, the Secretariat provided official letters of support regarding the adoption of the draft Plans to the relevant authorities in both Bulgaria and Greece.

[9] *Working Group Terms of Reference as developed by the AEWA Technical Committee in 2009:* ***https://goo.gl/uiqnSB***

[10] *BirdLife International, CIC, FACE, Wetlands International and the Wildfowl & Wetlands Trust*

[11] *All 22 Principal Range States identified in the International Single Species Action Plan are members of the Working Group, although only 12 of these countries are currently Parties to AEWA.*

[12] ***http://lesserwhitefrontedgoose.aewa.info***

[13] *AEWA provides some support to countries embarking on National Action planning processes in the form of AEWA Conservation guidelines: AEWA Conservation Guidelines No. 1. Guidelines on the preparation of National Single Species Action Plans for migratory waterbirds. AEWA Technical Series No. 15.* ***https://goo.gl/4PpnyX***

[14] *Mikander, N. 2015. Overview on the Status of Preparation and Implementation of AEWA ISSAPs, ISSMPs as well as Multi-Species Action Plans. Page 72.* ***https://goo.gl/78Mxan***

Members of the AEWA International Working Group take part in an excursion around Kerkini Lake at the second meeting in 2012. © AEWA

3.2 Linking the LIFE project with the wider international network

One of the key steps to ensuring the long-term conservation of a highly migratory species such as the Lesser White-fronted Goose is to build and maintain a wide network of people and stakeholders dedicated to implementing action for the species throughout the flyway. As such, the main role of the UNEP/AEWA Secretariat as a project partner and beneficiary in the EU LIFE+ Project was to maintain and increase the connections between the project partners and their activities and the wider Lesser White-fronted Goose conservation community, mainly though the AEWA International Working Group for the species described above.

3.2.1 2nd Meeting of the AEWA Lesser White-fronted Goose International Working Group

As such, the Secretariat organized and facilitated the 2nd Meeting of the International Working Group at Lake Kerkini in Greece on the 9 - 11 of November 2012. The meeting was attended by representatives from 15 countries including observers from the LIFE project and national partners from Greece[15].

The main outcomes of the meeting included the decision to establish a network of critical sites for the Lesser White-fronted Goose within the Western Palearctic, based on a selection of sites critical for the conservation and recovery of the Lesser White-fronted Goose in each Principle Range State, which are also important for other migratory geese and waterbirds[16].

The Working Group also started the revision of the AEWA Lesser White-fronted Goose International Single Species Action plan, by re-evaluating the threats to the species, as well as the corresponding actions. Unfortunately, the revision is still pending at the time of writing due to differences amongst some of the range states (see 3.2.2. in addition, below). Nevertheless, the reassessment exercise proved to be very useful, and the implementation of international projects and activities since late 2012 has been based on this re-prioritization[17].

Group photo of the AEWA Lesser White-fronted Goose International Working Group at its 2nd meeting at Kerkini Lake, Greece in 2012. © AEWA

Meeting outcomes also included the establishment of a common monitoring scheme for the Lesser White-fronted Goose based on the identification and field monitoring guidance produced under the LIFE project, a network of trained ornithologists/experts covering critical sites across the species' range (which was largely established under the LIFE project) as well as a common platform for reporting and accessing observations/data (which is provided by BirdLife Norway on http://piskulka.net)[18].

In Kerkini, the Working Group also decided to extend its membership to encompass the third population of the species which lies outside of the AEWA range in the East Asian-Australasian Flyway: the so-called Eastern main population[19].

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[15] *All meeting documents available on the AEWA website:* ***https://goo.gl/hUCmpM***

[16] *Doc: LWfG IWG 2.4.* ***https://goo.gl/2GHzUT***

[17] *Within the lifetime of an adopted AEWA Action or Management Plan, there can be a need for adjustment of the priority actions depending on the development of the species/population as well as the availability of new scientific knowledge. Such adjustments may not warrant a full revision of a Plan. Any changes to the actions should, however, be discussed and agreed within the framework of the respective AEWA International Species Working Group in order to ensure international consensus. In the case of contentious issues, the Action or Management Plan adopted by the MOP remains the international framework for the conservation or sustainable use of a species/population.*

[18] *Doc: LWfG IWG 2.7.* ***https://goo.gl/hiAzfX***

[19] *For a full overview of meeting outcomes, please see the final meeting minutes:* ***https://goo.gl/urUaSd***

Group photo of the AEWA Lesser White-fronted Goose International Working Group at its 3rd meeting in Trondheim, Norway in 2016. © Norwegian Environment Agency

3.2.2 3rd Meeting of the AEWA Lesser White-fronted Goose International Working Group

The third meeting of the Working Group was hosted by the Norwegian Environment Agency at their premises in Trondheim, Norway on the 12-14 April 2016[20], with a strong focus on the planning of concrete conservation action for the species in the short to medium term.

Following status updates on all global populations of the species (including detailed national updates presented by China and Japan, who were participating for the first time), it was concluded that although a certain stabilization has taken place, the status of the small Fennoscandian population which only numbers some 130 birds as well as the status of the Western and Eastern main populations remains precarious. For the larger Western and Eastern populations in particular, the threats of illegal killing and habitat loss remain acute.

The main outcomes of the meeting included the decision to select nine critical sites where urgent conservation action will, in particular, be implemented during the next four years. A full assessment and report will first be completed for each of the selected sites, including a full description of the legal status, the numbers and times of occurrence of geese, previous or ongoing monitoring efforts, a threat assessment, key stakeholders as well as recommendations for next steps[21]. The Working Group also discussed how to further strengthen the established monitoring network and Range States were provided with a monitoring and identification tool for use in their national capacity-building work prepared by WWF Finland.

Dedicated break-out groups undertook more detailed planning of key activities including the possible scope of a new EU LIFE+ Project, the organization of a large-scale monitoring expedition to Kazakhstan, the further identification and protection of key wintering sites of the Western main population as well as setting up an Action Plan framework for the Eastern main population. All activities and action points identified throughout the meeting fed into the four-year work plan (2016-2019), which is set to serve as the main basis for the activities of the Working Group[22].

The Working Group also initially reached an agreement on next steps regarding the revision of the 2008 AEWA International Single Species Action Plan for the Lesser White-fronted Goose. Estonia was re-elected to chair the Working Group for the next inter-sessional period, with the next meeting envisaged to take place in 2019, possibly in Iran[23].

4. Additional activities under the AEWA Lesser White-fronted Goose International Working Group

In addition to the actions foreseen under the EU LIFE project and to the measures being implemented nationally throughout the species' range, a wide array of further Lesser White-fronted Goose-related activities have been implemented under the auspices of the AEWA Lesser White-fronted Goose International Working Group.

Since the convening of the Working Group, monitoring expeditions, missions, workshops and conservation projects have been carried out in Azerbaijan, Greece, Iran, Kazakhstan, Russia, Syria and Ukraine, facilitated by the UNEP/AEWA Secretariat and funded mainly by the governments of Norway, Finland and Germany. Multiple projects to identify and secure key staging areas on spring and autumn migration in Russia, two expeditions to locate wintering sites in Iran in 2015 as well as several expeditions and projects implemented in Kazakhstan, both to assess the status of the Western main population and to diminish the threat from illegal hunting particularly warrant mentioning. The most recent (and to date most extensive) Kazakhstan survey carried out in autumn 2016, for example, indicates that the Western main population is much larger than previously estimated[24].

National stakeholders are joined by international experts in 2015 to search for Lesser White-fronted Goose wintering areas in Iran. © Petri Lampila

[20] *Additional financial support for the travel of funded delegates was provided through the EU LIFE project. All meeting documents are available online on the AEWA website:* **https://goo.gl/BtcXeA**

[21] *Doc: LWfG IWG 3.5.* ***https://goo.gl/rBQYgG***

[22] *Doc: LWfG IWG 3.6.* ***https://goo.gl/dC8rQB***

[23] *For a full overview of meeting outcomes, please see the final meeting minutes:* ***https://goo.gl/FDxxPL***

[24] *Cuthbert, R. & Aarvak, T. (Compilers) 2016. Population Estimates and Survey Methods for Migratory Goose Species in Northern Kazakhstan. AEWA Lesser White-fronted Goose International Working Group Report Series No. 5. Bonn, Germany. 96pp.* ***https://goo.gl/iN6tN7***

Flocks of geese gather to feed at autumn staging sites in Northern Kazakhstan 2016. © Attila Szilágyi

Activities under the Working Group also include linking the Lesser White-fronted Goose conservation agenda to other ongoing international processes, such as the wider AEWA waterbird conservation agenda (for example the development of guidance regarding look-alike species by the AEWA Technical Committee) as well as CMS (for example work on site connectivity, illegal killing and poisoning), the Arctic Migratory Bird Initiative[25] under the Arctic Council's biodiversity working group CAFF and the East-Asian Australasian Flyway Partnership (in particular the EAAFP Anatidae Working Group).

Other linkages include, but are not limited to, the IUCN Goose Specialist Group, the CMS Family Champions Programme, collaboration with the AEWA Red-breasted Goose International Working Group as well as promoting the Lesser White-fronted Goose as a flagship species at various events such as the Meetings of the AEWA Parties in May 2012 and November 2015 respectively[26].

5. Conclusions and outlook

Much progress has been made in increasing the international conservation efforts for the Lesser White-fronted Goose throughout its flyways in the Western Palearctic since the adoption of the International Action Plan in 2008, as a result of the combined efforts of individual range states, active NGOs, the implementation of dedicated projects as well as the international coordination of activities under the AEWA Lesser White-fronted Goose International Working Group. The continuously growing international network of government representatives, researchers, conservation practitioners and other stakeholders driving these efforts should be particularly highlighted.

As reports from the range states submitted to the AEWA Lesser White-fronted Goose International Working Group show, progress has been made in implementing the activities foreseen in the Action Plan, whereby the 2011-2017 EU LIFE+ Project has directly or indirectly contributed to much of this implementation progress in recent years.

However, illegal killing and habitat loss remain acute threats to the species, many of the wintering and staging sites remain unknown and the lack of resources and government support in many parts of the flyways continue to hamper conservation efforts[27]. And although it appears that the most dramatic decline of the Western Palearctic populations has levelled off, they are still far from secure. Therefore, much remains to be done.

Key challenges will include taking the international efforts against illegal killing and accidental shooting of Lesser White-fronted Geese to the next level by engaging directly with the

[25] **http://www.caff.is/arctic-migratory-birds-initiative-ambi**

[26] *For example: UNEP/AEWA Secretariat 2015. Stories from the flyway. Bonn, Germany. Pages 44-49.* **https://goo.gl/98aDyq** *In addition to several side-events which features the Lesser White-fronted Goose, the species was also included as part of UNEP/CITES/CMS exhibition "Wild and Precious" at MOP6.*

[27] *For latest comprehensive implementation review of the AEWA Lesser White-fronted Goose International Single Species Action Plan, please see: Mikander, N. 2015. Overview on the Status of Preparation and Implementation of AEWA ISSAPs, ISSMPs as well as Multi-Species Action Plans. Pages 70-77.* **https://goo.gl/F8GpTk**

relevant international, regional and local hunting communities, understanding the motivations behind hunting at critical sites and establishing a long-term process in Eastern Europe and Central Asia to address the current unsustainable harvest of waterbirds, including the protection of threatened species.

Work will also continue on strengthening the network of critical sites identified for the Lesser White-fronted Goose throughout its flyways, with a particular focus in the short term, on the sites prioritized at the 2016 Working Group meeting. This will include establishing the protection of these sites and developing and adopting management plans in cooperation with the local authorities and other stakeholders, as appropriate. Involving the relevant site managers in the wider conservation work for the species – including monitoring – will be of particular importance.

Under the International Working Group, efforts to close the remaining key knowledge gaps will also continue. The high population estimate for the Western main population reported by the 2016 field expedition in Kazakhstan mentioned above raises, for example, the question as to where these birds are wintering and confirms that there must be several unconfirmed wintering areas in Turkey, the Middle East and around the Caspian Sea. A key challenge for the years to come will be to locate and secure these wintering areas in collaboration with the local partners in these regions. There is general knowledge of widespread illegal killing and habitat degradation in many of these potential wintering areas, but without exact knowledge of the location and timing of occurrence of the birds, efforts to protect key sites are impossible to implement.

The continued strengthening of the common monitoring scheme will also remain a high priority. Efforts will include the continued extension of the monitoring network by increasing identification and monitoring skills and subsequently the regular monitoring of the species across its range in the Western Palearctic, to better understand the status and development of the populations as well as the effect of conservation action or where such action is needed. Trainings, as carried out thus far, will need to be complemented with national on-the-ground trainings and expeditions in key countries coupled with the provision of suitable monitoring equipment were needed.

Following the observations of changing migratory patterns – particularly of the Fennoscandian population – as well as reports of increasing changes to critical sites used by the species (for example increasing droughts), another focus of the international work during the coming years will be on assessing the vulnerability of the Lesser White-fronted Goose and its habitats to climate change and taking initial steps to ensure, for example, that enough suitable habitat will be available for the species across the flyways in the years to come.

Efforts to reach a consensus amongst AEWA Contracting Parties on the foreseen revision of the AEWA International Single Species Action Plan for the Lesser White-fronted Goose remain ongoing, and may take some years still to complete. However, as decided by the AEWA Standing Committee, the 2008 Action Plan remains valid and open for implementation until such a time that a new revised Plan is adopted by the AEWA Meeting of the Parties.

Janos Tar from the Hortobagy National Park Directorate counts Lesser White-fronted Geese in Northern Kazakhstan, 2016.
© Attila Szilágyi

The Working Group is also set to embark on the establishment of an over-arching communication strategy for the species underlining the flagship role it can play on behalf of other waterbirds as well as other bird species using the same habitats and facing similar threats. Amongst other actions, the strategy will also include measures to make the wide range of awareness-raising and educational materials developed by different partners available to the entire network.

Work will also continue to link the Lesser White-fronted Goose to the wider migratory waterbird and wetland conservation agenda within the African-Eurasian region, such as the BirdLife International work on illegal killing in the Middle East, to name one example. Collaboration will, in particular, continue with the East-Asian Australasian Flyway Partnership as well as the range states and stakeholders relevant for the conservation of the Eastern main population of the species, including providing assistance in developing a flyway Plan specifically for that population.

To conclude, it cannot be reiterated enough that international cooperation amongst all relevant stakeholders across the flyways throughout the Western Palearctic remains essential to the conservation of the Lesser White-fronted Goose. Without this, we will not be able to return the Lesser White-fronted Goose to a favourable conservation status. Keeping the existing strong network alive and enhancing it with relevant stakeholders on all levels is therefore the key element to ensuring the continued success of the international conservation efforts for the species.

Temporal migration analysis of the Fennoscandian Lesser White-fronted Goose population

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Lesser White-fronted Goose family. © Tomas Aarvak

1. Introduction

The Lesser White-fronted Goose *Anser erythropus* (later abbreviated LWfG) has fascinated birders and scientists for decades. For a long time its systematics and distribution was unresolved and much discussed. Alpheraky (1905) in his seminal work "The geese of Europe and Asia" wrote: *"Seeing that by many authors the bill of this species is described as orange, Mr. Buturlin decided to separate the geese of more eastern origin without orange bill as a separate species, which described under the name Anser rhodorhynchus. If merely on statements in literature, the esteemed author of Dikie Gusi Rossiiskoi Imperii had grounds or the right to proceed thus, I, on the other hand, after examining his question critically, come to the same result as in the cases of the grey-lag and white-fronted goose, namely, that the majority of author's descriptions of the bill of this goose as orange are inaccurate and I am therefore compelled to add the species established by Buturlin to the number of synonyms for A. finmarchicus". In Finnish the species name was given as Kilgo-hanhi or Kilju-hanhi. The latter was commented by Alpheraky with the following: "Notwithstanding Pallas's statement that he knows only one species of white-fronted goose (A. erythropus), it must be presumed that he met with both species, and that, like Linne he confused them; therefore very probably the above-quoted names refer partly to the white-fronted goose, A. albifrons, partly to the lesser species. Unfortunately, it is now impossible to decide this question – the natives must be questioned afresh."*

The Sami people living in Lapland would know the species well as it constituted an important prey, not only during spring, but also through mass catches of moulting birds during summer. The latter, a tradition continuing well into the 1950's and 1960's (Ryd 2007, Storå 1968). The Sami people lived as hunter gatherers up until the 17th century when reindeer pastoralism increased in importance. Few cultural traces are left inland from this period, but excavations in Lule and Mutenia rivers in Northern Sweden and Finland shows how, among animal bones, reindeer predominates, but also a great amount of bones from wood grouse, swans, ducks, geese and ptarmigans (Hansen & Olsen 2014).

At the time, though intimate knowledge of the species, locals would not know where the geese left for winter. This was slowly unraveled when the dwindling population drew attention by ornithologists. In his work 'Djurvärldens utbredningshistoria på Skandinaviska halvön [Distributional history of animals on the Scandinavian peninsular]' Ekman (1922) wrote (translated):
"the two breeding goose species, the Bean Goose and the Lesser White-fronted Goose, have totally different migration routes. The Bean Goose migrates in large numbers across Sweden and, as is well-known, being enthusiastically hunted. The Lesser White-fronted Goose on the other hand, migrates rarely through these areas, so seldom, that it can be with great certainty be claimed that the migration passes over non-Scandinavian areas. In Northern and east-

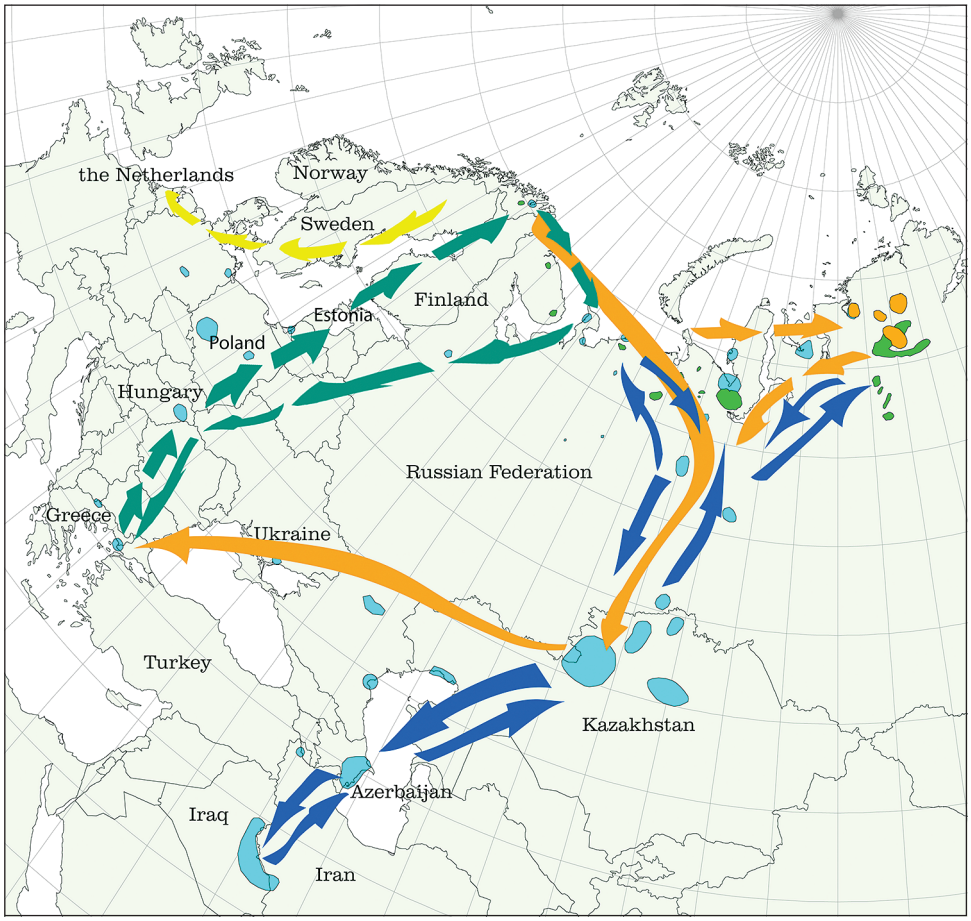

Figure 1. *Migration system for the Lesser White-fronted Goose in the Western Palearctic. Light blue shading = important staging sites and wintering sites, dark green = breeding areas, orange = moulting sites.*
Fennoscandian population: *Green arrows = migration route for successful breeders, orange arrows = moult migration route.*
Swedish reintroduced population: *yellow arrows show the main route southwards.*
Russian Western main population: *blue arrows show main routes (after Lorentsen et al. 1998, Aarvak & Øien 2003, Morozov & Aarvak 2004, BirdLife Norway unpublished data).*

ern Finland, it is a common migrant both in spring and autumn. The Lesser White-fronted Goose is with certainty a north-eastern immigrant and as is with other goose species, it migrates with adult and young birds together. It is here possible to think that the birds, generation after generation, could retain their ancient migration routes (the species immigration routes). This conservative adherent to old habits could be explained in such that the routes are learned by the young through the adult's guidance".

The later work by the Norderhaug's in the 1980's (Norderhaug & Norderhaug 1982, 1984) about the species occurrence and distribution in the north further inspired conservation related research.

Slowly, through counts, surveys, ringing, and later also by use of satellite transmitter telemetry (Lorentsen et al. 1998, Aarvak & Øien 2003, Øien et al. 2009) and color ringing, the various information was pieced together and we now know a lot of the whereabouts of the Fennoscandian population.

In autumn, after completing the moult, successful breeding pairs return with their offspring to the same staging area as used pre-breeding in spring. There, at the Valdak Marshes in Finnmark County, Norway, on average 54% of the population gathers each year (Aarvak et al. 2009). They spend about three weeks at Valdak before migrating eastwards to the Kanin Peninsula, north-west Russia, in early-mid September. From there the main migration route is towards the south-west via north-western Russia and Eastern Germany/Western Poland to Hortobágy in Eastern Hungary and further to the wintering areas in Lake Kerkini and the Evros Delta in Northern Greece (Lorentsen et al. 1998, Aarvak & Øien 2003, **Figure 1**). In 1995, one LWfG was tracked south-eastwards from the Kanin Peninsula, crossing the Ural Mountains to staging sites in the lower Ob River Valley (Lorentsen et al. 1998), and further south to the Kostanay Region in Northern Kazakhstan, an area that was subsequently surveyed for the occurrence of LWfG (Tolvanen & Pynnönen 1997, Aarvak & Øien 2003). Non-breeders and failed breeders follow a similar migration route southward from the Northern -Ob-valley after having left the breeding areas in Norway in late June and migrated eastwards to moulting sites in Northern Russia, some of them as far east as the Taymyr Peninsula (Aarvak & Øien 2003). From Kazakhstan, the Fennoscandian birds turn south-west crossing north of the Caspian and Black seas before ending up in Northern Greece together with the rest of the wintering Fennoscandian birds (Øien et al. 2009). The Ob valley route south through Kazakhstan, is also followed by the Russian Western Main population of LWfG, though these birds mainly continue further south to wintering grounds in Azerbaijan, Iran and Iraq (Morozov & Aarvak 2004, Morozov et al. 2015). A minor number of LWfG of the Western Main population, estimated at 50-100 ind., migrates with White-fronted and Red-breasted Geese *Branta ruficollis* to Hungary (Aarvak et al. 2016, **www.piskulka.net**).

As mentioned above, the sub-adults, failed- and non-breeders undertake a long-distance moult migration in late June, eastwards from the breeding areas to moulting sites, which stretches from the Kanin Peninsula, Kolgujev Island, and even all the way to the Taymyr Peninsula in Russia (Aarvak & Øien 2003), and these birds end up in the same wintering areas in Greece and Turkey as successful breeders and their offspring (**Figure 1**). This difference in migration routes between breeders and non-breeders is important since the mortality rate on the eastern routes is much higher due to exposure to excessive hunting pressure and illegal killing (Øien et al. 2009).

There are only a few recoveries of ringed LWfG from Fennoscandia before 1980, but the two recoveries that exist of birds ringed in Lapland, Sweden (one in winter on 7th of February 1956 in Macedonia, Greece, and one in autumn on 1st of September 1957 in the Manych area, Stavropol, Russia, between the Caspian and Black Seas), suggest that the Fennoscandian population at the time also had a similar system with moult migration to Russia and that they were wintering in Greece or surrounding areas (Fransson & Petterson 2001). The earlier interpretation of the latter of two recoveries was that the bird was on autumn migration to wintering sites in the Middle East and Asia Minor. However, present knowledge suggests that the recovery from Russia may equally likely be a bird that was actually moving from moulting sites in Arctic Russia, travelling through Kazakhstan and was on its way to the winter quarters in Greece. So, it was more likely travelling westwards rather than eastwards as was originally assumed based on the time of the year these birds were shot (Fransson & Petterson 2001). The moult migration from Fennoscandia to the Taymyr Peninsula was not known at that time.

Although a network of LWfG survey and monitoring teams now exists at the most important staging and wintering sites for the species in Europe, there are still gaps in our knowledge on the migratory movements of the LWfG. Therefore, it is important to try to connect the data to identify the gaps. The results of the monitoring of the total number of LWfG at the Valdak Marshes in Norway (Aarvak et al. 2017) is not independent of the numbers found at the other major staging and wintering sites as these are the same birds from the same population being identified and counted. So, when reading and interpreting the results in the present article, keep also an eye of the work undertaken, especially in Finland, Hungary and Greece (Tolvanen & Karvonen 2017, Szabó et al. 2017, Demertzi et al. 2017).

2. Methods

The different monitoring sites all have different function for the birds throughout their annual cycle. Calculating an exact time period for the presence of LWfG for each site throughout the year would require knowledge of individual's whereabouts, and even though much information exists on individual colour ringed birds, neither these provides all desired information. In this article, we have extracted weekly maximum number of LWfG in the years 2011-2016 for each country (from north to south: Norway, Finland, Estonia, Lithuania, Hungary & Greece) from the observation database at **http://piskulka.net**. To circumvent the effect of changing population size, data were standardised by calculating a percentage weekly occurrence of the maximum number observed within the individual years.

Another way to show between site variation in numbers, as well as, how these are connected, is to compare data from the spring monitoring in Norway in May and data from Greece the following winter. After the spring monitoring, the number of birds increase due to reproduction, but there is also a varying degree of loss of subadults and adults mainly among those individuals that undertake the eastward moult migration. So, based on calculated mortality rates and results from the monitoring of the autumn production it is possible to calculate an expected number of LWfG to be found in Greece during the next winter. Adult survival (0.88, Aarvak et al. 2009) was calculated for a seven-month period (June-December, = 0.93) and for juveniles (0.63) for a four-month period (October-December, =0.88). Data from 2005 to 2016 were included, for which we could be fairly certain that the surveys in Greece found the approximate number of wintering LWfG.

Lesser White-fronted Goose families fight for the best feeding areas during autumn staging at the Valdak Marshes in Finnmark, Norway, 2015.
© Tomas Aarvak

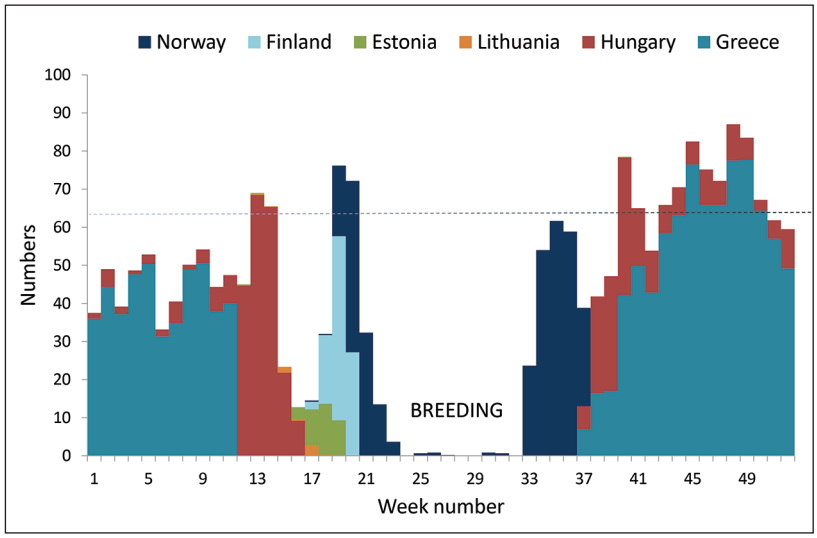

Figure 2.
Average of weekly maximum numbers of Lesser White-fronted Geese throughout the annual cycle in the years 2011-2016.
Data from ***http://piskulka.net***
Stippled line shows a theoretical average population size if all birds had been present at each site simultaneously without overlap between countries. Additional variation in the data are created by the small numbers of LWfG of the Western Main population wintering in Hungary, as seen also in the graph from week 42 until week 10 the following spring.

Country	Week nb.	# weeks	Week nb.	# weeks	Sum # weeks	% 52 weeks	% all weeks
Norway	19-37	19			19	36.5%	29.7%
Finland	18-20	3			3	5.8%	4.7%
Estonia	16-19	4			4	7.7%	6.3%
Hungary	12-16	5	37-42	6	11	21.2%	17.2%
Greece	1-11	11	37-52	16	27	51.9%	42.2%
sum weeks						52	64

Table 1.
Summation of number of weeks Lesser White-fronted Geese are present in significant numbers in the most important countries on the European route.

3. Results and discussion

Maximum weekly numbers of Fennoscandian LWfG present for the six most important countries in the years 2011-2016 (**Figure 2**) show that a considerable part of the Fennoscandian LWfG population disappear during late winter from the surveyed sites for a short period (estimated at 21.3 days by Demertzi et al. 2017 in the present report), as well as after having left Hortobágy in Hungary in spring before they later turn up in Estonia, Finland and Norway. The latter period of absence normally covers the weeks 15-17. Also during the breeding period in summer data are lacking, but the whereabouts of the birds are generally known for 80% of the breeders. During spring migration the LWfG flocks split up into smaller groups or pairs, so the maximum weekly numbers drop while they travel more independently in this period. However, also then, the birds are being missed for a two-weeks period after Hungary, but before they turn up in Estonia and Finland.

Based on an average of maximum weekly numbers for the years 2011-2016, the LWfG stay in Norway 36.5% of the year (breeding season) and 51.9 % of the year in Greece (wintering). Corresponding percentages during migration periods (staging) for the other countries are: Finland (5.8 %), Estonia (7.7 %) and Hungary (21.2 %). The sum of percentages is larger than 100% as there is an overlap when the geese are seen in several countries within one week due to migration. As there seems to be variation in how fast the migration proceeds, it is interesting to note that in 2016 the corresponding values were: Norway (34.6%), Finland (3.8%), Estonia (0%), Hungary (9.6%) and Greece (51.9%) (**Figure 3, Table 1**).

Lesser White-fronted Geese at the Valdak Marshes in Finnmark, Norway, 2016. © Ingar Jostein Øien

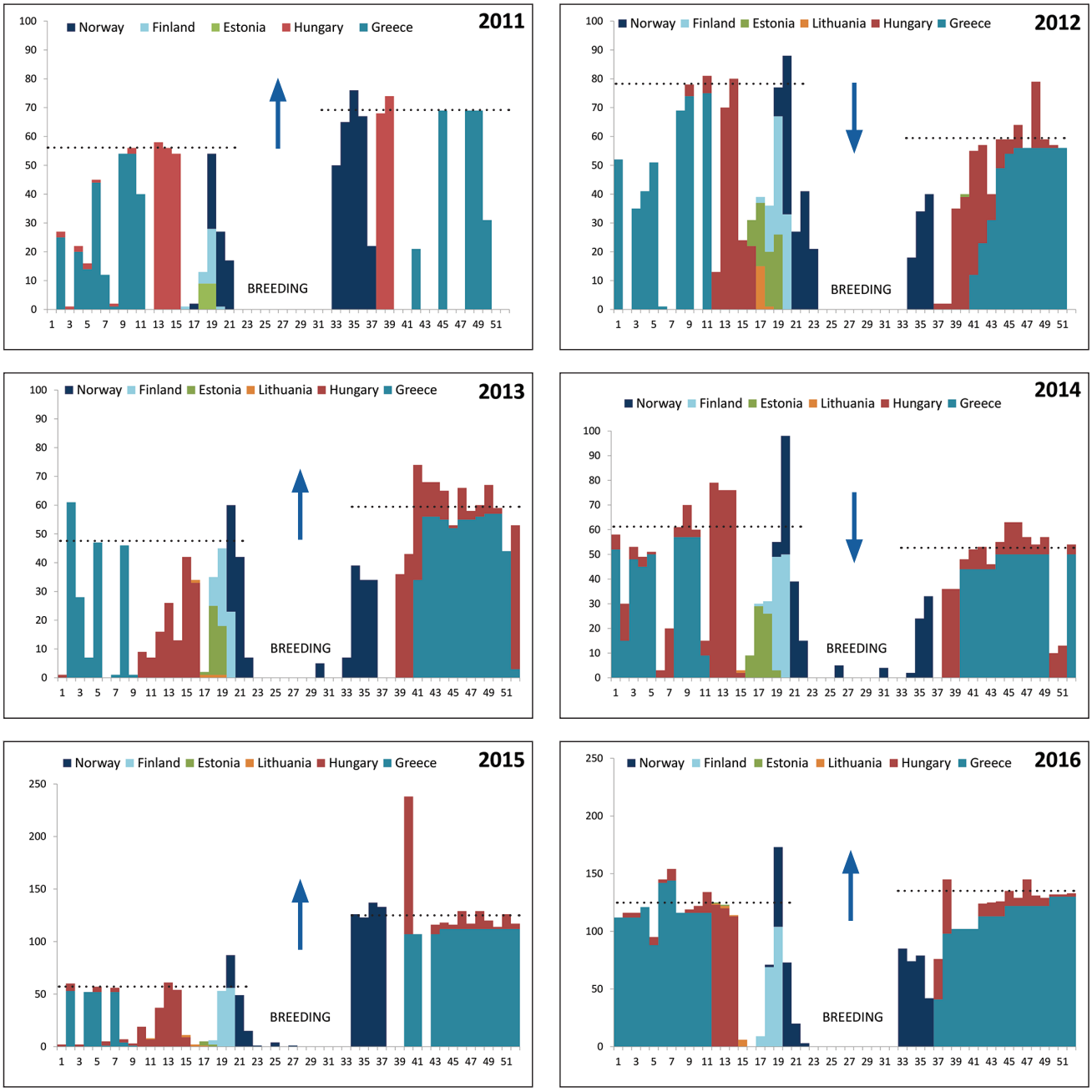

Figure 3.
Maximum weekly numbers of Lesser White-fronted Geese for individual years 2011-2016. Approximate population sizes for spring and autumn are marked with stippled lines fitted by eye and arrows indicate increase or decrease from spring to autumn. In some few weeks, like 19 & 20 in 2012, 20 in 2014, 40 in 2015 and 29 in 2016 the whole population is migrating and is thereby counted in two different countries in the same week. During migration periods this is evident also for parts of the population as seen in the figure.

By looking more closely into **Figure 3**, it is evident that the juvenile production explains the higher numbers in autumn/winter than in the preceding spring in the years 2011, 2013, 2015. In other years like 2012 and 2014, fewer birds were observed in autumn than in spring, while in 2016 the numbers were roughly at the same level (i.e juvenile production countered the mortality).

The maximum counts in Greece shows when part of the wintering LWfG population is absent, or not observed during the counts. In Greece, 40-60% of the birds that were present in November and December the previous year (the same winter) are normally not seen from January onwards (**Figure 4**). The observed number of LWfG increases from week 41 to week 45 and thereafter keep stable at approx. 80% of the highest count in the respective year until January when a substantial part of the birds either goes to other unknown sites or use habitats which are not covered by the monitoring. There is also quite a large variation between years in the occurrence, and further research is needed to find out what factors causes it.

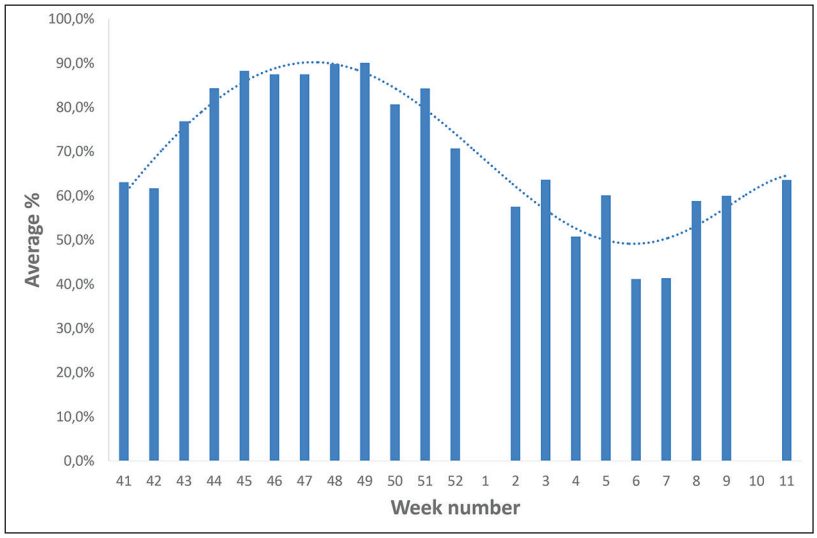

Figure 4.
Average of weekly maximum numbers shown as a percentage of single highest count within each year, in Greece during winter of the Fennoscandian Lesser White-fronted Goose population. Only weeks with counts in four or more years are included (2011-2016).

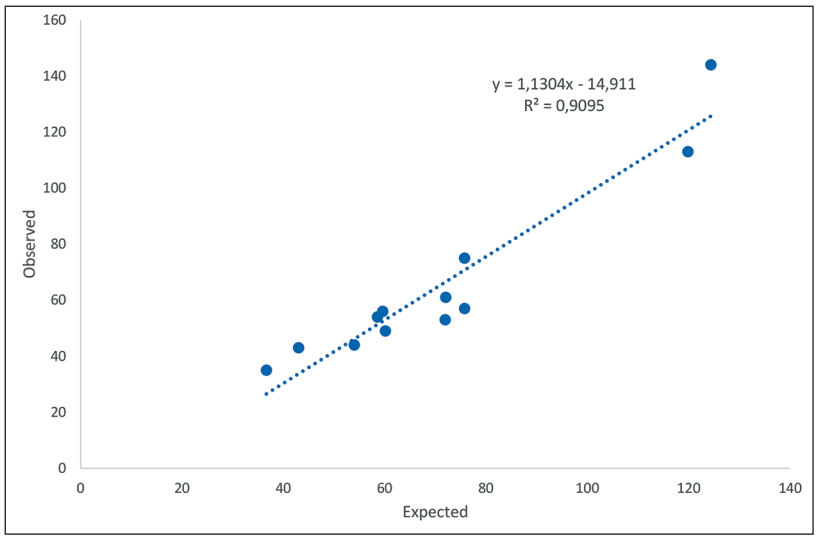

Figure 5.
Expected versus observed annual maximum of Lesser White-fronted Goose numbers in Greece for the period 2005-2016.

In addition to the monitoring of LWfG numbers in each site, satellite telemetry and individual colour ringing has confirmed that Greece is the main wintering site for the Fennoscandian LWfG population. To show how well numbers are related, we calculated an expected number of LWfG for wintertime based on the spring population estimate and production (as monitored at Valdak, Norway in late summer, Aarvak et al. 2017) for the years 2005-2016 (**Figure 5**). This shows that an average of 90.6% of the birds expected to be present in Greece were actually observed there (range 73.7-115.8% of the expected number). There are several explanations for the variation between expected and observed numbers which include absence of birds at the monitored sites, not full count coverage, different (higher) survival than modeled etc.

As all the major staging and wintering sites have been monitored on a daily basis for more than 20 years, the collected data represent a valuable base line set for further analyses into the population dynamics of the Fennoscandian population. With climate change now affecting all living organisms at an increasing level, these data will provide possibilities to not only describe ongoing processes but also facilitate projections of expected changes into the future. For instance, at the Valdak Marshes in Finnmark, Norway, the last staging area before breeding commences, the spring arrival has advanced with more than four days (BirdLife Norway unpublished data). However, as is evident from the present analyses, we have still not a complete knowledge of all the staging and wintering sites used throughout the annual cycle.

An adult Lesser White - fronted Goose in Finland.
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Development and key drivers of the Fennoscandian Lesser White-fronted Goose population monitored in Finnish Lapland and Finnmark, Norway

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A Lesser White-fronted Goose female on the nest within willow birch in the core breeding area in Norway, summer 2016. © Tomas Aarvak

1. Introduction

1.1 Populations and development

Three populations of wild/naturally occurring Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) are recognised internationally, of which the Fennoscandian is the smallest (Jones et al. 2008, **Figure 1**). In addition to these, there is a reintroduced Swedish population originating from captive bred and released birds with a human-modified migration route to the Netherlands (Aarvak et al. 2016, Øien et al. 2017, von Essen 1982) (**Figure 1**).

The original Fennoscandian population is monitored annually at several important staging and wintering sites (Demertzi et al. 2017, Tolvanen & Karvonen 2017 in the present report), of which the Valdak Marshes (used both spring and autumn) in Finnmark, Norway has been shown to hold an annual average 80% of the estimated total spring population size (Aarvak et al. 2009).

In the early part of the 20th century the population was considered to number an estimated 10,000 individuals, but was drastically reduced during the 1940's and 1950's and was on the brink of extinction in the late 1990's. By 2008, the Fennoscandian breeding population was estimated at less than 20 breeding pairs with only 11 pairs recorded at the Valdak Marshes during spring staging (Aarvak & Øien 2009). Fortunately, research conducted in Norway since 1991 has indicated that moult migration of non-breeders and unsuccessful breeders was influencing the population trend negatively through anthropogenic factors negatively affecting adult survival outside the breeding season (Øien et al. 2009). This led to the implementation of a Red Fox *Vulpes vulpes* culling program in the core breeding area for the species in Norway in 2007 (effective from summer 2008) (Øien & Aarvak 2009). The purpose of the culling is to reduce loss of egg clutches to avoid the birds undertaking the long moult migration to Russia where they are exposed to a heavy hunting pressure during the summer, but especially during the autumn migration through Russia, Kazakhstan and Ukraine. In Finland, culling of Red Foxes was undertaken regularly at least since 1997 (Markkola & Niittyvuopio 1997) within the then still used breeding areas. The Finnish culling effort is more sporadic and not that thorough as in Norway where the core breeding area is basically totally emptied within the late winter season. Data from Finland was made available from 2003 and onwards from four wilderness areas in Northern Finland (Pöyrisjärvi, Paistunturi, Kaldoaivi, Käsivarsi; Tuomo Ollila, Metsähallitus pers. comm.).

Figure 1. *Population delimitation of the Lesser White-fronted Goose*

1.2 Population cycles and Red Fox

In northern arctic regions, most ground breeding bird populations fluctuate in a 3-5 year cycle, of which the driver in the system is the lemming/vole - small predator dynamics (Angerbjörn et al. 1999, 2001, Ims et al. 2013, Nolet et al. 2013, Stenseth 1999). At locations with more than one species of lemming or vole, the different species cycle in synchrony (Stenseth & Ims 1993). When lemmings/voles are very abundant, foxes and mustelids feed almost exclusively on these and this leads to a relaxed predation and higher survival for breeders and most importantly, a high breeding output. The following year is usually characterized as a crash year, when lemmings/voles disappear and large predator populations switch to alternative prey as ground breeding birds and their nests (Bêty et al. 2001, Korpela et al. 2014, Lehikoinen et al. 2016). In these years, the production is often very low or zero.

However, for the breeding grounds, predation pressure is likely much higher at present due to the Red Fox that has expanded its distribution and numbers, while the former abundant Arctic Fox *Alopex lagopus* is now on the verge of extinction (Elmhagen 2003). Hunting bags shows how the Fennoscandian Red Fox population about tripled in size between 1930 and 1960 (Lindström 1989, Elmhagen 2003). Several factors are considered to have contributed to the increase of Red Fox populations. Important factors are general amelioration of the climate and decreased interference and exploitative competition with large predators such as Wolf *Canis lupus* and Lynx *Lynx lynx*. Furthermore, increased access to food left-overs in human garbage, increased access to carcasses through road kills and collisions with human infrastructure as fences and power lines, increased access to ungulate carcasses from organised hunting, and reindeer husbandry are considered to have an important impact. Finally, changes in forestry practices including large clear-cut areas that favor Field Voles *Microtus agrestis*, the main prey of boreal Red Foxes (Hersteinsson & Macdonald 1992, Lindström 1989, Elmhagen 2003, Lyngen 2016) may have contributed to immigration of Red Foxes from bordering boreal areas.

1.3 Breeding area

The last remaining known breeding site for the original wild Fennoscandian LWfG population is situated in Finnmark County in Northern Norway. A core breeding area of approximately 600 km^2 holds 50-75% of the total Fennoscandian breeding population. Although it is likely that single pairs also breed in the Northernmost parts of Finland and Sweden, the last confirmed nesting in Finland was in 1995, although birds continue to be reported annually close to potential breeding areas. The last large scale survey in Finland was carried out in 1997 when the Finnish LWfG Working Group organised a survey of known and potential breeding areas in Finnish Lapland with 19 field teams of altogether 30 persons, covering an area of 2600 km^2 (Markkola & Niittyvuopio 1997). Through the present LWfG LIFE+ Project (LIFE10 NAT/NAT/000638), surveys for breeding LWfG were carried out in Käsivarsi (2012), Pöyrisjärvi (2015, 2016) and Kaldoaivi (2012, 2016) wilderness areas in Finland, but no breeding LWfG were found.

The last confirmed breeding of native wild LWfG in Sweden was reported in 1988, and the last confirmed breeding in the southern distribution area in Norway (bordering the Swedish release area for captive bred LWfG since 1989; cf. Aarvak et al. 2016, 2017) was in 1991. After 1988, all other Swedish records come from the reintroduction/restocking project there (Aarvak et al. 2016). Biogeographically, the Fennoscandian population likely also includes birds nesting on the Kola Peninsula in North-Western Russia, but almost nothing is known about the current abundance, status and migration routes of the birds that possibly still breed in that area.

2. Methods

In Norway, a LWfG monitoring project by BirdLife Norway has been active since 1990, including annual monitoring of pairs and immatures at the Valdak Marshes staging site during spring (since 1990) and early autumn monitoring of brood production (since 1994). Also, other previous breeding areas in Finnmark County have been surveyed during the EU-LIFE Project period (2011-2017). Two recently discovered breeding areas were surveyed in 2015 and 2016. The belly patches of all birds were individually drawn on ready-made sheets. For accuracy and identification of 1-year old individuals that have very limited markings, all birds were also video-documented by filming through the telescope (Øien et al. 1996, Aarvak et al. 2009). The core breeding area was first surveyed in 1990, and then three times during the 1990's before annual surveys were established in 2006. The survey for breeding LWfG in the core breeding area is undertaken in early summer during the period of egg laying/ early brooding.

3. Results

3.1 Population development

After experiencing a steady negative trend since the monitoring project started in Norway in 1990, the first signs of a recovery became apparent in 2011, and the population has continued to increase after that (**Figure 2** & **Figure 3**). In 2016 we experienced the best year ever in terms of total numbers of staging individuals (**Figure 2**), and the second best year ever in terms of potential breeding pairs at the spring staging site with 28 potential breeding pairs identified during spring (**Figure 3**). The highest registered number of potential breeding pairs was in 1998 (33 pairs). The increase has come after a Red Fox culling program started in 2007 with effective culling implemented from 2008. The total population during 2008-2016 increased annually with 15.0% (SD=0.0263, ($p<0.01$), TRIM: Pannekoek & van Strien 2001). The total number of birds identified during spring 2016 was the highest registered at the site since the 1970's, and the observation of large amount of immature birds (40 2cy) holds a potential for further recruitment into the breeding population in 2018 and 2019. By 2016 the spring population size was estimated at 30-35 breeding pairs, totaling 105-120 individuals.

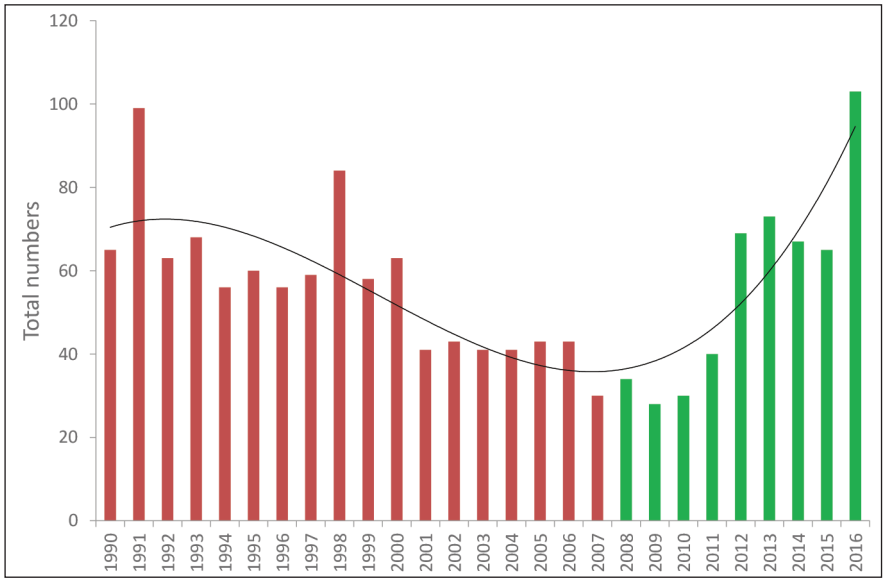

Figure 2. *Total number of individuals of Lesser White-fronted Geese identified at the Valdak Marshes, Porsanger Fjord, Finnmark, Norway in the years 1990-2016. Green bars show years with active Red Fox culling programme in the core breeding area.*

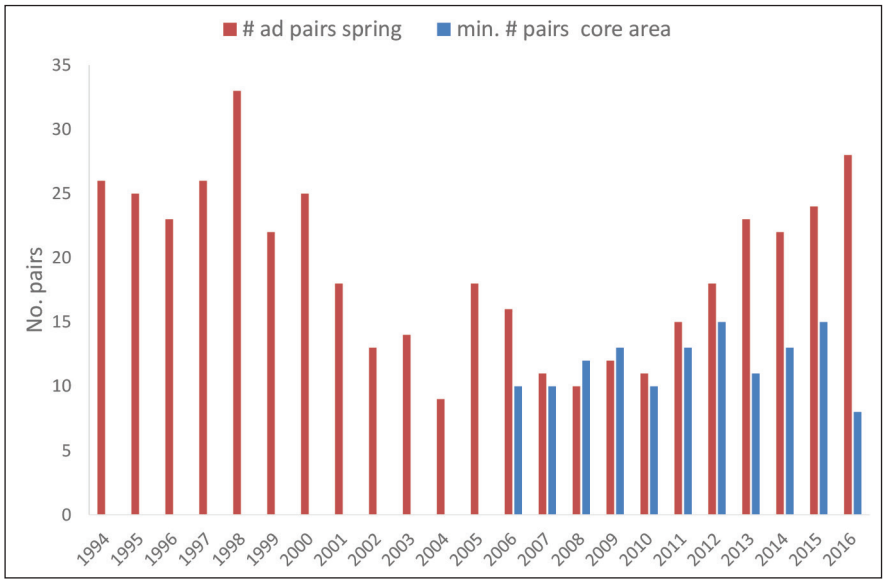

Figure 3. *Development in number of adult potential breeding Lesser White-fronted Goose pairs at the spring staging site Valdak Marshes and number of breeding pairs located in the core breeding area. The figure shows data from 1994 onwards when autumn monitoring at the Valdak Marshes started. Data from the breeding area shows only the work undertaken after 2006.*

Based on trend data at the Valdak Marshes, the population was estimated at 70-90 individuals in spring 2014, including 15-20 breeding pairs (I.J Øien & T. Aarvak, BirdLife Norway unpublished data), a slight increase from the estimate of 60-80 individuals given by Fox et al. (2010).

3.2 Breeding area surveys

In Norway, on average a minimum of 12 breeding pairs (range 8-15) have been found in the core breeding area since 2006, averaging 76.4% of the adult pairs identified during spring staging. The proportion and the recorded number of pairs in the breeding area varies not only due to numbers actually present but also the timing of the survey and the phenology that is also affecting the number of pairs found. During pre-laying and early egg laying period the pairs stay away from the nest site and can readily be found feeding in the marshes within the study area as long as it is not totally covered with snow. After the incubation starts, the behaviour changes radically and the guarding male can also be hiding in the vegetation and then be very difficult to locate even by telescope from long distance. The relatively low number of pairs located during the last three years (**Figure 3**) is probably the result of a late commencement of the survey as intended, as we wanted to get a better understanding of area/habitat use by nesting/brooding birds and more importantly, their behaviour. In 2016 one nest was located and inspected for clutch size and stage of the incubation. Compared with the 1990's, a notable difference is the larger amounts of young non-breeders observed during the surveys. In 2016 altogether 45 young birds were observed, while the average is 15.9 ind. for the years 2008-2016 (Red Fox culling years). In strong contrast: only one non-breeder was observed in the preceding years 2006-2007. In the period 2008-2009, we had no observations of non-breeders.

We do not present the data here, but it is worth noting that the increasing LWfG population, as observed at the Valdak Marshes spring staging site, has also lead to a recolonization of two former breeding areas and possibly a third new area during the last 2-3 years.

3.3 Production

The number of goslings produced has varied between 2 to 74 (**Figure 4**). The production is cyclic with "good" and "bad" breeding years in a 4-7 year cycle, with 1995 and 2015 standing out as the best years in absolute numbers. However, a better understanding of the variation in gosling production is possible when comparing years that are independent of population size. Dividing the annual number of goslings produced, by the number of potential breeding pairs identified pre breeding, shows the equal relative reproductive rate of the years 2002, 2007, 2010, 2011 to 1995 and 2015 (**Figure 5**). There is no trend in these data, but for those pairs that successfully produce goslings to fledging; the average brood size has increased from 3.04 to 3.37 goslings in the years after culling started, - an increase of 11%. Also these data are part of more specific modeling and analyses that we do not present here as not only culling efforts play a role, but so do also changes in lemming/rodent densities and changes in demographics in the LWfG population as it is changing from a decreasing to an increasing phase.

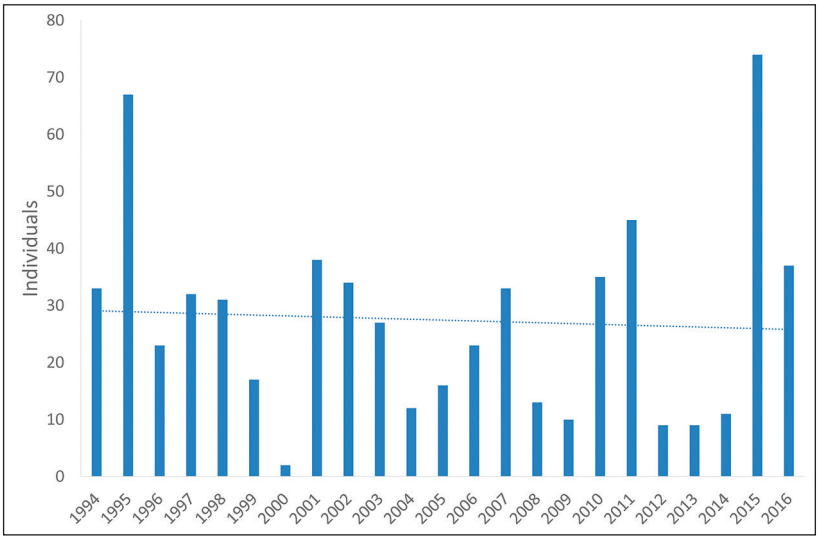

Figure 4. *Total number of Lesser White-fronted Goose goslings observed at the Valdak Marshes, Finnmark, Norway in the years 1994-2016.*

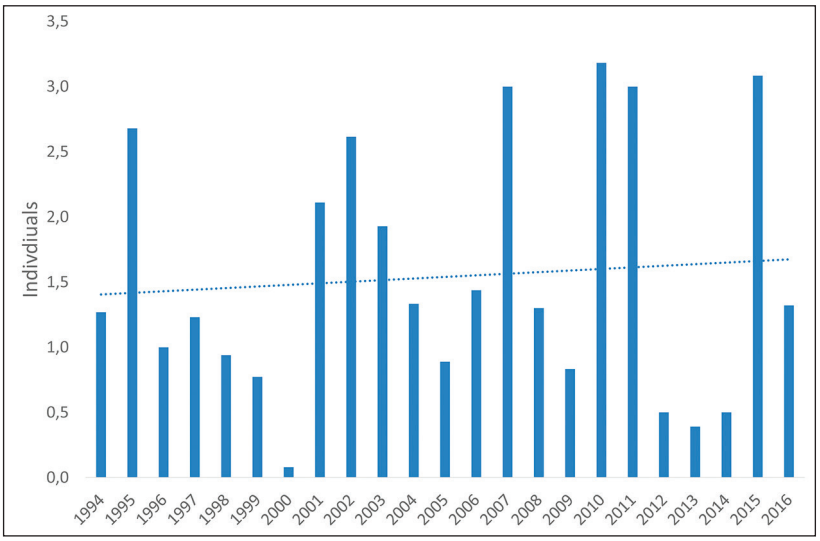

Figure 5. *Number of young produced per adult Lesser White-fronted Goose pair (potential breeders) present during spring staging at the Valdak Marshes, Finnmark, Norway in the years 1994-2016.*

The number of successfully reproducing pairs has increased by 2.5% from 46.1% to 47.3%. However, as was the main target for the Red Fox culling project, the largest change has come about through the percentage of the adult birds returning to the post breeding staging site in the Porsanger Fjord in late summer, independent of whether they produced goslings or not. This return rate has changed from ca 70% to 89%, a 29% increase.

Red Fox marking territory within the core breeding area of the Lesser White-fronted Goose.
© Ken Gøran Uglebakken

3.4 Culling of Red Fox

In Norway, 908 Red Foxes have been culled in total through the culling program run by the Norwegian Nature Inspectorate (SNO) in the years 2008-2016, averaging 101 ind. annually (**Figure 6**). However, 59% of these were shot in just two years (2012 and 2016), both following a lemming/vole peak year (in 2011 and 2015 respectively).

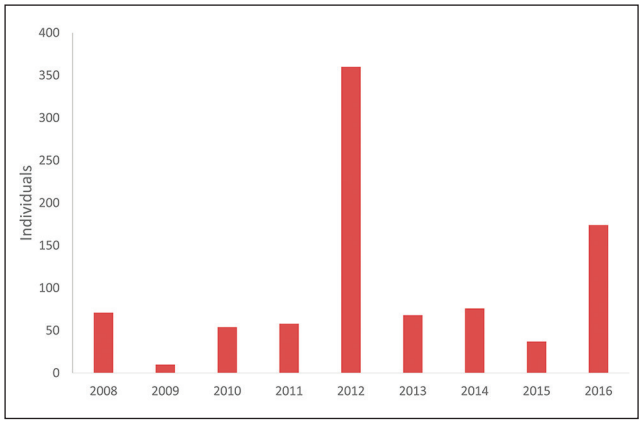

Figure 6. *Number of culled Red Foxes in the core breeding area for the Lesser White-fronted Goose in Finnmark, Norway.*

Vole and lemming density data are available for the core breeding area but are under analysis and are not presented here.
In Northern Finland, a similar Red Fox culling program has been running in the years 2003-2016, mainly in four former important LWfG breeding areas (Pöyrisjärvi, Paistunturi, Kaldoaivi and Käsivarsi wilderness areas). A total of 2,971 Red Foxes have been culled, averaging 202 individuals annually (**Figure 7**).

Research on lemmings and voles has been carried out in the core breeding area for LWfG in Finnmark Norway since 1977 (Olofsson et al. 2014). A resembling research project on birds and rodents has been running in Northern Finland in the Kilpisjärvi area (Lehikoinen et al. 2016). Here the peak rodent years were 2007, 2010 and 2015 (**Figure 8**), corresponding with a considerable increase in numbers of culled Red Foxes in the following years. There is no correlation between numbers of culled Red Foxes and rodent density in the same year. However, rodent density can explain 10% of the variation in numbers of culled Red Foxes the following year and 48% of the increase in numbers of culled Red Foxes two years later. As expected, there is no correlation between these factors in the third year (**Figure 9**).

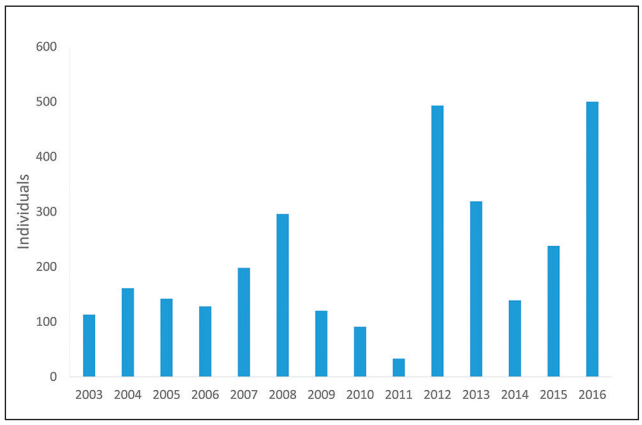

Figure 7. *Annual number of Red Foxes culled in Northern Finland in the years 2003-2016.*

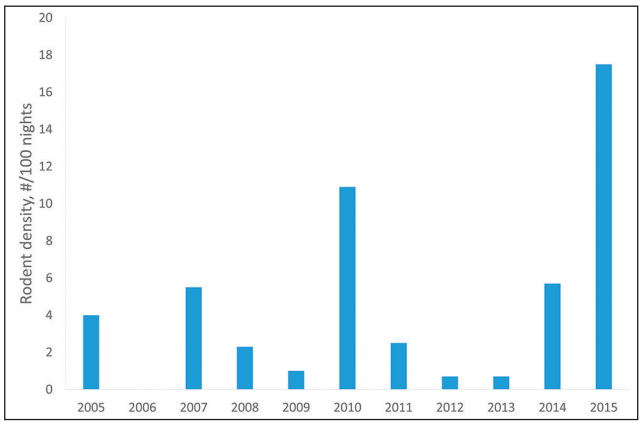

Figure 8. *Rodent density (number of rodents per 100 trap nights) in Kilpisjärvi area, Northern Finland (after Lehikoinen et al. 2016).*

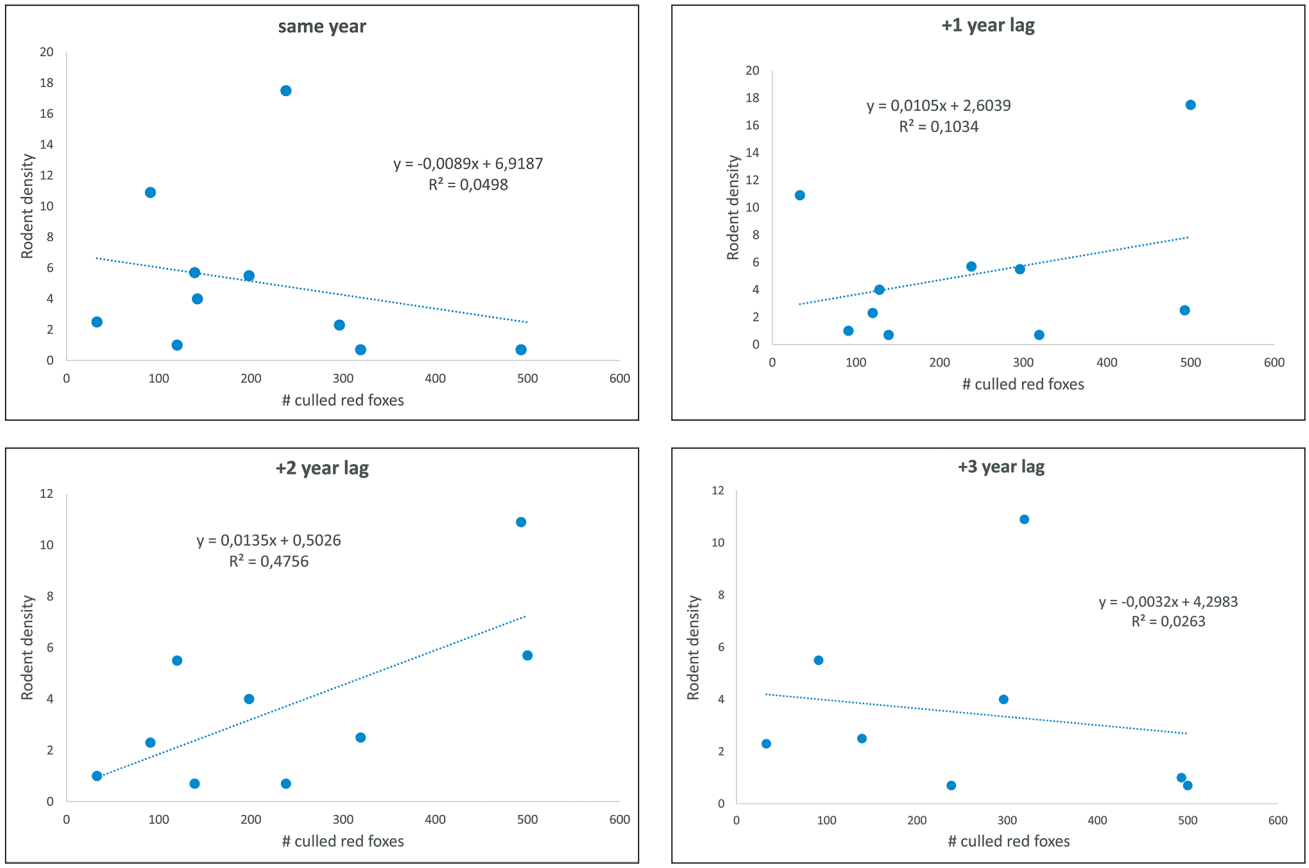

Figure 9. *The correlation between rodent density and number of culled Red Foxes in Northern Finland in the years 2003-2016 with zero, one, two years and three years lag.*

4. Discussion

The Fennoscandian LWfG population faces a multitude of threats. From poaching and accidental killing during migration and wintering periods, to loss of habitat and possible negative influence on genetic composition and behaviour from reintroduction projects that are working across internationally agreed conservation priorities (Øien et al. 2017). During the breeding season, also anthropogenic factors play a negative role through loss of habitat, disturbance and increased predation through a human-related high density of Red Foxes as well as the impending negative effects of changes to vegetation and weather through climate change. Red Fox culling is a temporary makeshift, carried out while more permanent conservation actions can be implemented at all important staging, wintering and breeding areas for the Fennoscandian LWfG population. Habitat loss and illegal killing are the most important negative factors that need to be addressed for the recovery of this population.

To understand the population dynamics in the Fennoscandian LWfG, it is important to know how the various factors influence the population numbers. There is a lag of 2-3 years after a good production year, before a LWfG (from birth to being a prospective breeder) enters the breeding population and contributes positively to the measured population development. In contrast, in a bad breeding year where >50% of the population undertake a moult migration to Russia (Aarvak & Øien 2003), the subsequent increased mortality of subadults and adults has an immediate negative impact on the population. In addition to the lag in recruitment into the breeding population, there is also a lag in the Red Fox population dynamics from a lemming/rodent high year and to the point in time when the Red

Lemming, Lemmus lemmus. © Karl-Otto Jacobsen

Fox becomes very abundant and so proportionally negatively affecting ground breeding bird species (**Figure 9**). The key driver in the system is the population dynamics of lemmings and rodents; however, these are poorly understood despite decades of research. During the past two decades, the population cycles in voles, grouses and insects have been fading out in Europe (Ims et al. 2008) and recent evidence indicates that changes have already taken place in the dynamics of some key herbivores and their predators, consistent with the expected impacts of climate change (Ims & Fuglei 2005, Ims et al. 2008).

This further obscures causes and effects in the population trend of the LWfG. Analyses on these relationships as well as the effect of Red Fox culling is now underway, so few details are presented in this article.

At present, the Fennoscandian LWfG population has taken a small step away from the very brink of extinction, but further conservation work is highly needed. To further understand the mechanisms and effects of climate change, predation and cyclic nature of environment on the population dynamics of the Fennoscandian LWfG, more fundamental research is needed. In 2016, BirdLife Norway joined the Norwegian research programme "Sustainable management of renewable resources in a changing environment: an integrated approach across ecosystems" (SUSTAIN). Here the monitoring data on Fennoscandian LWfG from Norway will be incorporated into one of six case studies to model the effects of climate change and culling of Red Foxes in the breeding areas upon the population development of the LWfG. This will hopefully lead to even better knowledge and improved conservation actions in the future.

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Mixed flock of Greater White-fronted and Lesser White-fronted Geese in flight in Northern Kazakhstan. © Nicky Petkov

The Lesser White-fronted Goose in Greece

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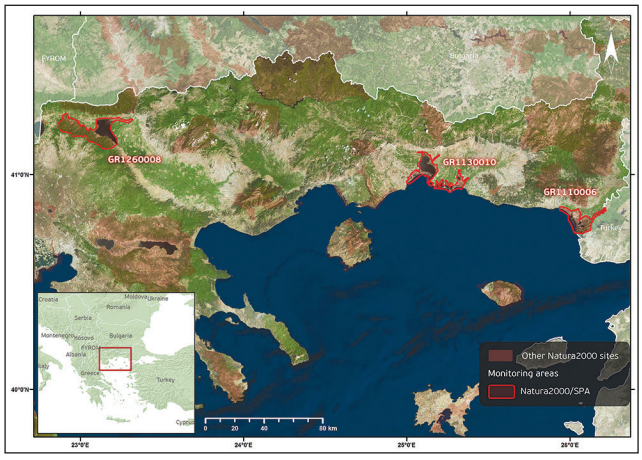
The entire Lesser White-fronted Goose Fennoscandian population of the 2014 autumn-winter season (53 individuals) at Kerkini Lake, in a single shot.
© Kostas Papadopoulos, Management Authority of Kerkini Lake National Park, 14/11/2014



Map 1. *The three project sites in central Macedonia and Thrace, Greece.*

1. Introduction

The Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) continues to be one of the most endangered waterfowl species in the Western Palearctic. Ongoing conservation efforts and systematic monitoring of the wintering population in Greece are now completing a 20-year venture that aims to understand the phenology of the LWfG. Mainly found in central and eastern Macedonia and Thrace, the species has seen its natural habitat shrink significantly, fragmentized and heavily disturbed by continuous human presence. Confined in suitable natural habitats, nowadays only in Kerkini Lake and Evros Delta, the species appears regularly each winter from early October until the middle of March. The number of LWfG observed in Greece during the last decade is somewhat stable with observed numbers ranging from 35 to 75 (average 54 ± 11) individuals. The 2015-2016 wintering period has proven to be exceptional, with a total number of 144 LWfG observed overall and record numbers for each site independently (85 ind. in Evros Delta, 118 ind. in Kerkini Lake). It was also one of the longest wintering periods for the LWfG in Greece, counting a total of 168 days. Subtle shifts in the wintering phenology of the LWfG are apparent during the past wintering periods (2010-2016) triggering speculations of a possible tendency of climate change adaptation and microhabitat favoring. The aim of this article is to present the monitoring data collected during 2011-2016 within the framework of the LIFE10 NAT/GR/000638 project and to bridge past and current knowledge regarding the wintering pattern of the LWfG in Greece.

2. Study area and Methods

2.1 Monitoring areas

Monitoring was focused in the main wetlands where the LWfG are found, primarily in Kerkini Lake and Evros Delta and secondarily in Ismarida Lake. Further monitoring visits were also conducted at areas such as Lakes Koronia and Volvi and the Nestos Delta, where the species had been found in the past. These areas belong to the Natura 2000 Network, are characterized as National Parks and also contain Wildlife Refuges. In order to protect the LWfG from accidental shooting and illegal killing, goose hunting has been banned within the SPA boundaries of these areas since 2012.

Overview of Kerkini Lake. The LWfG flock can be seen feeding at the extended grasslands revealed by the lake's water withdrawal. © Lavrentis Sidiropoulos /HOS, 2016

a) Kerkini Lake:

Is the first stop-over site for the LWfG arriving early to mid-October. Kerkini Lake (N 41o12', E23o 09') is a large semi-natural wetland/ freshwater reservoir, which is supplied from Strimonas river. The reservoir serves three main purposes; flood protection, irrigation for the valley of Serres and nature conservation. The protected area includes apart from the lake, remnants of riparian forest along the banks and the mouth of Strimonas River, wet meadows and flooded areas surrounded by forested mountains. The LWfG feeding and roosting areas here consist of sparsely vegetated alluvial surfaces at the northeast part of the lake, revealed during winter period by the lowering of the lake's water level (Panagiotopoulou et al. 2009).

Typical habitat of the LWfG in Evros Delta, Dimitriadis meadow. © Dimitris Kokkinidis, 2015

b) Evros Delta:

The LWfG leave Kerkini Lake in mid-December / early January and arrive in Evros Delta, where they usually stay until departure to their breeding areas (early to mid-March). The Greek side of Evros Delta (N 40o 52', E 26o 00') includes halophytic marshes, reed beds, tamarisk shrub, grasslands, various cultivations, riparian woodland, as well as wet and dry meadows. It also includes the coastal lakes Skepi and Nymfon and the lagoons Paloukia, Drana and Laki. Major activities in the area include livestock breeding, agriculture and fisheries. Furthermore, the area is one of the most popular waterfowl hunting areas in Greece. Wintering LWfG habitat consists of halophytic marshes, wet meadows and natural grasslands (almost exclusively Dimitriadis meadow and Paloukia lagoon) (Panagiotopoulou et al. 2009).

Wet meadows in Ismarida Lake area. © Savas Kazantzidis

c) Ismarida Lake:
Belongs to the National Park of East Macedonia and Thrace along with Vistonida Lake and Nestos Delta. The area has lost its importance for the species since 1999 due to intensive hunting, disturbance caused by road improvement and degradation of the wet meadows at the eastern part of the lake. Prior to 1999, the LWfG overwintered in the area in significant numbers (40-43 individuals). Ismarida Lake (N 40o59', E 25o19') is a natural shallow freshwater lake, surrounded by extensive reed beds and cultivations, coastal lagoons (Karatza, Aliki, Ptelea and Elos), salt marshes and wet meadows. The main habitat of the LWfG included the salt marshes east of the lake, the wheat fields close to the lake as well as the reservoirs north of Ismarida and the areas close to Elos and Ptelea lagoons (Panagiotopoulou et al. 2009).

2.2 Monitoring method

Monitoring took place at Kerkini Lake and Evros Delta from early October until late March, two to three times per week, for five consecutive winter periods (2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016). Ismarida Lake was monitored during early January until February with further visits when the LWfG flock could not be observed in the other project areas. Other areas were also monitored irregularly, when some or all the LWfG went missing from the monitored sites. Monitoring was supported by each area's Management Authority (MA) and the LWfG were observed by 20-60x and 90x telescopes from suitable positions. During a monitoring visit the area was scanned for geese flocks, with focus to all known sites the LWfG visit. Data collected included, position of the flock relatively to the observer, number of juveniles and adults observed, number and size of discrete sub-flocks, number of families/pairs, position in mixed geese flocks, behavior/activity, other species of geese present and Color Ring Codes (CRC). When observation conditions were favorable, videos of the flock were captured in order to isolate and identify individual LWfG from their distinctive belly patches. Observation distances were on average between 500-800m. Since winter period 2014-2015, monitoring was supported by the use of tablets in the field and customizable applications in the form of electronic protocols. These protocols automatically collected data such as the observer's position, date and time and contained all the relevant data fields described above.

3. Results

3.1 Definitions

A winter period is defined as the period commencing from the moment the LWfG flock arrives in Greece until the moment that it departs, usually from October of one year until March of the following year. Similarly, the population wintering is defined by the maximum number of LWfG individuals observed simultaneously in the same or in distinct areas. The maximum estimated number of individuals wintering in Greece is derived by the true maximum number observed plus an added number of individuals bearing identification marks such as CRCs that have been observed in one area but not in another. In most of the following graphs, data from previous monitoring years are also included with the year 1996 taken as the reference year; at which monitoring of wintering LWfG became more systematic through the implementation of a LIFE project (LIFE96 NAT/GR/003217).

Lesser White-fronted Geese in Kerkini Lake riparian forest. © Lavrentis Sidiropoulos/HOS

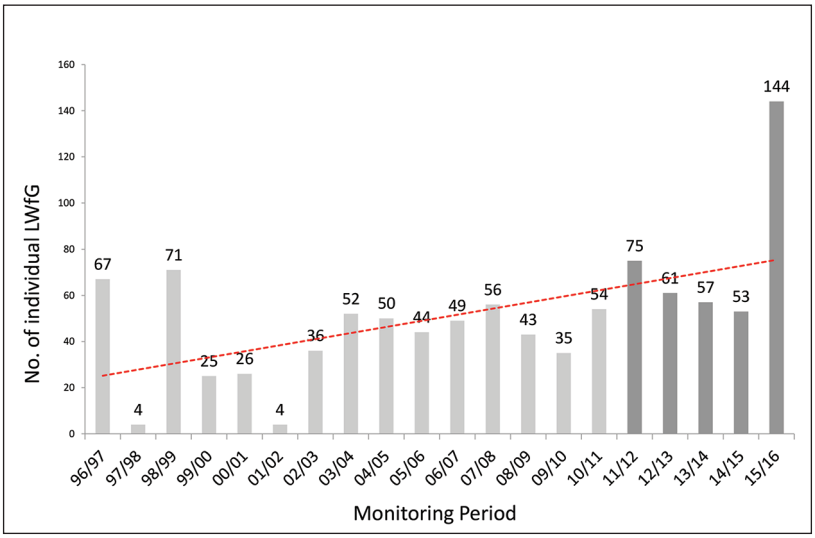


Figure 1.
Maximum number of wintering LWfG observed simultaneously during monitoring periods in Greece (1996-2016).

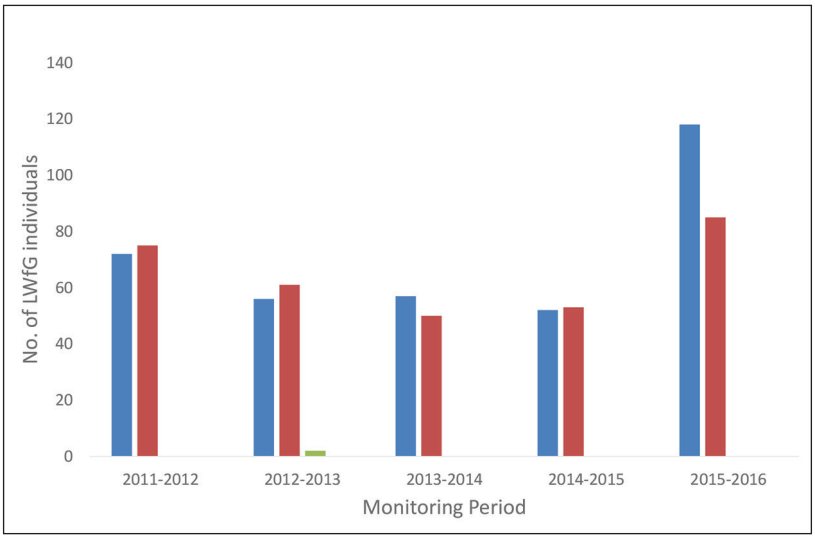


Figure 2.
Maximum numbers of LWfG individuals per site and year (2011-2016). With blue colour the numbers in Kerkini Lake, with red in Evros Delta and with green in Koronia Lake.

3.2 Wintering population

The LWfG population wintering in Greece between 2011 and 2016 ranged from 53 individuals to 144 (**Figure 1**), the latter being the highest number of LWfG observed since 1988 when 116 individuals were seen at Evros Delta (21/01/1988) (Handrinos & Goutner 1990). The numbers appear to be steadily increasing despite the various peak numbers during some monitoring periods that affect the overall trend line (year 2011-2012 and 2015-2016). Examining a complete series of monitoring data dating back to 1996 until 2015-2016, it can be observed that there is a distinct five-year cycle in the LWfG numbers observed in Greece (**Figure 1**) starting from 2003-2004 (year 1) until 2015-2016 (year 5).

Between 2011 and 2016, the maximum number of LWfG was mostly observed in Evros Delta with one exception during 2013-2014 where 57 LWfG were observed in Kerkini Lake and during 2015-2106 when a total 144 individuals was the result of simultaneous monitoring in Kerkini Lake (114 ind.) and Evros Delta (30 ind.) (**Figure 2**). No further observations came from Ismarida Lake since 2006 (1 LWfG observed on 3/2/2006), which seems to have lost its importance for the species. During winter period 2012-2013, a single LWfG was observed among a flock of 500 Great White-fronted Geese (GWfG) in Koronia Lake (20/01/2013) while on 25/01/2013 2 LWfG were reported by the Koronia-Volvi Management Authority at the same site **www.piskulka.net/**. Additionally, an observation in Lake Koronia by the MA's staff in 2014-2015 (9/2/2015), where 42 unidentified geese were seen flying at the western part of Koronia coincide with the time and number of LWfG that were missing (Lila Karta, MA of Koronia-Volvi Lakes National Park, pers. com.); indicate that this area might also be a stop-over site.

Among the wintering population of the LWfG, juvenile birds were also observed, although recording the age of the individuals in the flock has proven to be demanding, due to poor visibility (haze, fog, tall grasses), long observation distances and advanced development of juveniles by January (white blaze already developed). Numbers of juveniles appear also stable with the exception of 2015-2016 were a total of 55 juveniles was observed in Kerkini Lake (**Figure 3**). The percentage of juvenile LWfG during the monitoring period ranges from 8.8% to 18.9% until 2014-2015, while in 2015-2016 the percentage reached 38.2%.

Since 1997 when the first record of juveniles was made possible, the rate of juvenile observations in wintering LWfG flocks in Greece is quite low compared to the Valdak marshes during autumn, ranging on an average less than 25%. Up until 2013, most juvenile observations came from Evros Delta (5.3 ± 4.3 juv.) and since winter period 2013-2014 most juveniles are ob-

served in Kerkini Lake (**Table 1**). The rate of juvenile observations in Greece for the season 2015-2016 rose to 78% of the total number of juveniles observed in the Valdak marshes, which is far from the previously recorded rates. An exception is also observed during 2012-2013 when 11 juveniles were recorded in Evros Delta, while in Valdak marshes only 9 juveniles were recorded.

	Greece	Kerkini Lake	Evros Delta
Average juvenile individuals/ year (1997-2013)	4.9 ± 3.7	3.9 ± 1.8	5.3 ± 4.3
Average juvenile/year (1997-2016)	5.8 ± 1.3	8.3 ±6.2	3.0 ± 3.3
observed juveniles 2011 – 2012	9-11	9-11	-
observed juveniles 2012 – 2013	4-11	4-5	11
observed juveniles 2013 – 2014	1-5	1-5	2
observed juveniles 2014 – 2015	8-10 (2 unidentified)	8-10 (2 unidentified)	-
observed juveniles 2015 – 2016	55	55	-

Table 1.
Juvenile observations in Greece.

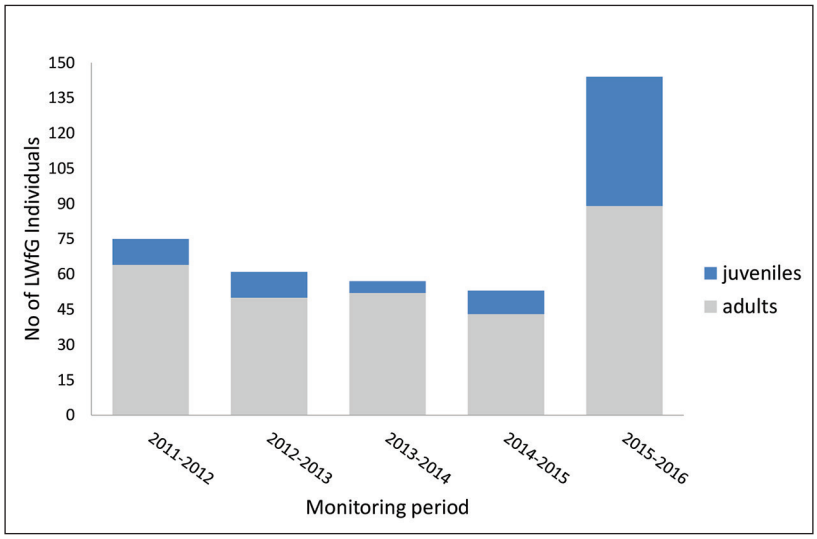


Figure 3.
Numbers of juvenile LWfG individuals among the maximum individuals observed during monitoring periods 2011-2016.

3.3 Flock associations

Regarding flock association with the other species of geese, mainly the GWfG, the LWfG show a tendency to remain separate from other goose flocks. During 2013-2016, in most occasions, the LWfG were separate (62%) while in only 38% of occasions the flock was observed mixing with other species. Even so, the LWfG flock was mainly observed at the edge of the mixed flock (75%) and less often dispersed within it (25%) as single birds.

3.4 Timing and movements during wintering period

During the five consecutive monitoring periods the LWfG progressively arrived on early October in Kerkini Lake (2014-2015 observed on 1/10/2014, earliest ever recorded in Greece at the time). Moreover, since 2013-2014 it has been observed that after arriving in Evros Delta the LWfG spend a shorter period of time there and return in Kerkini Lake in late January, from where they depart to their breeding grounds (**Figure 4**). More surprisingly, at the beginning of winter period 2016-2017 the first 41 LWfG were observed in Kerkini Lake on 15/9/2016.

Lesser White-fronted Goose (individual from captivity).
© Chris Vlachos

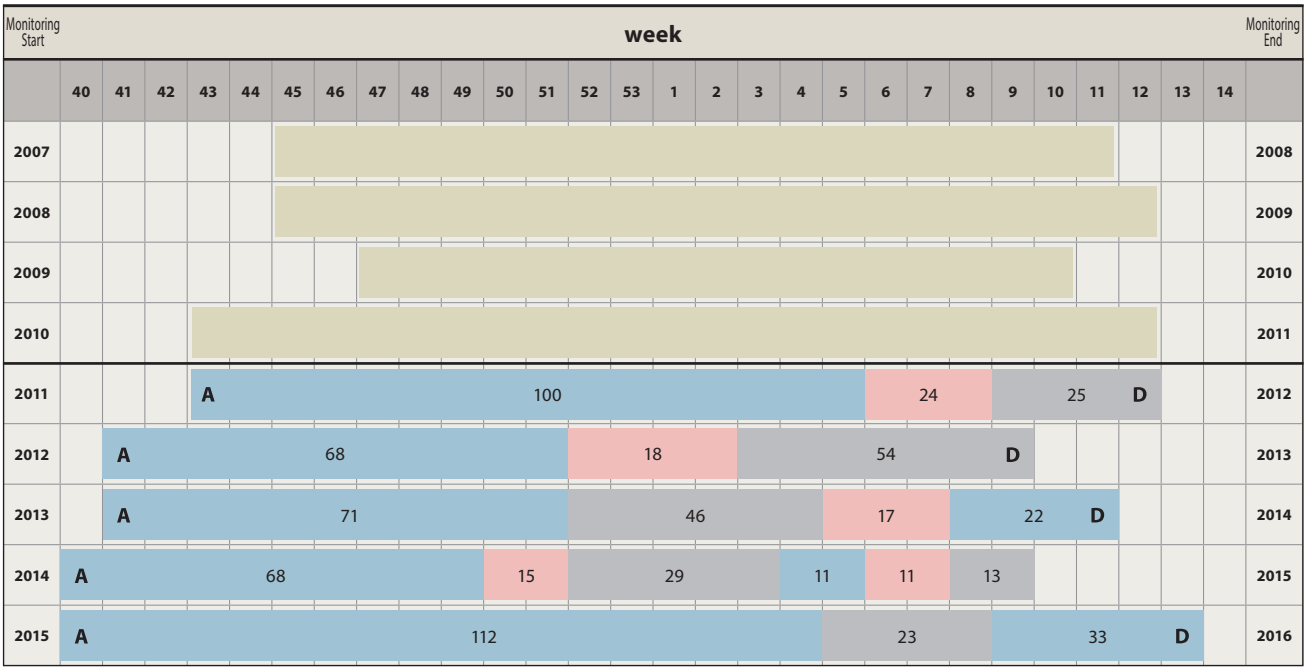


Figure 4. *Annual wintering period of LWfG in Greece.*
A: *arrival week,* ***D:*** *departure week,* ***Blue:*** *time spent in Kerkini Lake (days) -* ***Grey:*** *time spent in Evros Delta (days) -* ***Pink:*** *missing period (days).*

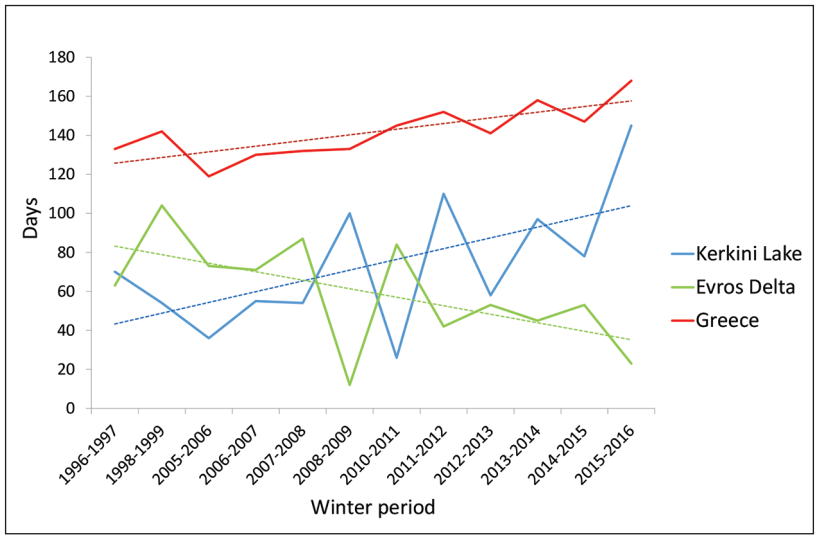


Figure 5.
Total number of days the LWfG spent in Greece and in the two project areas.

On average, the LWfG spent 152 ± 10.6 days in Greece during the five wintering periods, from which 97 ± 29.6 in Kerkini Lake and 38 ± 13.5 in Evros Delta. It has been observed in various winters that the flock visits an unknown site for a period of 21. 3 ± 4.4 days, during which, it is not observed in any of the known sites (**Figure 5**).

2011-2012:
The first LWfG were observed in Kerkini on 19/10/2011. The flock remained in Kerkini Lake until 5/2/2012 and on 6/2/2012 the LWfG appeared in Evros Delta. The flock was not found in any site between 10 and 22/2/2012. The last observation for this period was in Evros Delta on 18/3/2012. The maximum number of the LWfG flock was 75 LWfG individuals, observed in Evros Delta on 12/3/2012. The estimated max number for the period was 78 individuals with an addition of three CRCs.

2012-2013:
During this period the first flock of 12 individuals was observed in Kerkini Lake on 13/10/2012. The last observation for this area was on 9/12/2012 whilst, the first LWfG were observed in Evros Delta on 9/1/2013. Maximum count was observed on 10/1/2016 when 61 LWfG were observed in Evros Delta. The last observation of the flock was on 2/3/2013. Two LWfG individuals were also seen in Koronia Lake on 25/1/2013. No LWfG were observed in any site during 22/12/2012 and 9/1/2013.

2013-2014:
The LWfG flock was first observed at Kerkini Lake on the 6/10/2013 when 29 individuals were observed. The flock remained in the area until 15/12/2013 and on 20/12/2013 it was observed in Evros Delta. The LWfG flock could not be located in any site for a period of 16 days (1/2/2014-16/2/2014). On 17/2/2014 57 individuals reappeared at Kerkini Lake where they remained until 12/3/3014. The maximum number of LWfG was recorded in Kerkini Lake whilst in Evros Delta the maximum number of individuals observed was 52 on 2/1/2014.

2014-2015:
The 44 LWfG were first observed in Kerkini Lake on the 1/10/2014. On 1/11/2014 the LWfG increased to 50 and remained in the area until 6/12/2014. In Evros Delta the first LWfG were

seen on 22/12/2014 following a missing period of 15 days. The flock remained in Evros Delta until 19/1/2015 and then on 21/1/2015 the geese moved back to Kerkini Lake. On 11/2/2015 the LWfG returned to Evros Delta due to heavy rainfall and subsequent flooding of Kerkini Lake. The last LWfG departed from Evros Delta on 24/2/2015. The maximum count of LWfG for the period was 53 individuals although according to CRCs observed in both areas, the estimated maximum number was 55 individuals (2 additional CRC observed in Kerkini Lake).

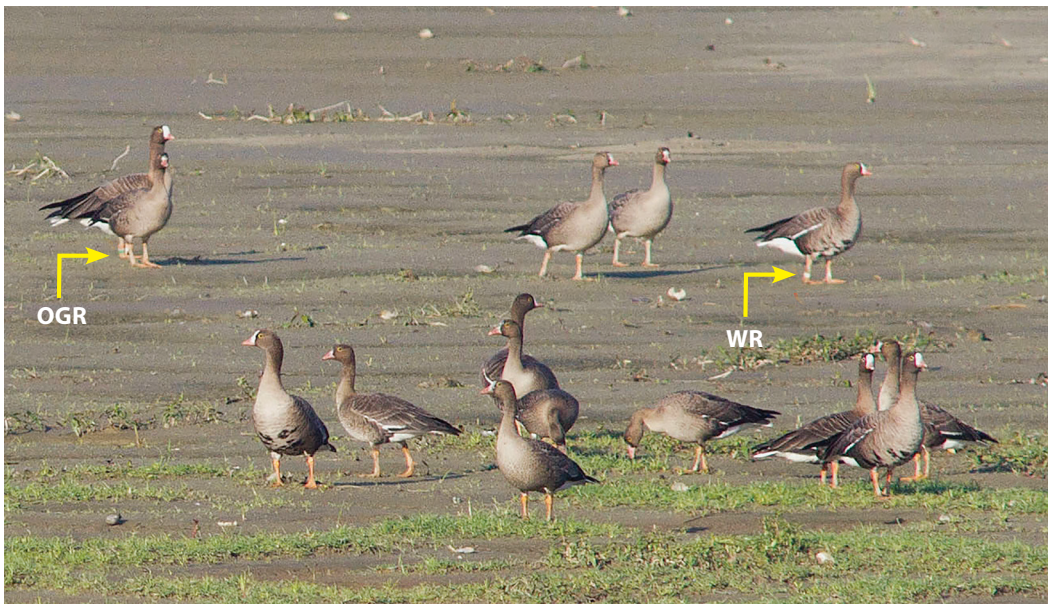
2015-2016:
The first 104 LWfG individuals were observed in Kerkini Lake on 2/10/2015. Until 22/1/2016 112 individuals remained in Kerkini Lake. On 29/1/2016 85 individuals were recorded in Evros Delta with 36 LWfG being observed in Kerkini the following day (30/1/2016). The maximum number of LWfG was observed on 15/2/2016 when 114 individuals were found at Kerkini Lake and 30 LWfG in Evros Delta totaling 144 LWfG individuals.

3.5 Colour code observations

In Greece, the first observation of a Colour Ring Code (CRC) was made in Kerkini Lake on 7/11/1996. Since then, there have been 395 observations of 29 different CRC (Aarvak et al. 2009). During 2011-2012, a total of 5 CRC were identified in Greece; 5 in Evros Delta and 1 in Kerkini Lake (**Table 2**) from which the code White Right (WR) was recorded in Evros Delta for the first time. During 2012-2013, in total 8 CRC and 1 unidentified code were observed in Greece. The following period 2013-2014, 5 CRC were observed in total in Greece. It has been noted by observers that CRC individuals with codes WR and Orange Green Right (OGR) were probably a pair. During winter 2014-2015 a total of 5 ringed birds were observed in Greece with only 3 CRC being identified in Evros Delta. The next winter period, 2015-2016 there were 5 CRC observed only in Kerkini Lake, one of which was the bird named Finn (Orange Red Left) first ringed in 2006. The pair OGR-WR was observed along with 3 juveniles (see photo).

	2011-2012		2012-2013		2013-2014		2014-2015		2015-2016		
Colour Ring Code	**E**	**K**	**E**	**K**	**E**	**K**	**E**	**K**	**E**	**K**	**Total obs. per CRC**
BL	4		2	4	2	10		1		1	**24**
GL				1							**1**
GR	4										**4**
OGR	4		1	8	3	10	2	1		23	**52**
OL			1	3	1	11	2	2		14	**34**
OR				1							**1**
ORL	2	3									**5**
RGR				1							**1**
RR				1							**1**
WR	2		2	5	2	10	1	2		23	**47**
Total obs. per year/area	**16**	**3**	**6**	**24**	**8**	**41**	**5**	**6**	**-**	**61**	**170**
CRC's per year & area	**5**	**1**	**4**	**8**	**4**	**4**	**3**	**4**	**-**	**4**	**29**
Unidentified	**2**	**11**	**1**	**4**	**3**					**1**	**29**

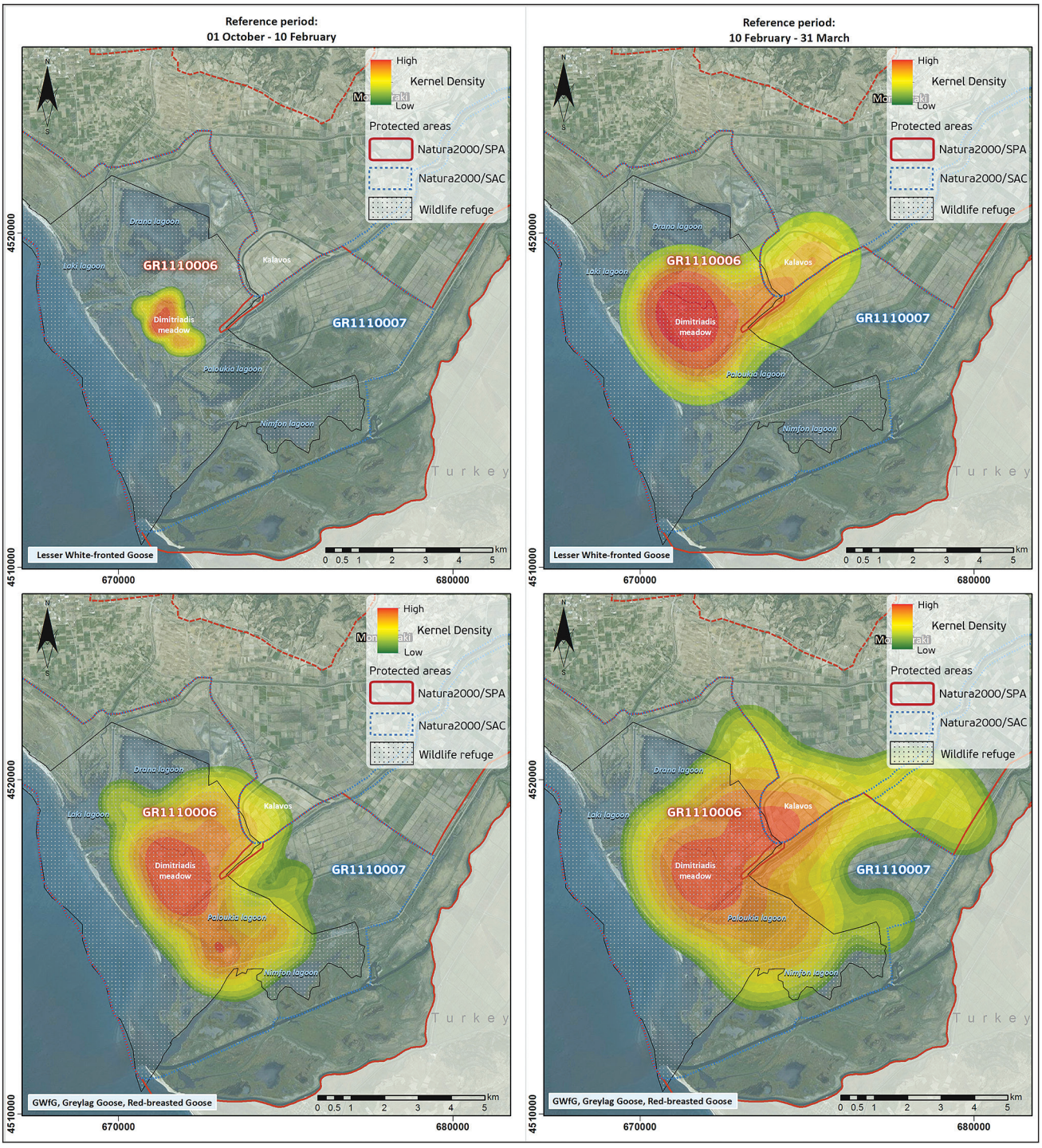
Table 2.
*Colour Ring Code observations during 2011-2016 in Evros Delta (**E**) and Kerkini Lake (**K**).*



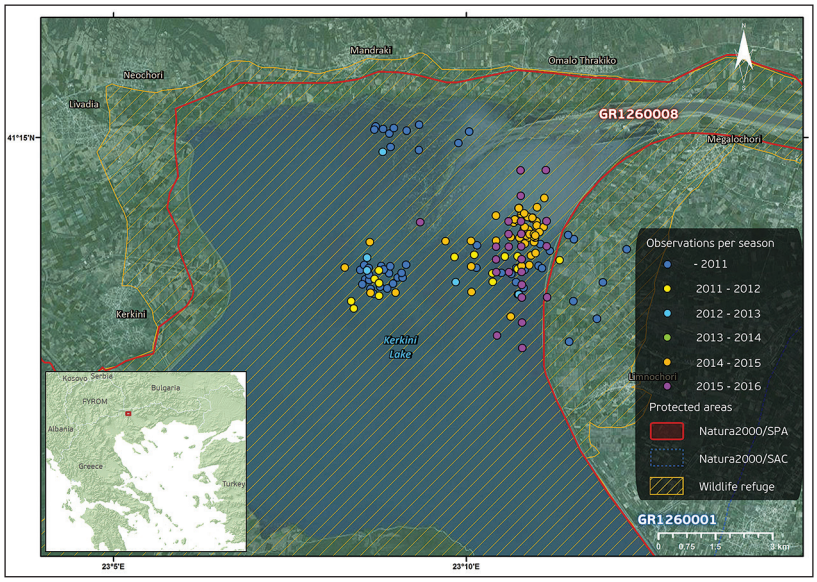
The pair holding codes OGR and WR with three juveniles in Kerkini Lake 2015-2016.
© Kostas Papadopoulos/ Management Authority of Kerkini Lake National Park

3.6 Hunting activity and Lesser White-fronted Goose distribution

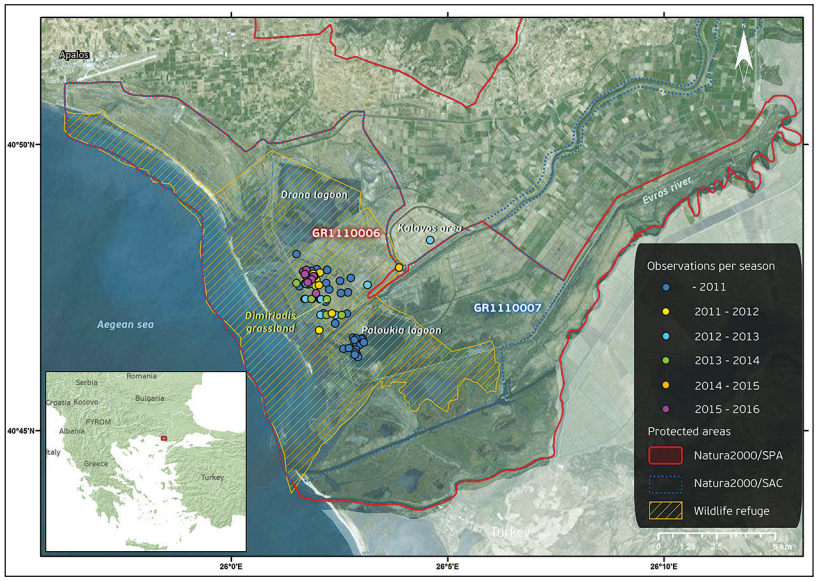
A limiting factor for the distribution of geese and LWfG specifically in Evros Delta continues to be the direct effect of hunting activity. It has been observed that geese remain within the Wildlife Refuge boundaries and disperse to other suitable areas when the hunting season is over. This conclusion is supported by the delineation of the area boundaries used by geese in terms of time and space. Kernel density surfaces were estimated by applying KDE (Kernel Density Estimation) algorithm in Geospatial Modelling Environment (Version 0.7.4.0/built on R language) and ArcGIS 10.3 (ESRI). The calculation is based on the primary monitoring dataset (species presence points) after the implementation of the Gaussian kernel (bivariate normal) distribution option of the KDE algorithm toolbox. The density surface allowed the determination of the spatiotemporal habitat use by the LWfG, GWfG, Greylag Goose *Anser anser* and Red-breasted Goose *Branta ruficollis* in Evros Delta, during and after the end of the hunting season. The calculation has revealed that the geese use an extended area when disturbance from hunting stops (**Map 2**).



Map 2. *LWfG (top row) disperse in a larger area after the end of the hunting season while the other geese (bottom row) also use a much larger area (data from 2011-2012 until 2014-2015 monitoring seasons).*



Map 3. *Distribution of LWfG in Kerkini Lake 1991-2016.*



Map 4. *Distribution of LWfG in Evros Delta 1996-2016.*

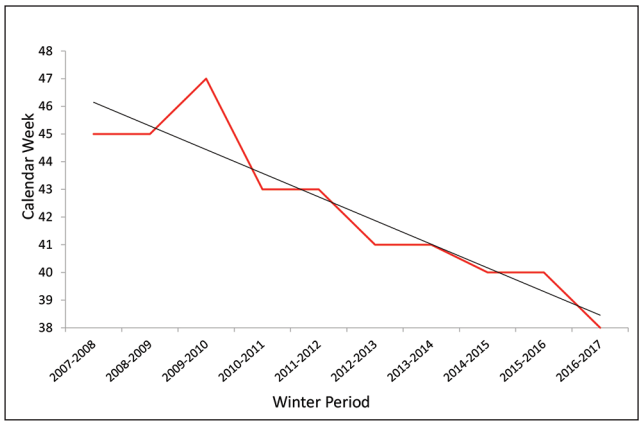


Figure 6.
Arrival week of the LWfG in Greece during 2007-2016.

4. Discussion

During the LIFE+ Project's duration, a tendency for the LWfG to arrive in Kerkini Lake earlier every season has been observed. Since no difference has been observed on the date of departure, the overall period spent in Greece is progressively expanding to almost an additional 4-week period (**Figures 6 & 7**). Similarly, departure dates might be influenced by the percentage of juvenile individuals among the population (**Figure 8**), while the LWfG seem to favor Kerkini Lake to Evros Delta since the time spent to the later site is reduced. The reduced numbers or complete absence of LWfG in most years during January-February, indicate that the flock visits an unknown site, which despite ongoing efforts, has not been identified. Monitoring effort should focus in covering other possible sites and to intensify during "missing periods" in areas that the species had previously been recorded or that match the preferred habitat profile.

During the LWFG monitoring in Kerkini Lake, the LWfG mostly used the north eastern part of the lake and remained within the boundaries of the protected area (**Map 3**). In Evros Delta, the LWfG mostly remained within the Dimitriadis grassland, while some cases LWfG were observed on the border and even outside of the protected area (**Map 4**).

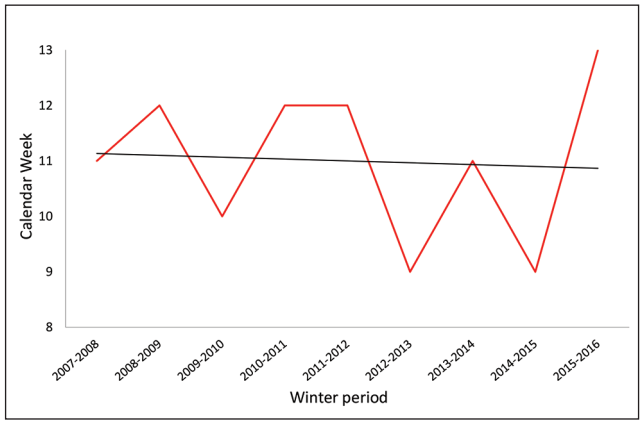


Figure 7.
Departure week of the LWfG in Greece during 2007-2016.

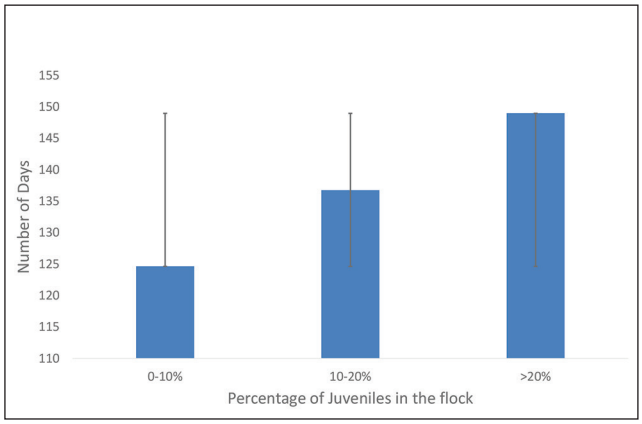


Figure 8.
Mean number of days spent in Greece relatively to juvenile presence in the flock. Data from 2005-2009 and 2011-2016.

Monitoring of the LWfG during 2011-2016 has helped increase awareness among different groups of people, which are the main users of these areas. It is worth mentioning that through various ornithological groups created over the past 5 years, many volunteers were interested in supporting monitoring efforts, by providing information on sightings of the species, quite often along with reliable photographic material. Strengthening this network, can support monitoring and speed in information exchange regarding the LWfG sites.

5. Acknowledgements

Monitoring of the LWfG population in Greece took place in the framework of the LIFE NAT/GR/000638 project, which is co-financed by the European Commission and the Norwegian Environment Agency. We thank the Management Authorities of Kerkini Lake, Ismarida Lake and Evros Delta National Parks for their support in the field and all the people who contributed to LWfG monitoring throughout these years. A special thanks to Kostas Papadopoulos, Panagiotis Ioannidis and Vasilis Terzis for their engagement in the monitoring scheme.

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Geese flying above the Dimitriadis meadow in Evros Delta. © Savas Kazantzidis

Status and numbers of the Lesser White-fronted Goose population in Bulgaria

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Greater White-fronted Geese in Bugras lakes in 2016. © Nicky Petkov / www.naturephotos.eu

1. Introduction

The Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) is a globally threatened species, listed as Vulnerable (VU) by IUCN (BirdLife International 2016). In Bulgaria, it is classified as critically endangered by the Bulgarian Red Data Book (Simeonov & Dereliev 2011) and is protected by the National Biodiversity Act. The species is breeding in the Palearctic and its western populations are wintering and staging mainly in southeastern Europe and the Middle East, while the eastern population winters in southern Asia, more or less exclusively in China. The species has three native populations, two of which naturally occur in Bulgaria during wintering and staging (Ruokonen et al. 2004, Simeonov & Dereliev 2011). Through the use of satellite telemetry and targeted surveys, it has been shown that they are both occuring in the country during spring/autumn migration and during winter (Jones et al. 2008). In the last 125 years, the species has been registered on more than 140 occasions in Bulgaria, but due to uncertainties and lack of high quality data, no good estimation of numbers and distribution could be provided. The main reasons are related to identification problems, especially with the lookalike/resembling Greater White-fronted Goose *Anser albifrons* (hereafter GWfG). Secondly, as the species occurs in low numbers and is very difficult to identify within the larger flocks of White-fronted Geese, specific monitoring is necessary in addition to the annual monitoring schemes for geese in Bulgaria where the LWFG is only registered by accident (Kostadinova & Dereliev 2001, Michev & Profirov 2003). In the present study, we report the results of five years of surveys of the LWfG in Bulgaria. We summarise here the species wintering population size and describe the most important sites for the wintering and staging in Bulgaria.

2. Study areas and Methods

The survey included wetlands in Bulgaria, where LWfG had been observed before and sites where significant and regular waterfowl numbers have been registered in the past years (Petkov & Mateeva 2012). These included: SPA "Pyasachnik reservoir", SPA "Zlatiyata", SPA "Batova"and Burgas lakes area, Svishtov – Belene lowland, Ovcharitsa reservoir, Danube plain, Struma valley and Northeastern Bulgaria (Shabla and Durankulak lakes) respectively (**Figure 1**). All the sites were chosen according to previous studies (Petkov et al. 1999, Petkov & Mateeva 2012), historical data and to additional criteria as well, i.e. the number of LWfG observations and the time of the observations.

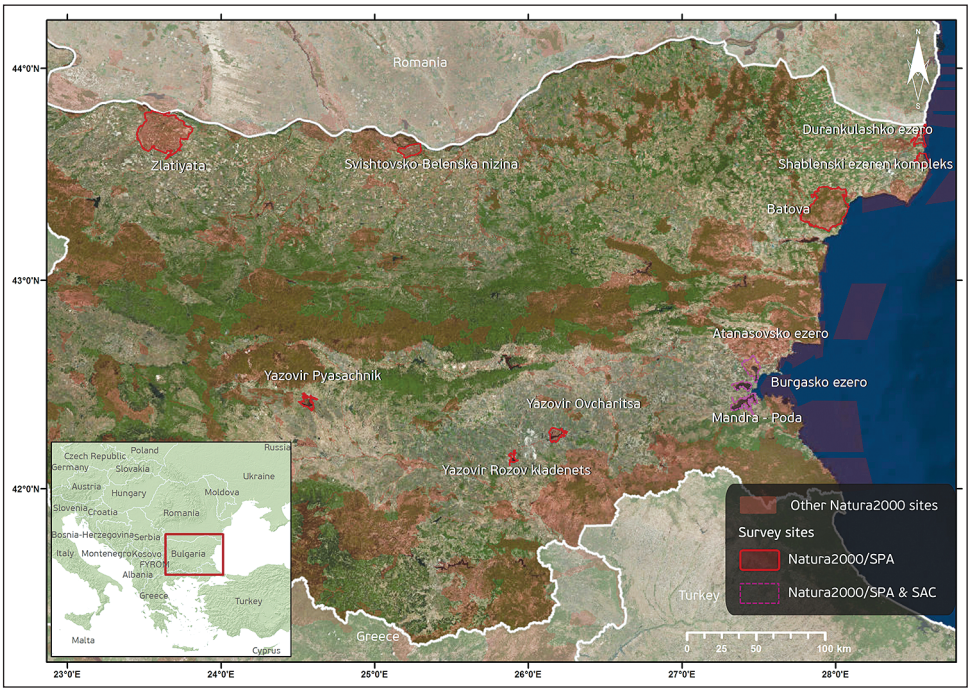

Figure 1.
Survey range and sites in Bulgaria.

The study was conducted between mid-October when the first flocks of geese begin to arrive in Bulgaria and mid-March when the geese start their migration north, for the years 2011-2016. The main aims of the survey were:

- To reveal the numbers and age ratio (when possible) of LWfG staging and wintering in Bulgaria
- To localize the most important feeding and roosting areas for LWfG and to assess possible threats for LWfG during the staging and wintering period
- To gather new and update the existing data for the species phenology in order to provide information for Environmental Impact Assessments compilation, Natura 2000 forms update, National Action Plan updates, wetlands and sites conservation measures proposals, nature conservation legislation changes and updates

The observations were made by continuous observations with binoculars and telescopes from the stationary observation points and using transect method in the selected areas, covering the whole day light period (Kostadinova & Dereliev 2001). Roosting sites of geese were counted in the morning. Usually the observers took their position before sunrise, to count the geese when taking off from the roost. In order to establish the exact number of wintering geese, every flock was counted separately. Number, species, direction of flight and time was written in the monitoring protocol. Following the morning goose flock count, and after the geese would leave their roosts the researchers would monitor them in the field to establish their foraging habitat and to identify the species composition within the flocks. In a closer distance, geese were monitored for colour-ring marked individuals as well. The monitoring and mapping of foraging geese was usually conducted between 10:00 – 12:00 and 14:30 – 16:30 when the geese are less mobile and concentrated at foraging sites (Petkov et al. 2011). In conclusion, counting a flock of geese and identifying all individuals required plenty of time for finding LWfG in a flock of hundreds of thousands of other goose species. Once the flocks were located in the field, several repeated careful "scans" of the whole flock by telescope were taken. Additional information on the meteorological conditions was collected. Additional information on goose movements was gathered from hunters, land owners and locals when needed.

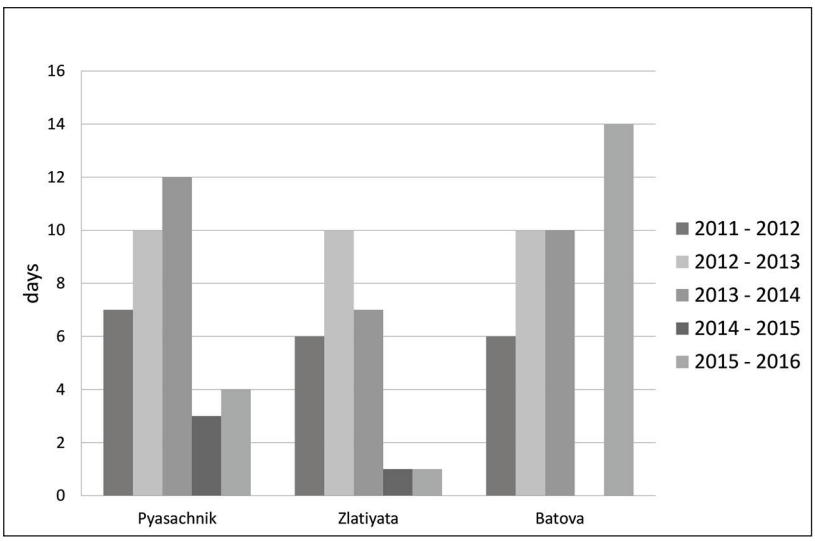

Figure 2.
Distribution of monitoring days for the years 2011-2016 in Bulgaria.

3. Results

The present survey covered the period December 2011 – February 2016, totaling 101 days of field monitoring, separated into 5 winter seasons (2011 – 2012, 2012 – 2013, 2013 – 2014, 2014 – 2015 and 2015 - 2016). The monitoring covered three NATURA 2000 sites (Pyasachnik, Batova and Zlatiyata) with an average of 34 days per site for the whole period. They were distributed almost equally between these sites (**Figure 2**).

3.1 SPA Pyasachnik reservoir

A total of 36 days of monitoring were carried out between December 2011 and February 2016 in the SPA and the surrounding areas. During the regular monitoring, no geese were observed to stage in the area before 4th of December. The vast majority of the geese observed were GWfG. The highest number of wintering geese was observed in the second monitoring season (2012 – 2013), when more than 5,800 GWfG were registered in the area for 10 monitoring days added together. Nevertheless, the biggest flock of GWfG was observed in the beginning of 2015, with 1,991 individuals. Only twice were other goose species observed in SPA Pyasachnik reservoir. In February 2012, a Red-breasted Goose *Branta ruficollis* was observed, and in January 2014 three Greylag Geese *Anser anser* were observed.

3.2 SPA Zlatiyata

A total of 25 days of monitoring were carried out between December 2011 and January 2016 in the SPA and the surrounding areas. This site has been identified to host the first geese to arrive in Bulgaria. The first wintering geese arrive in the second half of October. The most common wintering goose species was the GWfG of which more than 7,000 were registered in the second monitoring season added together. The largest registered flock consisted of 6,869 GWfG, 62 Greylags and 4 Red-breasted Geese on 25/11/2012.

3.3 SPA Batova

A total of 40 days of monitoring were carried out between December 2011 and January 2016 in the SPA and the surrounding areas. This site neighbors the main goose staging sites along the Bulgarian Black sea coast, the Shabla and Durankulak lakes. Around 2,000 geese in total were observed in the area during the study period. The most common species was the GWfG again of which more than 90% of the geese observed belonged to. At the same time, almost 200 Red-breasted Geese and 30 Greylag Geese were registered, as well. The geese were observed to stage and winter here mainly in January and February. The largest registered flock consisted of 960 GWfG, 18 Greylag geese and 9 Red breasted geese on 09/02/2014.
During the monitoring of these sites no LWfG were observed within the SPA boundaries and consequently additional search was conducted in adjacent regions.

3.4 Monitoring results from adjacent regions in Bulgaria

During the study period 102 days altogether were spent searching for LWfG in neighboring potential regions in accordance with the gathered historical information for the LWfG distribution: Burgas lakes (25 days), Svishtov – Belene lowland (47 days), Ovcharitsa reservoir (5 days), Danube plain (3 days), Thracian plain (Pyasachnik region) (3 days), Struma valley (1 day) and Northeastern Bulgaria (**Figure 3**). Most of the monitoring days were carried out in 2013 – 2014 season. During the duration of the present study all historical data for LWfG distribution from various sources of information was collected as well.

3.5 Svishtov – Belene lowland

This site was chosen for monitoring the distribution of the LWfG because of historical data and huge numbers of geese wintering here in the early stages of winter (October – January). During the study period forty-seven days of monitoring were carried out in order to identify and count geese and search for LWfG. Most of the monitoring days were undertaken in the winter of 2013 - 2014. In this season, more than 250,000 GWfG added together were registered in the area together with more than 200 Greylags and Red-breasted Geese. In this period one LWfG was observed within a flock of thousands of GWfG. This site is known to hold large flocks of geese in October - December when the geese first arrive here to benefit from the suitable foraging conditions in this part of Bulgaria. Another observation of LWfG into this area was registered in 2012. During the second monitoring season, more than 90,000 geese were registered, mainly consisting of GWfG. The largest flock observed was more than 22,000 individuals in late November. More than 200 Red-breasted Geese were observed within this monitoring season as well. During the last monitoring season, more than 60,000 GWfG in seven different visits were counted together with a few Greylags and Red-breasted Geese.

3.6 Burgas lakes

Situated along the Black sea coast, this area has always been a hot spot for wintering geese in Bulgaria because of the high suitability of foraging and roosting habitats for the wintering birds. A monitoring team was established and a training course of identification of LWfG was attended by the team. As a result, 25 days separated into 3 monitoring seasons (2013 – 2014, 2014

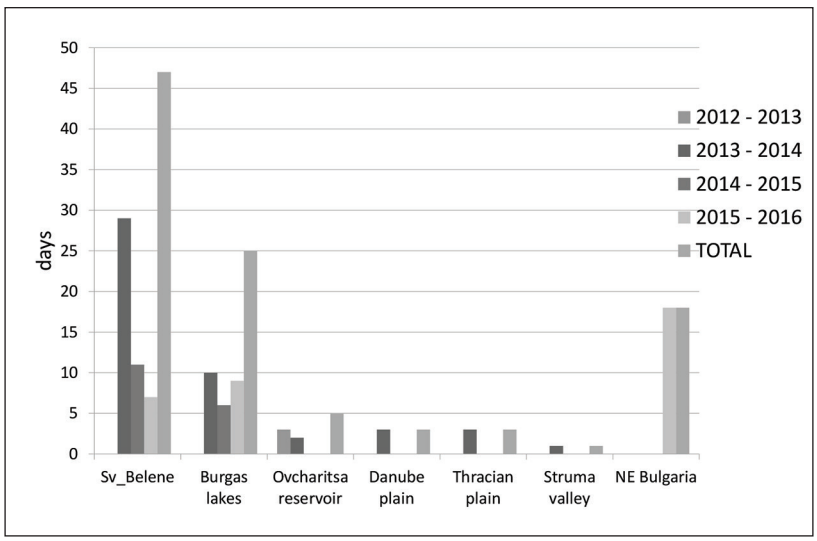

Figure 3.
Distribution of monitoring days in potential sites in Bulgaria in the winters 2012-2016.

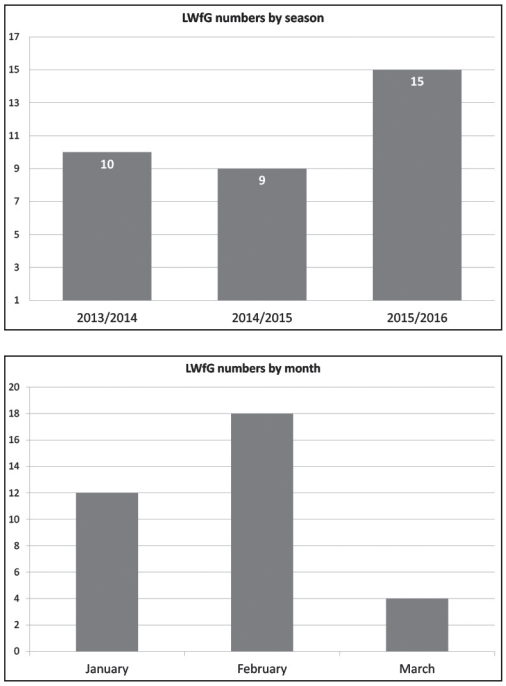

Figure 4.
Numbers and phenology of Lesser White-fronted Geese around Burgas lakes in Bulgaria.

– 2015 and 2015 - 2016) were spent surveying the whole area. The wintering goose populations in these seasons was estimated between 210,000 – 290,000 GWfG and 4,300 – 9,000 Red-breasted Geese, arriving in the beginning of January until mid of March. The results of the monitoring revealed the importance of the lakes around the town of Burgas for the different goose species and the LWfG in particular in Bulgaria. In the first season, more than 470,000 GWfG and 15,000 Red-breasted Geese were observed in total. The second monitoring season revealed the same and even higher numbers of the wintering geese in the area. Observations of Bean goose Anser fabalis, Barnacle Goose *Branta leucopsis* and Brent goose *Branta bernicla* were made, as well.

The greater monitoring effort in the area brought the first promising results, as 34 LWfG from 21 observations during the survey period were made. In the first period 10 individuals out of 7 observations were registered while another 9 LWfG were found in 2014 – 2015. In the last survey season, 15 individuals out of 9 observations were registered here, mainly due to the increased experience in identification and intentional search of the monitoring team in Burgas lakes area. Most of the birds were observed in January and February where 30 out of 34 individuals were registered. The results underlined the importance of the area and shed some light over the phenology and the wintering pattern of the LWfG around Burgas lakes (**Figure 4**).

*Greater White-fronted Geese in Durankulak Lake in 2016. © Nicky Petkov / **www.naturephotos.eu***

3.7 Northeastern Bulgaria (Shabla and Durankulak lakes)

Meanwhile, 14 observations of 29 individuals of the species were made in northeastern part of Bulgaria (Shabla and Durankulak lakes) as a result of the improved survey efforts and raised awareness amongst experts and ornithologists working on other goose conservation projects. Most of the observations in this part of the country were made in January and February and only a few in March when the first geese leave for northern latitudes. The results of the additional monitoring revealed the need of better and intensive search for LWfG in some of the potential sites. For example, it appeared that Svishtov – Belene lowland and Burgas lakes areas are concentrating huge numbers of geese during witner. Large flocks of geese first arrive in Svishtov – Belene lowland (October – November – December) and after the weather conditions get worse, geese mainly concentrate in Burgas lakes lowland in January – February and March. In this area during field inspections, more than 450,000 geese in total for a season were found foraging and roosting. Observations of LWfG were made despite only 25% of the flocks were surveyed. Because of the huge numbers and dense concentration of geese, the occurrence of many more LWfG could be almost impossible to document even if present in the flocks.

3.8 Ovcharitsa reservoir, Danube plain, Struma valley

Altogether nine observation days were spent in mid-January in these regions, but no LWfG were located.

4. Discussion

The very first survey on the wintering and staging of the LWfG in Bulgaria was undertaken in 1996 by a Bulgarian – Norwegian team of experts from BSPB and NOF (BirdLife Bulgaria and BirdLife Norway). During this expedition many suitable wetlands in Bulgaria were visited by the team and data on the species distribution, numbers and threats were gathered. The team established no more than 8 – 10 LWfG in the region of Zlatiya and Shabla and Durankulak lakes (Aarvak et al. 1997). In 1998, 10 LWfG were identified in mixed flocks of GWfG and Red-breasted Geese (Petkov et al. 1999). The present study presents the data from the second study targeted for the LWfG in Bulgaria.

We report here new important sites for the LWfG in Bulgaria and contribute significantly to the understanding of the pattern of staging and wintering of the species in Bulgaria. By the end of the 20th century the estimate of the LWfG wintering population in Bulgaria equaled to 30 – 40 individuals (Aarvak et al. 1997), and on some occasions when suitable conditions were met, the population could reach even 100 individuals (Petkov et al. 1999). During the current survey, 44 separate observations of 64 individuals were registered in five winter seasons, which is significantly higher than in any previous efforts to establish the real population numbers of the species in Bulgaria (Aarvak et al. 1997, Petkov et al. 1999). Our data indicate that species numbers could be much higher, reaching over 100 individuals, especially in the region of Burgas lakes where up to four individuals were registered together in a flock of tens of thousands of other goose species. Considering the fact that the results stem from only scanning less than 5% of the goose flocks and that the total number of wintering geese in this region in some years numbers up to 400,000 - 500,000 individuals. The number of the wintering and staging LWfG could be ten-fold higher than estimated before.

So far, the highest number registered is 15 birds separated in 8 observation events, but within our study we registered 16 individuals in 9 separate observations. However, when comparing historical data and recent years, the number of registered individuals seems to be higher before 1900s than nowadays as 34 individuals was registered in 1889 (Hristovich 1890) in a time period with much less ornithological research. In 1965, 12 individuals were registered within a single observation (Donchev 1967). Some data exists for even much higher numbers of the species in Bulgaria (Zoemer 1987, Baumgart 1984), but these data is neither accepted by other authors (Aarvak et al. 1997, Michev & Profirov 2003, Simeonov & Dereliev 2011) nor corresponding with population estimates of the species in Europe by that time (Jones et al. 2008). Although there is no specific monitoring protocol for the LWfG, the species is regularly observed in Bulgaria during the winter goose monitoring or by accidental observations which proves the fact that it is a regular visitor in the country. The recent distribution of the species in Bulgaria includes the north-eastern part of the country, Shabla and Durankulak lakes, Burgas lakes, Danube plain and Pyasachnik dam in the inner part of the country (Jones et al. 2008).

The historical data shows that the LWfG is regularly observed during spring and autumn migration in Bulgaria (Prostov 1964, Donchev 1967, Iankov 1996) although in our survey it has been observed only a few times in this period of the year that could be a result of the smaller population size or by a shift of the migrating routes of the species. There is some data regarding a loop migration of the species form Kerkini towards Thracian lowland in Bulgaria and Marica river mouth in Greece, the second most important wintering site for the Fennoscandian Lesser White-fronted Goose population (Aarvak et al. 1997, Iankov 1996).

Most of the old data doesn't provide any information for the age ratio of the observed individuals, but still some more information on this matter could be obtained by the data gathered after 1990 where nearly half of the observed individuals were adults, 18% of the birds are defined as 1st winter birds and the rest were not aged thus no conclusions about the LWfG age structure could be provided. During the present study 44 observations of 64 LWfG were registered or reported in the country. 48 of the reported individuals were defined as adult birds (75 %), 9 of them as immature birds, 2 individuals as juvenile or 1st winter birds and for 5 LWfG the age couldn't be determined. Most of the observations were reported from the Black Sea Coast and Northern Bulgaria. Most of the observations were made in January and February when the peak number of wintering geese occurs in Bulgaria. There were only a few observations of the species reported in October, November and March when the migration usually occurs.

5. Acknowledgements

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Geese in cultivation field in Bulgaria. © Svilen Cheshmedzhiev

Expanding the international Lesser White-fronted Goose monitoring network and subsequent observation results

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The monitoring of the critically endangered Fennoscandian population of the Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) has a long continuum at several traditional sites along the migration route in Norway, Finland, Estonia, Hungary and Greece. However, there are still some major gaps in our knowledge of the migratory movements between these sites, even within the European Union. This has been a major obstacle in the conservation of the species. For example, during many years there has been a period of several weeks when the main part of the Fennoscandian LWfG flock has left Hortobágy, Hungary, on spring migration, but has not arrived at the consecutive known stopover sites in Estonia and/or Finland (Aarvak et al. 2017). During this period, the LWfG use currently unknown stopover sites, which may be situated e.g. in Poland, Lithuania or Latvia.

To fill in these knowledge gaps, a specific research to strengthen and complement the network of national and regional LWfG monitoring teams was included in the present LWfG LIFE+ Project. The aim was to organize international field training workshops for people enthusiastic to set up new LWfG monitoring teams, and to also support the new teams.

The LWfG LIFE project organized three identification and survey training workshops in the Hortobágy National Park (eastern Hungary), in the autumn staging period of the LWfG in the years 2012–2014. Altogether 36 birdwatchers and ornithologists from 15 countries were trained, selected and invited based on their skills and interest to set up a local LWfG monitoring team. The main results of the trainings and of the consecutive national field work are summarized in **Table 1**, and the results of the most active teams are reported in more detail below.

Country / area	Persons trained	Main results in the field
Azerbaijan	2	LWfG observations received*
Bulgaria, Bourgas area	2	Regional field work, complementing the LIFE project team, for results see Dobrev et al. 2017
Estonia	2	More observers trained to complement existing field teams, for results see below
Greece	3	More observers trained to complement the LIFE project team and new sites; the first record of LWfG at Lake Koronia, Central Macedonia for ca a hundred years, see also Demertzi et al. 2017
Hungary, south parts	3	National field work established, for results see below
Iran	2	National field work established, two surveys in 2015 (Lampila 2017)
Iraq	2	LWfG observations received*
Kazakhstan	3	LWfG observations received*
Lithuania	4	National field work established, for results see below
Poland	1	National field work established within two areas, for results see below
Romania	2	LWfG observations received, also see Short Notes page 149
Russia	2	LWfG observations received*
Serbia	3	National field work established, for results see below
Slovakia	1	LWfG observations received*
Turkey	4	Two field surveys, see www.piskulka.net and Short Notes page 146
Ukraine	2	LWfG observations received*
		* see **www.piskulka.net**

Table 1. *Summary of participation and results of the identification and monitoring workshops in Hungary.*

Before the training workshops, the LIFE project produced standard instructions for LWfG field monitoring (the first version published by Tolvanen et al. 1999), as well as a LWfG Field Guide summarizing the main points of monitoring and identification of the species. These instructions were later adopted by the LWfG international (AEWA) working group in the 2nd meeting of the AEWA Lesser White-fronted Goose International Working Group. The LWfG Field Guide has been translated and printed also in Greek, Russian, Kazakh and Azeri languages, and a Chinese and Farsi language version are also under preparation.

For reporting LWfG observations, an online form was developed for the Portal to the Lesser White-fronted Goose at
http://www.piskulka.net/
In addition, an identification tool, in the form of a Power Point presentation, was developed for the training workshops. It is made available to all members of the AEWA Lesser White-fronted Goose International Working Group
http://lesserwhitefrontedgoose.aewa.info/
to assist them in their national awareness-raising and capacity building work. The LIFE project also established an email list for informing the national teams for dissemination of recent LWfG observations, the progress of the migration and conservation related issues. By the end of year 2016, the email list had approximately 100 members in 19 countries along the migration routes of the LWfG.

Estonia *(data collected by Jyrki Pynnönen)*

An important spring staging area of the Fennoscandian LWfG population was revealed in western Estonia in the end of 1990's (Tolvanen 1999). During 1999–2004, the spring monitoring of LWfG in this area was carried out annually by WWF Finland's LWfG conservation project and the staff of the Matsalu National Park. In the years 2005 - 2008, the monitoring was part of the previous LWfG LIFE project (Toming & Pynnönen 2009). After that, the monitoring has been carried out by Estonian ornithologists assisted by Finnish volunteers, but there has been lack of trained, skillful local people to cover the whole spring staging period and all potential sites. Therefore, two persons from Estonia were trained by the project in the field training workshop in 2012, and since 2013 they have participated in the spring monitoring in western Estonia. This report summarizes the results of the monitoring by all Estonian and Finnish observers in the years 2009–2016.

The monitoring covered annually the whole potential spring staging period from mid-April until mid-May, and both traditional Estonian spring staging sites: the Haeska region in the municipality of Ridala on the northern coast of the Matsalu Bay, and the Tahu–Pürksi¬–Saare region in the municipality of Noarootsi, north-west of the Haapsalu Bay.

The main results of the monitoring are summarized in **Table 2** and **Figure 1**. The first LWfG arrived in most years around 23 April (variation 19 April – 6 May), which has average arrival time also in longer term (Toming & Pynnönen 2009). The date of annual peak counts varied from 21 April to 9 May, and the last observations were made in range of 3 – 13 May. The average length of the staging period, calculated from the first to the last observation (excluding the year 2016 without any LWfG observations) was ca 15 days, which is 3-4 days shorter than in the period 2004–2008 (Toming & Pynnönen 2009).

The relative importance of the two main Estonian staging areas has clearly changed during the latest ten years. Earlier, the Haeska area was more important (Toming & Pynnönen 2009), while since 2008, most of the LWfG observations as well as the highest annual counts, have been made in Noarootsi. The reason for this change is not known, and there have not been any major visible changes in the habitat quality at either of the two sites.

The annual total numbers of individuals were rather stable during the springs 2009–2014, but in 2015–2016 the numbers declined dramatically: in spring 2015 only 4 individuals were observed, and in spring 2016 no observations were made at all. The average annual total number in the years 2009–2014 was ca 29 individuals, which is very close to the long term (1999–2014) average of ca 26 individuals. The monitoring effort remained roughly the same over the years.

Thus, it is evident that in 2015–2016 the Fennoscandian LWfG avoided (the known sites in) western Estonia as a spring stopover site, while at the same time the Fennoscandian population passing the Baltic states on spring migration has increased markedly.

Table 2.
Main results of the spring monitoring of Lesser White-fronted Geese in Estonia in 2009–2016.

	2009	2010	2011	2012	2013	2014	2015	2016
Monitoring period	18 Apr. – 15 May	20 Apr. – 9 May	17 Apr. – 13 May	23 Apr. – 8 May	19 Apr. – 11 May	17 Apr. – 11 May	17 Apr. – 10 May	15 Apr. – 10 May
First observation of LWfG	21 April **2 ind.** Haeska	21 April **2 ind.** Noarootsi	6 May **9 ind.** Noarootsi	21 April **5 ind.** Haeska	23 April **1 ind.** Haeska	19 April **9 ind.** Haeska	21 April **2 ind.** Noarootsi	-
Peak day(s)	7 May **30 ind.** Noarootsi	25 April **29 ind.** (Haeska 22 + Noarootsi 7)	6 and 9 May **9 ind.** Noarootsi	6-8 May **26 ind.** Noarootsi	3 May **27 ind.** Noarootsi	21 April **29 ind.** 30 April **26 ind.** Noarootsi	26 April **4 ind.** 3 May **4 ind.** Noarootsi	-
Last observation of LWfG	13 May **6 ind.** Noarootsi	9 May **2 ind.** Noarootsi	11 May **9 ind.** Noarootsi	8 May **26 ind.** Noarootsi	8 May **7 ind.** Noarootsi	8 May **2 ind.** Noarootsi	3 May **2 ind.** Noarootsi	-

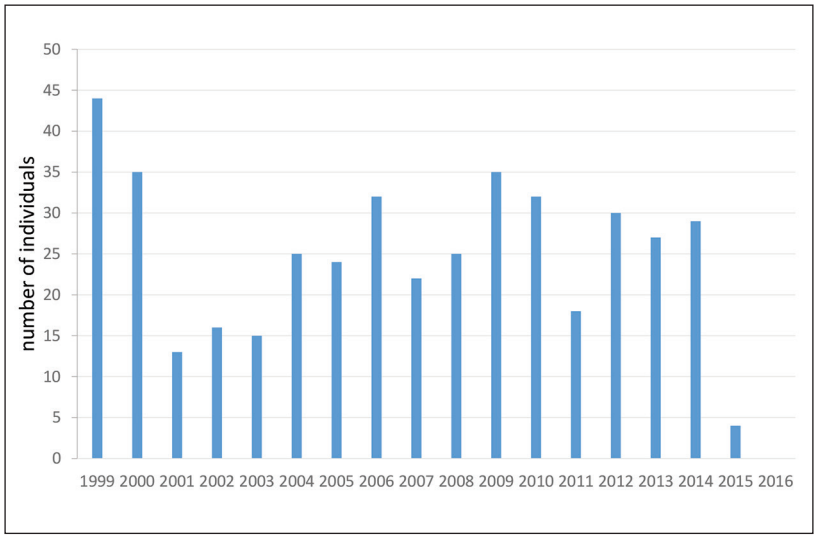

Figure 1.
Total minimum number of LWfG in Estonia in spring during 1999–2016.

Another remarkable finding is that already before the dramatic drop of the LWfG numbers in Estonia in 2015–2016, the steady increase of the Fennoscandian LWfG population, observed since 2010 at all other constantly monitored sites, was not reflected in the number of spring staging LWfG in Estonia. Since 2008, the relative importance of western Estonia as a spring staging area of the Fennoscandian LWfG has decreased, while at the same time the relative importance of the spring staging areas on the Finnish Bothnian Bay coast has increased (see **Figure 3** in Tolvanen & Karvonen 2017, of the present edition). The reason for this remains to be clarified, but it has been noticed that the extent of scaring geese away from fields to protect crops in the Noarootsi area has increased simultaneously.

Lithuania *(data collected by Julius Morkūnas)*

In Lithuania, the LWfG is a rare but regular spring migrant. Before the present LWfG LIFE project, there was only very few confirmed observations of the species. In April 2007, a potential previously unknown spring stopover site of the Fennoscandian LWfG population was located in the Nemunas River delta with the help of satellite tracking, and since then LWfG have been searched for in the area (Kaartinen et al. 2009).

Four persons from Lithuania were trained by the present project in the field training workshops, and since spring 2012 a team of Lithuanian volunteers surveyed the Nemunas delta annually from mid-March or early of April until early May (**Table 3**).

The main results of the monitoring are presented in **Table 3**. Almost all observations of LWfG in 2011–2016 in Lithuania were made in the Nemunas delta area. The only observation outside the Nemunas delta was made in the Žuvintas reserve in southern Lithuania on 4 April, 2015. Both the Nemunas delta and the Žuvintas reserve host huge congregations of arctic geese during spring migration (Švažas et al. 1997). Finding LWfG in these areas is challenging due to high number (up to 30,000 at one site in one single day) of Greater White-fronted Geese (*Anser albifrons*) being present at the same time.
First sightings of LWfG were normally made in the first days of April, but in 2015–2016 already in the end of March. The first LWfG in the spring appeared normally at "marginal sites" of the Nemunas delta (e.g. Pagėgiai and Vilkyčiai in district of Šilutė), while later in the season the LWfG were mainly observed at Šyša, Sausgalviai and Rupkalviai. The peak numbers, variating from one to 15 individuals, were recorded in the latter half of April.

The annual total number of LWfG varied from one or two to 17 individuals. The observation of a flock 15 LWfG, observed at Šyša on 24 April 2012, is especially remarkable. It is the first confirmed observation of a larger flock of LWfG in Lithuania.

The Nemunas delta is a large floodplain area, where the LWfG and other arctic geese are mainly feeding on flooded grasslands. The area is mainly used as pastures for dairy industry. No threats from illegal killing or poisoning were recorded in the area. The main threat for the geese in the area is degradation of feeding habitats due to overgrowing of grasslands by bushes. Natural grasslands are also changed to arable fields and biofuel plantations.

Lesser White-fronted Goose monitoring at Noarootsi area, Estonia.
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	2011	2012	2013	2014	2015	2016
Start of the survey	No special survey	18 March	28 March	9 March	1 April	16 March
End of the survey	-	9 May	8 May	5 May	15 May	5 May
First observation of LWfG	9 April	6 April	16 April	2 April	13 March	23 March
Peak simultaneous count(s) of LWfG	**1 ind.**	24 April **15 ind.** (Šyša)	**1 ind.**	18 April **1 ind.** (Rupkalviai)	26 April **2 ind.** (Sausgalviai) **+ 1 ind.** (Rupkalviai)	17 April **6 ind.** (Sausgalviai)
Last observation of LWfG	30 April	1 May	9 May	24 May	26 May	17 April
Minimum total number of LWfG individuals	2	17	1	5	4	12
Estimated total number of LWfG individuals	2	17	2	5	7	13

Table 3.
Main results of the Lesser White-fronted Goose monitoring in Lithuania in 2011–2016. Observers: Boris Belchev, Edmundas Užpelkis, Povilas Bagdonas, Vytautas Eigirdas, Antanas Petraška, Eglė Pakštytė, Augustas Šimkus, Gediminas Eigirdas, Vilius Paškevičius, Julius Morkūnas, Milda Šniaukštienė, Laimonas Šniaukšta and Vytautas Jusys.

Poland

Poland is one the most promising countries where the Fennoscandian LWfG may have a stopover during the period when the main flock is "lost" for up to several weeks after they leave the Hungarian staging areas. To intensify search for LWfG, two ornithologists from Poland were invited to the field training workshops by the present project. Eventually only one of them could take part in the training, but both set up regional LWfG monitoring.

Biebrza Basin, north-eastern Poland
(data collected by Michał Polakowski)

The Biebrza Basin, located in the north-eastern Poland is – along with the Nemunas delta in Lithuania – one of the most important spring stopover areas of arctic geese (particularly Greater White-fronted Goose) wintering in Western and Central Europe (Polakowski et al. 2011, Ławicki et al. 2012, Polakowski & Kasprzykowski 2016). A large part of the area is protected as a national park, Natura 2000 SPA and/or as IBA (Important Bird Area).

The number of geese staging in the area has rapidly increased during the last ten years, reaching currently up to 100,000–150,000 individuals. Single LWfG have been recorded in the area almost annually, mostly in large flocks of the White-fronted Geese. It has not been confirmed by ring recoveries or satellite transmitters, if the LWfG occurring in the area belong to the western (Russian) main population, the Fennoscandian population, or both.

Specific monitoring of LWfG in north-eastern Poland was started in spring 2014. The monitoring concentrated in the Biebrza Basin area, described in detail by Polakowski et al. (2011) and Polakowski & Kasprzykowski (2016). Besides the Biebrza valley, the monitoring covered also some parts of the Narew river valley in its middle run (Wizna Marsh and Tykocin Basin), Marshy Valley of the Narew River, Narew River Gaps and Upper Narew Valley. Some accidental records were also made in the arable lands near Hajnówka in the eastern part of the North Podlasian Lowland (sources: Polish Avifaunistic Commission 2015, www.clanga.com and www.piskulka.net; see **Table 4**).

The main results of the monitoring are shown in **Table 4**. Altogether eight spring observations of nine LWfG were reported (Polish Avifaunistic Commission 2013, www.clanga.com, own unpubl. data). Moreover, single adults (one each year) were observed by Paweł Białomyzy on the fields near Hajnówka in 2014-2016 (sources: **www.clanga.com** and **www.piskulka.net**). No observations were made in autumn or winter.

	spring 2011	spring 2012	spring 2013	spring 2014	spring 2015	spring 2016
Monitoring period	No specific LWFG survey	No specific LWFG survey	No specific LWFG survey	26 Feb. – 9 April	13 Feb. – 27 April	6 Feb .– 1 May
First observation of LWfG	-	17 March	-	21 March	26 March	10 March
Last observation of LWfG	-	3 April	-	21 March	4 April	10 March
Number of LWfG individuals	0	3	0	1	3	2

Table 4.
*Observations of the Lesser White-fronted Geese in the Biebrza Basin, north-eastern Poland, in 2011–2016. All records from the period when they were verified by the Polish Avifaunistic Commission (**http://komisjafaunistyczna.pl/?lang=en**) were accepted. The main part of the surveys was carried out by Michał Polakowski and Monika Broniszewska, however some observations were also obtained from Paweł Białomyzy, Grzegorz Grygoruk, Oliwia Karpińska, Tomasz Kułakowski, Wojciech Piechowski and Michał Wołowik.*

Barycz River Valley and Zbiornik Mietkowski reservoir, south-western Poland
(data collected by Wiesław Lenkiewicz)

The Barycz River Valley is well-known stop-over site for geese in Poland (eg. Wuczyński et al. 2012). The geese staging in the area are roosting on fishponds and feeding on agricultural fields. Usually the fields close to the fishponds are used, but in some years – probably due to hunting pressure or other disturbance factors – the geese use unknown feeding grounds outside the monitored area. Zbiornik Mietkowski is a large water reservoir (ca 920 hectares) situated in the center of Silesian Lowlands which is the warmest region in Poland and because of that is in intensive agricultural use. The geese are roosting in the reservoir and feeding on fields in a large area around the reservoir. Intensive hunting of geese and waterfowl takes place at both sites throughout the winter season.

Specific monitoring for LWfG was started in the area in the winter 2011–2012, and since then it has been conducted annually covering the whole winter period from September until spring. The main results of the monitoring are shown in **Table 5**. It can be concluded that the area hosts regularly a small number (3–13) of overwintering LWfG. It has not been confirmed by ring recoveries if the LWfG recently observed in the area belong to the western (Russian) main population or the Fennoscandian population or both. However, in autumn and early winter 1995 an adult non-breeding male from Fennoscandian population fitted with satellite transmitter was recorded in both of the monitored sites (Aarvak & Øien 2013).

The first LWfG arrive in the area normally in late October, and the last observations in spring were made normally in mid-March, while in some winters (2011–2012 and 2012–2013) no records were made during spring.

	winter 2011-12	winter 2012-13	winter 2013-14	winter 2014-15	winter 2015-16
Monitoring period	25 Sep. – 10 April	28 Sep. – 7 April	29 Sep. – 23 March	26 Sep. – 18 April	25 Sep. – 9 April
First observation of LWfG	30 October	20 October	5 October	2 November	8 November
Last observation of LWfG	10 December	10 November	14 March	16 March	18 March
Minimum total number of LWfG individuals	6	3	13	10	4
Estimated number of LWfG individuals	7	3	13	12	4

Table 5. *Main results of the Lesser White-fronted Goose monitoring in the Barycz River Valley and Zbiornik Mietkowski reservoir, south-western Poland in 2011–2016.*

Southern Hungary *(data collected by Zsolt Ampovics)*

The Hortobágy National Park in eastern Hungary is a traditional stopover site of the LWfG, while in other parts of the country observations of the species have been only sporadic. Three persons from southern Hungary were trained by the present project in the field training workshops, and have since 2011 been searching for and monitoring LWfG, covering three areas in the southern part of the Great Hungarian Plain: Pusztaszer (including Lake Csaj), Kardoskút (including steppes of Makó) and southern parts of Bács-Kiskun county (Solt, Dunatetétlen, Miske).

Since 2011, altogether 107 observations of LWfG were made in the area: 50 observations in the Pusztaszer area, 31 observations in the Kardoskút area and 17 observations in the southern parts of Bács-Kiskun county. In addition, six observations of LWfG have been obtained from Szeged and Szentes. The estimated total number of individuals varied from 6 to 23 individuals in the five winter seasons between 2011 and 2016 (**Table 6**).
At the Pusztaszer and Kardoskút sites, which are protected as national parks, the LWfG use "classical LWfG habitats" like sodic lakes for roosting and natural grasslands for feeding. At the other sites LWfG have been mostly observed on fishponds (e.g. Lake Szegedi Fehér) and agricultural fields (southern Bács-Kiskun).

It can be concluded that as a result of the intensified monitoring efforts, supported by the LWfG LIFE project, the number of LWfG observations in the area have increased markedly, and the southern part of the Great Hungarian Plain has been shown to host a small wintering population of the species. Although there is no direct evidence like ring recoveries or locations of satellite transmitters to confirm the breeding area origin of these birds, it is generally assumed that they belong to the western (Russian) main population. The assumption is mainly based on the timing of the arrival of the LWfG in the area, which coincides with the arrival of the Greater White-fronted Geese.

	winter 2011-12	winter 2012-13	winter 2013-14	winter 2014-15	winter 2015-16
First observation of LWfG	13 November	18 November	2 October	21 October	10 November
Peak simultaneous count(s) of LWfG	13 November **2 ind.** (Lake Csaj) 22 November **2 ind.** (Dunatetétlen)	8 April **18 ind.** (Pusztaszer)	2 January **6 ind.** (Kardoskút) 13 January **6 ind.** (Pusztaszer)	4 December **6 ind.** (Tótkomlós, steppes of Makó)	2 February **6 ind.** (Kardoskút)
Last observation of LWfG	27 January	10 March	25 February	27 March **2 ind.** (Kardoskút)	13 March **4 ind.** (Pusztaszer)
Estimated total number of LWfG	6	23	21	23	18

Table 6. *Occurrence of Lesser White-fronted Geese in the southern part of the Great Hungarian Plain (Pusztaszer, Kardoskút and southern parts of Bács-Kiskun county) in 2011–2016. The main part of the surveys were carried out by Zsolt Ampovics, and observations were also obtained from Andras Domjan, Tamas Nagy, Adam Kaczkó, Csaba Mészáros and Ádám Tamás.*

Serbia *(data collected by Marko Šćiban)*

Although Serbia hosts large numbers of wintering geese, and is situated on the way between the known stopover sites of Fennoscandian LWfG in Hortobágy in Hungary, and Kerkini Lake in Greece, there were no confirmed records of alive LWfG in the country before we started searching for LWfG in the winter 2012–2013 (only birds shot by hunters were regarded as reliable data).

Three persons from Serbia were trained by the project in the field training workshops and subsequently established a Serbian national LWfG team. Field work was started in January 2013 and surveyed the potential sites for LWfG every autumn - winter. That resulted in six confirmed observations of the species in Serbia (**Table 7**). It remains to be revealed if the birds occurring in Serbia belong to the Fennoscandian or the Russian breeding population.

Based on the results, it can be assumed that some tens of LWfG might be wintering in Serbia, mixed in the large geese flocks. Of the sites visited in the surveys (see **Table 7**), only the lakes Slano Kopovo, Palić and Kraljevac are protected from hunting, and even at these sites hunting is forbidden only on the waterbodies, while intensive waterfowl hunting takes place in their surroundings. At the Novi Kneževac fishpond where four LWfG were observed in January 2015, intensive goose hunting was ongoing. Novi Kneževac is at the moment the only site beside Slano Kopovo natron lake where species has been recorded in Serbia.

	winter 2012-13	winter 2013-14	winter 2014-15	winter 2015-16
Survey period	3 Jan. – 23 March	6 Oct. – 14 April	4 Oct. – 21 March	14 Oct. – 8 March
Number of survey trips	48	86	75	70
Main sites covered by the surveys	Slano Kopovo natron lake, Palić lake, Ludaš lake, Kapetanski rit fishpond, Novi Kneževac fishpond	Slano Kopovo natron lake, Palić lake, Ludaš lake, Kapetanski rit fishpond, Novi Kneževac fishpond, Danube–Tisa–Danube Canal	Slano Kopovo natron lake, Palić lake, Ludaš lake, Kapetanski rit fishpond, Novi Kneževac fishpond, Danube–Tisa–Danube Canal	Slano Kopovo natron lake, Palić lake, Ludaš lake, Kapetanski rit fishpond, Novi Kneževac fishpond, Danube–Tisa–Danube Canal, Jazovo fishpond
LWfG observations	None	13 November 2013 **1 ind.** at Slano Kopovo natron lake 17 February 2014 **1 ind.** at Slano Kopovo natron lake	8 December 2014 **2 ind.** at Slano Kopovo natron lake 25 December 2014 **1 ind.** at Slano Kopovo natron lake 17 January 2015 **4 ind.** (2 ad. + 2 juv.) at Novi Kneževac fishpond	14-15 November 2015 **at least 4 LWfG** (2-3 ad. + 1-2 juv.) at Slano Kopovo natron lake

Table 7. *Results of the Lesser White-fronted Goose monitoring in Serbia in 2013–2016.*

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The spring migration of the Lesser White-fronted Goose on the Bothnian Bay coast, Finland, in 2009–2016

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Lesser White-fronted Geese. © Tapio Kostet

1. Introduction

The estimate of the size and trend of the critically endangered Fennoscandian Lesser White-fronted Goose (*Anser erythropus*, later abbreviated LWfG) population is mainly based on the numbers observed during the spring migration at the annually monitored traditional spring staging sites. Undertaking estimates at the breeding sites in the Fennoscandian tundra areas is not feasible as these are scattered and partly unknown.

In the Oulu region on the Finnish Bothnian Bay coast, the migration and spring staging of the LWfG has been regularly monitored for longer than at any other site. The annual monitoring of LWfG in the area started in spring 1985 by the LWfG project of WWF Finland. Since then, WWF Finland has conducted the monitoring by constant method annually, covering the whole spring staging period. A comprehensive review of the results of the first 25 years of the monitoring (1985–2009) was published in Finnish by Markkola (2010). The previous similar report of the monitoring in English (Luukkonen 2009) covered the years 2004–2008.

The coastal meadows west of Oulu on the Finnish Bothnian Bay coast make up the only remaining regular staging area of LWfG in Finland. The LWfG sites of the area consist of natural low-growth saline coastal meadows, and of agricultural fields nearby (Markkola 2010). The sites in Liminka and Hailuoto are included in the Natura 2000 network (Isomatala-Maasyvänlahti and Liminganlahti), while the main feeding areas in Siikajoki are situated outside of the Natura 2000 site (Säärenperä and Karinkannanmatala).

2. Methods

The primary aim of the monitoring was to collect data on the number and age structure of the Fennoscandian LWfG, as well as on the timing of the migration. The methods of the monitoring are described in detail in a field manual, and the monitoring effort remained constant during the reporting period. In the latest 15 years, the LWfG have also been recorded on digital video to identify the individuals by their individual belly patches (see Aarvak et al. 2009 for further details).

The monitoring covered all the traditional and still potential staging areas of LWfG in the Oulu region: Siikajoki–Lumijoki, Hailuoto and Liminka Bay (**Figure 1**). In the 1980's and 1990's, the main LWfG staging sites in the area were situated on the island of Hailuoto, but since 2000 the LWfG have mainly used the Säärenperä–Karinkanta area in the municipality of Siikajoki on the mainland (Markkola 2010). Therefore, the monitoring in 2009–2106 focused on sites in Siikajoki–Lumijoki, while other formerly important sites on Hailuoto and in the Liminka Bay area were also monitored regularly, but less intensively (**Table 1**).

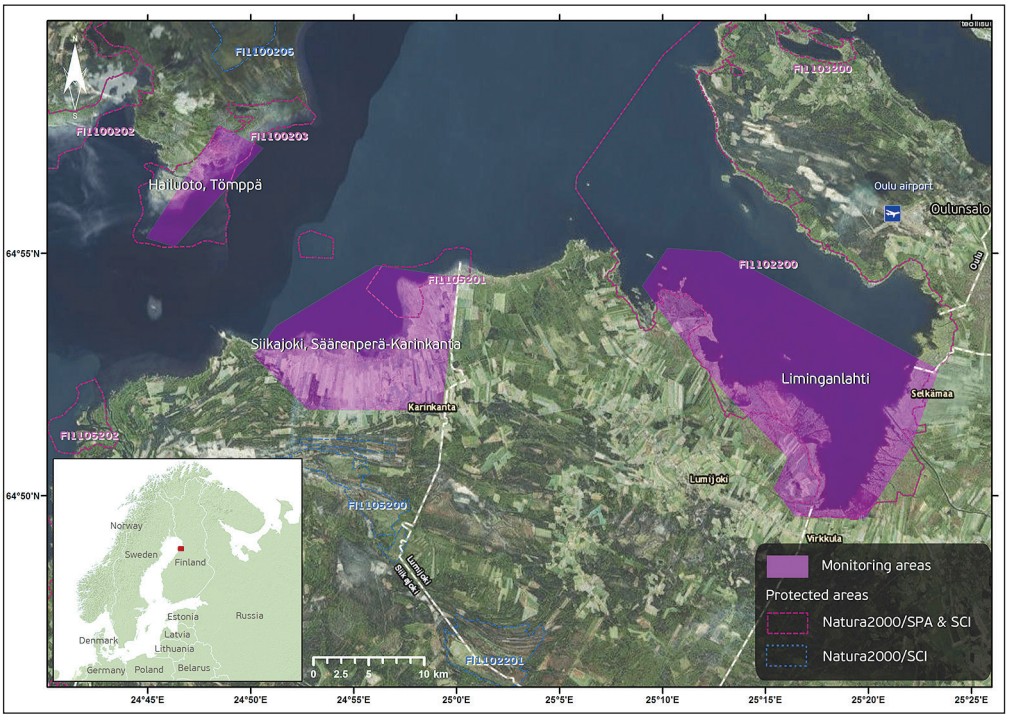

Figure 1.
Location of the monitoring area of Lesser White-fronted Geese on the Finnish Bothnian Bay coast in 2009–2016.

Year	Monitoring period	Siikajoki–Lumijoki	Hailuoto	Liminka Bay
2009	April 27 – May 25	Continuous, daily	Almost daily for three weeks, starting from last days of April	Occasional visits
2010	April 29 – May 22	Continuous, daily	Almost daily for two weeks, starting from last days of April	Occasional visits
2011	April 29 – May 22	Continuous, daily	Almost daily	Regular but not daily visits
2012	April 27 – May 19	Continuous, daily	Continuous 13-18 May, otherwise occasional visits	Occasional visits
2013	April 28 – May 20	Continuous, daily	6 visits	Occasional visits
2014	April 28 – May 19	Continuous, daily	7 visits	4 visits
2015	April 25 – May 20	Continuous, daily	9 visits	11 visits
2016	April 27 – May 17	Continuous, daily	Daily 30 April – 16 May	Almost daily 30 April – 16 May

Table 1.
Timing and coverage of the monitoring of Lesser White-fronted Geese on the Finnish Bothnian Bay coast in 2009–2016.

Lesser White-fronted Geese feeding. © Tapio Kostet

3. Results

The total spring numbers of LWfG observed in the area increased markedly during the report period, from less than 30 individuals in 2009–2010 to 105 individuals in 2016 (**Figure 2**).

The dates of the first and last observations of LWfG, as well as the highest daily counts are presented in **Table 2**. The first individuals arrived in the end of April or in the beginning of May (28 April – 7 May). The highest daily counts were made around 11 May, and the last observations were made in most of the years in mid-May (14–24 May).

Most of the LWfG were observed each year in the Siikajoki–Lumijoki area, mostly in the Säärenperä–Karinkanta area. Small flocks and single individuals were observed on Hailuoto in most of the years, while in the Liminka Bay area LWfG were observed only in 2009 and 2014–2015 (**Table 3**).

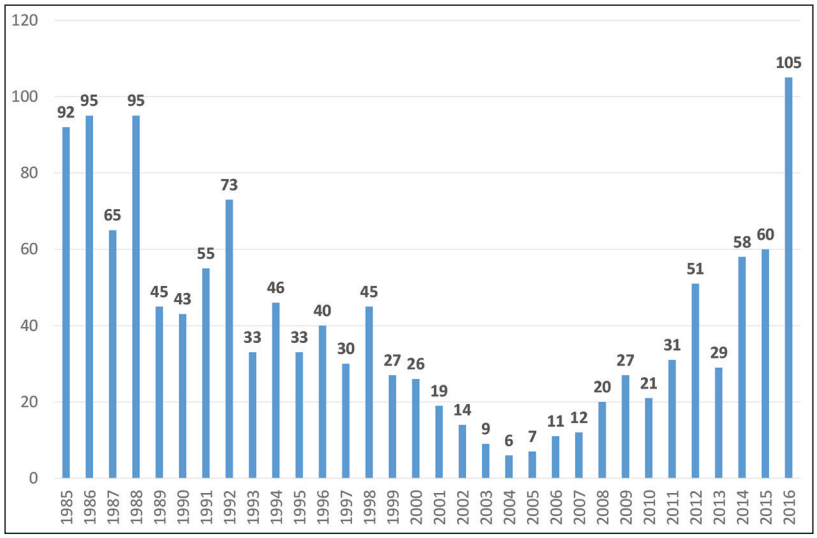

Figure 2.
The annual total numbers of Lesser White-fronted Geese on the Bothnian Bay coast, Finland, during the spring migration in 1985–2016.

	2009	2010	2011	2012	2013	2014	2015	2016
First observation of LWfG	3 May **2 ind.**	1 May **7 ind.**	7 May **4 ind.**	28 April **2 ind.**	4 May **9 ind.**	28 April **1 ind.**	29 April **4 ind.**	29 April **2 ind.**
Peak day(s)	10 May **21 ind.**	12-14 May **9 ind.**	11 May **8 ind.**	14 May **46 ind.**	12 May **27 ind.**	15 May **56 ind.**	9 May **58 ind.**	11 May **104 ind.**
Last observation of LWfG	24 May **1 ind.**	14 May **9 ind.**	14 May **8 ind.**	20 May **2 ind.**	17 May **2 ind.**	16 May **6 ind.**	18 May **2 ind.**	14 May **15 ind.**

Table 2. *Timing of the staging period of Lesser White-fronted Geese on the Finnish Bothnian Bay coast in 2009–2016.*

Year	Siikajoki–Lumijoki	Hailuoto	Liminka Bay
2009	**25**	**2** (10 May)	**2**
2010	**21**	**5** (11 May)	-
2011	**29**	**6** (**4 ind.** 11 May + **2 ind.** 12 May)	-
2012	**51**	-	-
2013	**29**	-	-
2014	**54**	**1** (only voice)	**4**
2015	**53**	-	**7**
2016	**105**	-	-

Table 3.
Distribution of Lesser White-fronted Goose observations (number of individuals) between the three main sites within the study area.

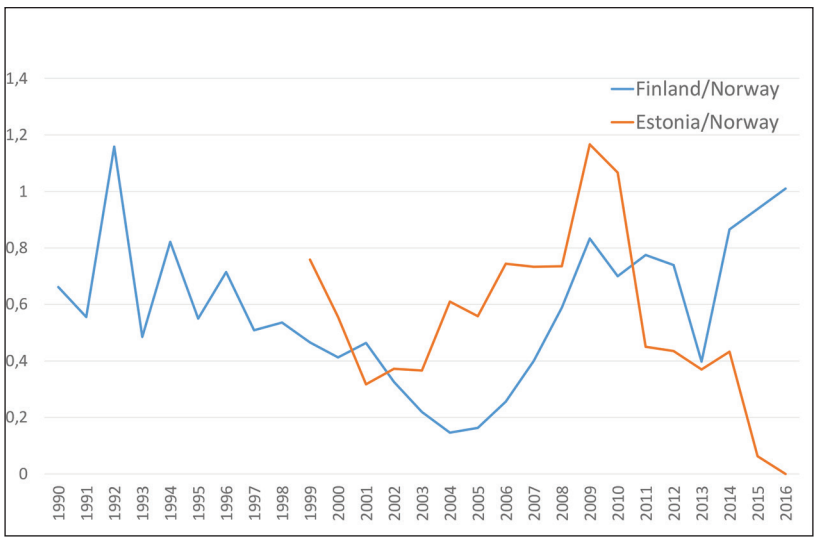

Figure 3.
The relative importance of the Finnish Bothnian Bay coast (blue line) and western Estonia (orange line) as spring staging areas of the Fennoscandian LWfG population, calculated as ratio of the annual total spring numbers in these areas versus spring total numbers at the Valdak marshes, Norway. In two years (1992, 2016) during the history of the spring monitoring, more individuals were observed in Finland than in Norway, and in one year (2009) more individuals were observed in Estonia than in Norway.

4. Discussion

The recovery of the Fennoscandian LWfG population during the latest decade is evident from the trend of the spring total numbers in the study area (**Figure 2**). The total during spring 2016 (at least 105 individuals) is the highest record in the history of the LWfG monitoring in the area (i.e. since 1985) (**Figure 2**). Higher counts than this date back to spring 1963, when 309 LWfG were counted. The spring total numbers were regularly higher than the highest daily counts. This is due to turnover of individuals, which was in most cases proven by individual belly patch markings and/or colour rings.

As expected, a significant leap upwards in the spring total number was observed in spring 2012, after good reproductive success of the Fennoscandian population in the summer 2011 (Aarvak et al. 2017). Another, even more obvious leap was observed between the years 2015 and 2016, after the record autumn numbers observed in the inner Porsangen Fjord, Norway in 2015.

At the same time, also the importance of the Finnish Bothnian Bay coast as a spring staging area of the Fennoscandian LWfG population has recovered (**Figure 3**). In the years 1990-2016, the average ratio of total LWfG spring numbers in Finland vs. the respective figure in Norway was 0.60; i.e. the annual total spring numbers in Finland were on average 60% of the respective total spring number at the Valdak Marshes, Norway. In the report period (2009–2016) this ratio was 0.79 (i.e. clearly above the long-term average), while in the preceding eight-year period (2001–2008) it was 0.32 (i.e. well below the long-term average). It is however also worth noting, that according to Aarvak et al. (2009) some 10–15 % of the individuals recorded on spring migration in Estonia and/or in Finland were not recorded at the Valdak Marshes, which implies that part of the Fennoscandian population possibly breeds in other areas than the Norwegian core breeding area.

The spring staging of LWfG in the study area takes place earlier than in the past. The median date, calculated as the percentage of birds present each day of the total number of individuals for the season, was 17 May in the early years of the monitoring (1985–1989), and 11 May in the years 2005–2009 (Markkola 2010). Also, the first arrival date has got earlier. Before the year 2002, the first arrival was never recorded in April, except for single birds of supposedly Swedish reintroduction origin accompanying the Taiga Bean Geese (Markkola 2010), while in the latest ten years (2007–2016) first arrival in April was recorded in five years.

5. Acknowledgements

Ari Leinonen, who sadly passed away in autumn 2011, organised the spring monitoring of the years 2009 and 2010. Juha Markkola carried the main responsibility of the monitoring efforts on Hailuoto throughout the reporting period. In addition, we are grateful to a large number of people who participated in the monitoring:
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Migration of the Fennoscandian Lesser White-fronted Goose in Hungary during years 2011-2017

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An adult pair with one juvenile LWfG at Görbe-Hát in the Hortobágy National Park on 8 March 2017. © Attila Szilagyi

1. Introduction

The Hortobágy National Park in Hungary is an important and traditional stopover site of the globally threatened and vulnerable Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) (Jones et al. 2008, Bogyo et al. 2014). Continuous natural grasslands cover an almost 54,000 ha area within the 82,000 ha National Park. This large area is diversified by different wetlands, patches of alkaline marshes, fishponds, small croplands and forests (**www.hnp.hu**).

The Fennoscandian population of the LWfG is the last population of the species breeding and migrating mainly in Europe that has witnessed a dramatic decline from an estimated 10,000 individuals (early 20th Century) to 20-30 breeding pairs (2000's). However, due to the continuous efforts along the European flyway, the population development has now a positive trend, evident recently with more than 130 individuals observed (**www.piskulka.net**). This critical situation highlights the importance of the knowledge about the biology of the species and the population.

During the period 2011-2017, the Hortobágy National Park and its surroundings (Hajdú-Bihar and Jász-Nagykun-Szolnok counties) also hosted individuals of the Western Main LWfG population at many different sites (number of observations: 493; www.piskulka.net, HNPD database). These birds used a broader variety of habitats and a much larger area, following the huge flocks of the Greater White-fronted Geese *Anser albifrons* (hereafter GWfG) coming into the Carpathian Basin from Siberia, usually after the 20th of October in autumn and leaving around mid-March in spring. The individuals of the Fennoscandian population usually leave the area for the southern European wintering sites at latest by the 22th of October and arriving back at earliest by the 2nd of March.

The daily routine of the Western Main population individuals is similar to the GWfG. Families as well as single individuals of LWfG do not aggregate in a large goose flock and feed as families or alone at different agricultural fields. However, in the last years many goose flocks seem to prefer well managed natural habitats instead of agricultural fields. It is also evident that in the last few years, 10 or more individuals of LWfG in mixed goose flocks are regularly observed, belonging to the Western Main Population that were not recorded previously.

An external study has been made about the occurrence of LWfG at the nearest important wetland called Lake Tisza, the biggest artificial reservoir of Hungary, which has a size of 127 km^2 (Bogyo et al. 2014, Hortobágy Environmental Association 2016). Details from this work are also given below.

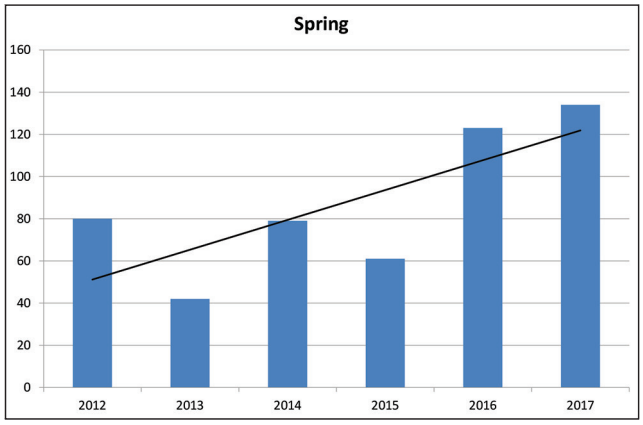

Figure 1.
Maximum number of Fennoscandian LWfG individuals in spring in the years 2012-2017.

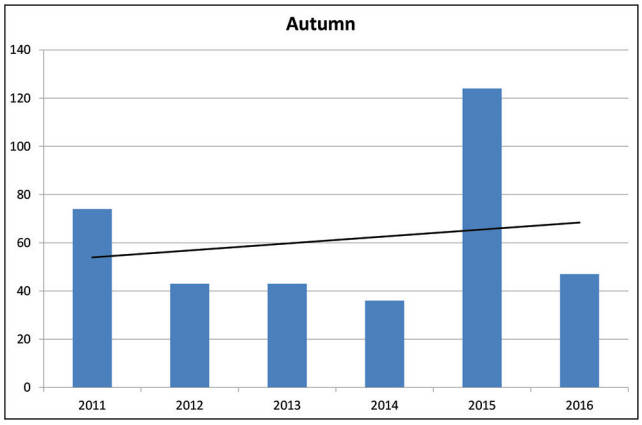

Figure 2.
Maximum number of Fennoscandian LWfG individuals in autumn in the years 2011-2016.

2. Results and discussion

During the migration periods from autumn 2011 up to spring 2017, the observations both in spring and autumn showed a positive trend in the maximum numbers of individuals from the Fennoscandian population (**Figure 1 & 2**).

Some trends can be identified, but 2016 was an exceptional year. As one possible explanation for the low number of individuals in autumn, we consider that we observed two parts of the whole flock. The first part consisted of 35 LWfG that arrived and after their departure, a second group of 47 LWfG arrived two days later. This could potentially explain why after observing 41 individuals throughout half of September on Kerkini Lake, 57 additional LWfG arrived on September 23rd, and the numbers slowly began to rise. However, even by adding the two numbers together (which is 82) it is a lower result than expected.

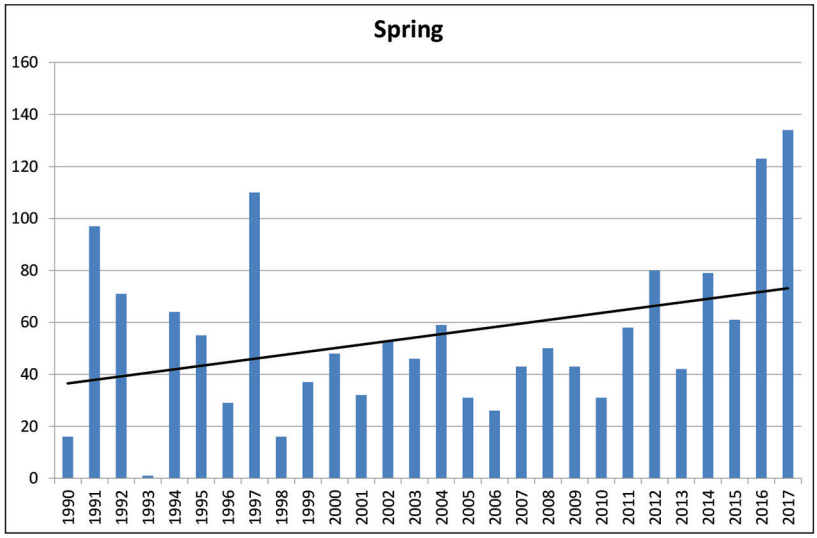

Figure 3.
Maximum number of LWfG individuals in spring during the years 1990-2017. The data include birds from both the Fennoscandian and Western main populations.

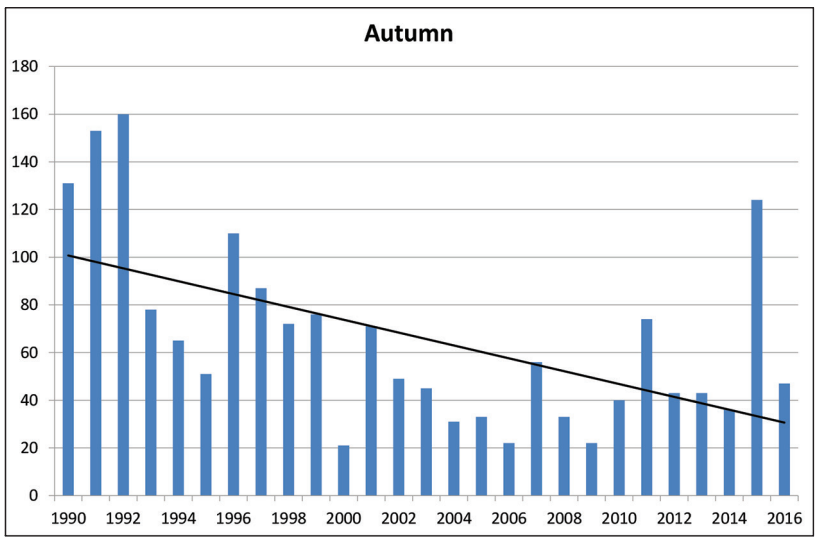

Figure 4.
Maximum number of LWfG individuals in autumn in the years 1990-2016. The data include birds from both the Fennoscandian and Western main populations.

As it can be seen (**Figures 5 & 6**), the Fennoscandian LWfG are spending fewer days at the Hortobágy National Park in autumn, a dramatical decline that is hard to explain.
Possible explanations could be related to the slowly raising temperature and drought in the Hortobágy region during the whole year and the migration season as well. The average temperature of September in 2013-2016, as the crucial month for the LWfG, were 15.7°C, 17.4°C, 18°C and 18.9°C respectively (**http://www.amsz.hu/eszleles/static_charts/**).

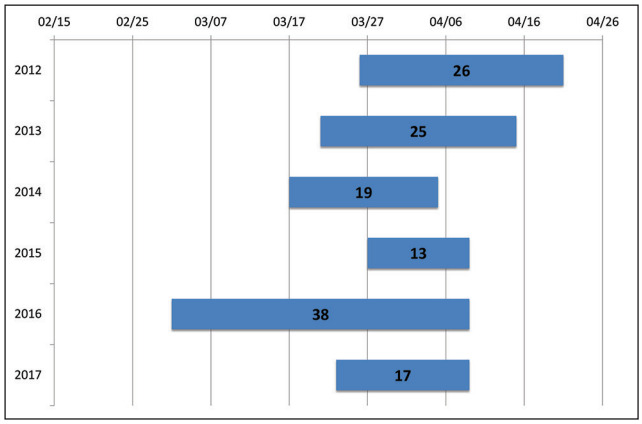

Figure 5.
Timing of staging period and total number of days for Fennoscandian LWfG during spring in the years 2012-2017.

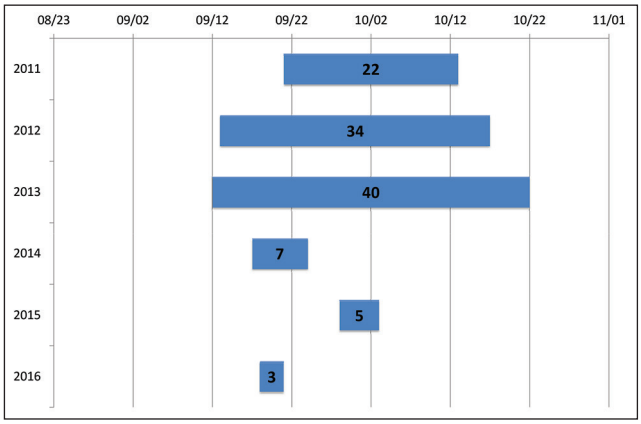

Figure 6.
Timing of staging period and total number of days for Fennoscandian LWfG during autumn in the years 2012-2016.

LWfG were observed eight times (1-7 individuals) during the monitoring of Lake Tisza, all of them were from the Western-Main population (Hortobágy Environmental Association 2016).

2016 was a year with significant observed changes in the LWfG phenology. During spring the Fennoscandian flock remained in the area much longer (over a month) than usual, while in September they remained only 3-4 days. Significant changes in the spatial distributions of the LWfG at the Hortobágy were also documented and the LWfG showed preference to the newly managed habitats for feeding and roosting. The LWfG concentrated around the Kondás site and the northern Hortobágy-fishponds, using mainly the surrounding habitats for feeding (Kecskés, Rókás, Vince-fenék grassland/marshland habitat mosaic areas; **www.piskulka.net**, HNPD database).

The low number of LWfG observed at Lake Tisza was probably an effect of the absence of natural feeding habitats and the high disturbance within this artificial environment (Lake Tisza is surrounded by heavily used agricultural lands) and because it's not a traditional site for the Fennoscandian flock.

During the project period a number of important conservation actions have been implemented to safeguard the Fennosandian population at it's most important staging areas in Hungary. As documented during this project, the Hortobágy National Park with adjacent areas, is an international hot-spot for the conservation of the species, and is especially important for the Fennoscandian population. In additon, an increasing number of sporadic observations of single to smaller groups of LWfG are observed at traditional goose stop-over sites during the migration and wintering periods throughout Hungary. These scattered single individuals or small numbers of Lesser White-fronted Geese most likely originate from the Western Main population of the species breeding in western and central Russia. The new National Action Plan for LWfG in Hungary describes conservation actions both for the Fennoscandian and Western Main population. The growing number of observations of individuals, sometimes even smaller flocks of LWfG from the Western Main population, neccesitates implementation of conservation actions in new sites and areas in Hungary not covered by the present project.

3. Acknowledgements

Monitoring of the LWfG in the Hortobagy National Park was conducted in the framework of the EU LIFE + project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway" (LIFE 10 NAT/GR/000638), which was funded by the European Commission and the Norwegian Environment Agency.

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Diet composition of Lesser White-fronted Geese *Anser erythropus* wintering in Greece

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A Lesser White-fronted Goose feeding on grasses in captivity. © Morten Ekker

1. Introduction

The Lesser White-fronted Goose (*Anser erythropus*), hereafter LWfG, is classified as Vulnerable according to the criteria of the IUCN Red List of Threatened Species (Birdlife International 2013) and as Critically Endangered in the Red Data Book of the threatened animals of Greece (Legakis & Maragou 2009). The known breeding areas of the Fennoscandian population are located in Northernmost Norway, while the known wintering sites are located in east central Europe and the Balkans (Jones et al. 2008). The main wintering areas for the LWfG in Greece are the Kerkini Lake and the Evros Delta (Kazantzidis & Naziridis 1999, Vangeluwe 2004).

Information is available on the diet composition of the LWfG in Northern Europe during spring, summer and autumn (Lorentsen & Spjøtvoll 1990, Aarvak et al. 1996, Niemelä & Markkola 1997, Markkola et al. 2003), where grasses are the most important food category for the LWfG, and consumption of dicotyledons is at a relatively low level. During winter however, knowledge of LWfG diet composition is extremely poor. Based on the analysis of 9 droppings collected in Evros Delta during the wintering period of 2005 – 2006, grasses were also identified as the main food resource for LWfG (Karmiris et al. 2009). With the exception of this note on the wintering diet of LWfG, no other relevant research has been conducted. An assessment of foods consumed by LWfG is crucial for understanding their feeding ecology and is essential for the design and implementation of appropriate management of their wintering habitat.

We addressed this issue by investigating the diet composition of the LWfG at its wintering areas in Northern Greece, namely at the Kerkini Lake and the Evros Delta during the 2011-2012, 2012-2013 and 2013-2014 wintering periods, using the method of microhistological analysis of droppings.

2. Study areas and Methods

2.1 Kerkini Lake

Kerkini Lake is a freshwater reservoir created in 1932, mainly for irrigation and flood control purposes, following the construction of a dam along the Strymon River. In 1982, dykes were constructed along the eastern lake coast and the dam height was increased. Kerkini Lake is a National Park included in the list of wetlands of international importance (according to the Ramsar convention), and is part of the Natura 2000 network as a Special Area for Conservation (SAC) and a Special Protection Area (SPA) where goose hunting is forbidden.

The study area was the marshy habitat (no more than 300 - 400 m away from the shoreline) in the northern and eastern parts of the Kerkini Lake. It is dominated by plant species adapted to grow under these conditions, such as the *Echinochloa crus-galli, Paspalum paspalodes, Ranunculus* spp. and species of the *Cyperaceae* family. Goose species, such as the Greater White-fronted Goose *Anser albifrons*, the Greylag *Anser anser* and, occasionally in very small numbers, feral Egyptian Geese *Alopochen aegyptiacus* also use the same feeding habitat as the LWfG.

2.2 Evros Delta

Since 1986, the Evros Delta is also included in the list of wetlands of international importance (according to the Ramsar convention), and it is part of the Natura 2000 network as a SAC and a SPA. Over the last 60 years, various draining projects were instigated in the area, whose primary objective was to increase the amount of arable land available. As a result, a decrease in the aquifer level and a concomitant increase of soil salinity were observed that eventually favoured the halophytic vegetation over the, less tolerant to salinity, grass-forb communities. Nowadays, the vegetation communities are both variable and patchy due to the shifting properties of the environmental conditions, namely, the presence or absence of fresh water, water quality and depth, levels of salinity, etc. Several human activities, such as hunting, agriculture, livestock farming, fishing and recreation, are carried out in Evros Delta.

The main habitat of LWfG in Evros Delta is at the Dimitriadis grassland, which is a typical Mediterranean halophytic grassland dominated by halophytes (*Salicornia* spp., *Limonium* spp., *Halimione portulacoides*, *Halocnenum strobilaceum*), grasses (*Cynodon dactylon*, *Puccinelia festuciformis*, *Poa* spp., *Agropyron* spp.), grass-likes (*Carex* spp.), legumes (*Trifolium* spp., *Medicago* spp.) and other forbs (*Taraxacum officinale*, *Plantago* spp., *Potentilla* spp.) (Platis et al. 2013). Several other avian and mammalian wild herbivores, such as the Greater White-fronted Goose and the European Hare *Lepus europaeus*, as well as livestock (cattle) also use this area for feeding.

The Dimitriadis grassland, Evros Delta. A valuable coastal grassland which is used as a feeding area by the LWfG, usually during January and February, and other avian herbivores, such as the Greater White-fronted Goose, as well as by cattle and European Hares. © Ilias Karmiris, January 2014

LWfG dropping collection. © Savas Kazantzidis, October 2013

2.3 Methods

Fresh LWfG droppings were collected at Kerkini Lake during the 2012-2013 and 2013-2014 wintering periods and at Evros Delta during the 2011-2012, 2012-2013 and 2013-2014 wintering periods. The LWfG flock was located using a telescope in order to identify its exact location without causing any disturbance. When the LWfG flock was not mixed with other goose species, fresh droppings were collected *in situ* following the flock departure. When dropping piles where located; only one dropping per pile was analysed to minimize the possibility of including different droppings belonging to the same individual. In total, 246 (Kerkini Lake) and 82 (Evros Delta) LWfG droppings were collected, stored separately in plastic bags, and analysed microscopically at the laboratories of the Forest Research Institute in order to estimate the LWfG diet composition.

Microhistological analysis of droppings is the most frequently used method to estimate the diet composition of wild and tame herbivores (Paola et al. 2005). This technique causes minimal

disturbance to secretive and endangered species (Holechek & Gross 1982a), such as the LWfG. The dropping samples were oven dried at 60 °C for 48 hours, grounded, mixed thoroughly and sieved through a 1-mm mesh screen to ensure particle uniformity. Five microscopic slides were prepared per dropping. Twenty systematic fields per slide were examined for particle frequency, with a field defined as the area visible on a microscope slide using 100 x magnification. The relative frequency for each plant species was calculated as its frequency divided by the sum of frequencies of all species (Holechek & Gross 1982b). Each plant species identified in the LWfG droppings was assigned to one of the following forage classes:

Kerkini Lake:
(1) grasses, (2) other graminoid species (species of the *Cyperaceae* and *Juncaceae* families), (3) aquatic plants, i.e. submerged, emerged and amphibious species that occur in permanently or seasonally wet environments and (4) forbs, i.e. all other broad-leaved herbs present in the non-marshy grassland area.

Evros Delta:
(1) graminoids (grasses and other graminoid species), (2) halophytes, (3) legumes, (4) other forbs.

3. Results

3.1 Kerkini Lake

At least 33 plant species were recognized and quantified in the droppings of the LWfG during this study at Kerkini Lake. The main food of LWfG was grasses (especially *Echnochloa crus-galli*) and other graminoids (mainly species of the *Cyperaceae* family). About the 2/3 of the LWfG diet composition was constituted by these two categories of plant species (**Table 1**). Aquatic species and other forbs were also found in the droppings of the LWfG but to a lesser extent (about the 1/4 of the total diet). *Echinochloa crus-galli, Paspalum paspalodes, Cyperus spp., Scirpus lacustris, Limosella aquatica* and *Ranunculus sceleratus* constituted important food resources for the LWfG in all sampling periods. These species are mainly found in the marshy habitat of the Lake, but some of them (*Paspalum paspalodes*) are also part of the vegetation composition of the terrestrial habitat. A great similarity of food items was observed among LWfG droppings during the whole period of the study.

3.2 Evros Delta

The diet composition of LWfG at the Evros Delta included at least 18 plant species. The main food was grasses (mainly *Poa* sp., *Bromus hordeaceus, Avena barbata*, and *Hordeum* spp.) as they constituted about 1/3 of the total diet (**Table 2**). Grasses and other graminoids (Carex spp.) constituted almost half of the total diet composition. Consumption of halophytes (*Halimione portulacoides* and *Salicornia europaea*) was relatively high (about 20%). Legumes (*Trifolium* spp. and *Medicago arabica*) and other forbs (mainly *Spergularia media*) were consumed by the LWfG in smaller percentages, however these forage categories constituted together about the 26% of the total diet. As in Kerkini Lake, limited variation of food items was also observed among LWfG droppings collected in Evros Delta.

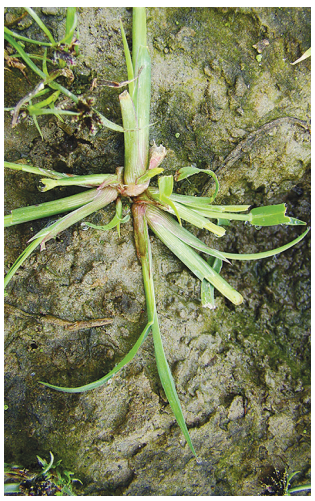
A pile of LWfG droppings at the river mouth, Kerkini Lake.
© Ilias Karmiris, November 2013

Forage category	Dry Weight (%)
Grasses	**58.0**
Other graminoids	**12.0**
Aquatic plants	**10.2**
Forbs	**11.8**
Unidentified	**8.0**

Table 1.
Consumption of major forage categories by LWfG based on 246 droppings in Kerkini Lake during the 2012-2013 and 2013-2014 wintering periods.

Forage category	Dry Weight (%)
Grasses	**34.7**
Other graminoids	**11.7**
Halophytes	**20.0**
Forbs	**26.6**
Unidentified	**7.1**

Table 2.
Consumption of major forage categories by LWfG based on 82 droppings in Evros Delta during the 2011-2012, 2012-2013 and 2013-2014 wintering periods.



Echinochloa crus-galii heavily grazed by LWfG at Kerkini Lake. This plant species constitutes the main food resource for LWfG during the wintering period at the Kerkini Lake. However, the availability of above ground biomass of this plant species is greatly reduced from the middle of December and onwards, due to the usually low prevailing air temperatures during the winter (unpublished data).
As a consequence, during the remainder of the wintering period, LWfG either increases the consumption of other available plant species at Kerkini Lake (mainly graminoids), or departs to Evros Delta.
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4. Discussion

The LWfG consumed mainly grasses in both study areas; however, the diet composition between the two wintering habitats (Kerkini Lake and Evros Delta) varied significantly, highlighting the flexibility in LWfG feeding behavior. The LWfG habitat in Kerkini Lake differs significantly from the one in Evros Delta. The former is a marshy, temporarily flooding, freshwater habitat dominated by aquatic and other plant species adapted to grow under such conditions and the latter is dominated by halophytic vegetation and generally by species capable to grow in soils with high salinity levels. This difference was reflected in the diet composition of the LWfG in the two study areas.

LWfG consumed biomass produced by several plant species capable of growing in the marshy habitat at Kerkini Lake and in the Dimitriadis grassland in the Evros Delta. These species are commonly found in European temporary flooded and halophytic dominant areas and especially in the Balkans and Eastern Europe (Pál et al. 2006, Lukács et al. 2013, Dítě et al. 2015), i.e. along the LWfG flyway. Although the LWfG consumed a variety of plant species in both wintering areas, the limited variation of the diet composition that was observed among LWfG droppings indicates that the individuals in the LWfG flock consumed more or less the same food items, in similar proportions, and on the same feeding grounds.

The trend observed in this study (i.e. grasses constitute the main food for the wintering LWfG) has also been reported for this species during the breeding season (Aarvak et al. 1996, Niemelä & Markkola 1997, Markkola et al. 2003). In general, grasses on rangelands, pasturelands and agricultural crops are considered an important food category for many goose species (van der Wal et al. 2000, Best & Arcese 2009, Soininen et al. 2010). Grasses were also the preferred food resource for LWfG at Kerkini Lake (Karmiris et al. 2017). Although goose species tend to exhibit more or less constant food preferences in their feeding areas (Summers et al. 1996, Gill et al. 1997), neighbouring habitats with suitable nutritional resources may attract them away from regularly used habitats (Bos et al. 2005, Fox et al. 2005, Wang et al. 2013). Thus, the provision of adequate food stocks in their wintering areas, which are not subject to hunting, is potentially a valuable management tool for the conservation of LWfG and its wintering habitats. Increasing the availability of food could expand the carrying capacity of the wintering sites and prolong the length of the LWfG stay within the boundaries of the protected area, and thus reduce LWfG movements to other, less protected or of lower quality habitat areas. This may further reduce the threat of accidental shooting of LWfG (the main threat of the LWfG according to Jones et al. 2008), as it was recorded in 2007, when an adult bird was found shot outside the protected area of Kerkini Lake (Tsougrakis et al. 2009). The further and in depth investigation of the potential influences of the food availability on the feeding behavior and the movement pattern within and between habitats of LWfG during the upcoming years should be a high research priority. This knowledge is required to assist in prioritizing multiple management actions for the conservation of the European LWfG population and its habitats.

5. Acknowledgements

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Diet and feeding habitats of the Lesser White-fronted Goose in the Hortobágy National Park, Hungary

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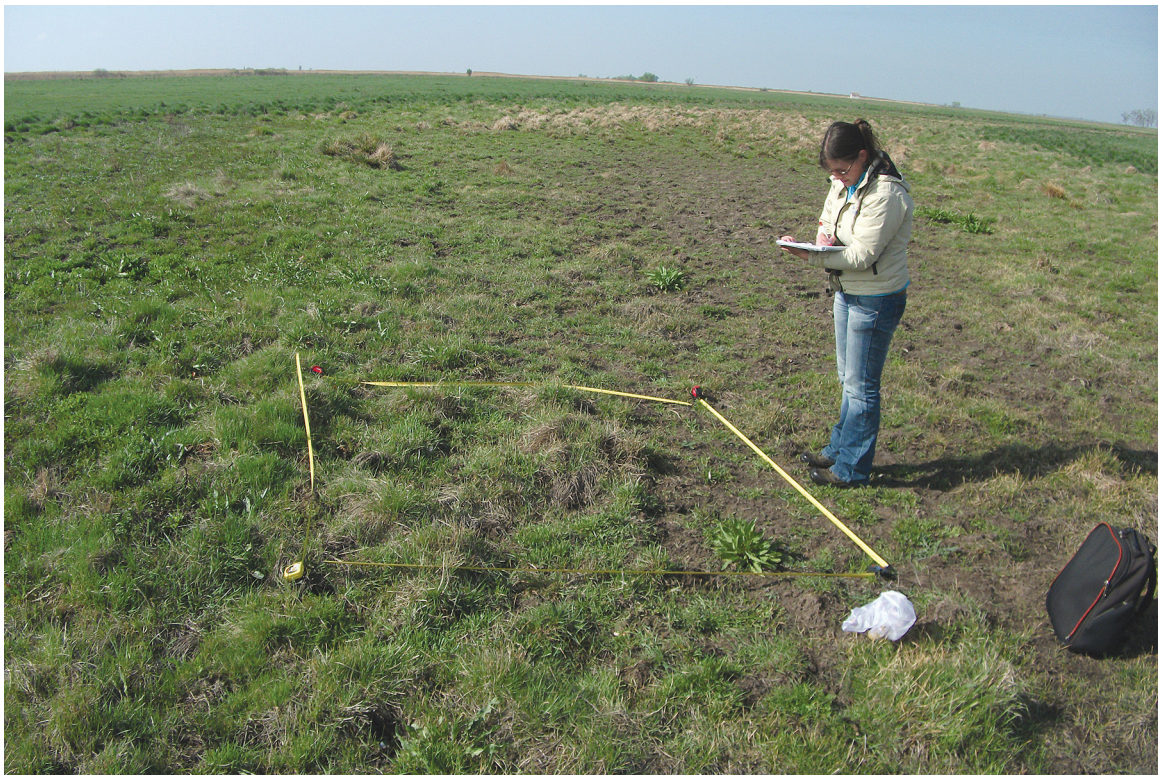

Botanical data collection at the Rókás site, Hortobágy National Park, Hungary in April 2011. © David Bogyo/HNPD archive

1. Introduction

The Hortobágy National Park (Hungary) is an important and traditional stopover site of the globally threatened and vulnerable Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) (Jones et al. 2008, Bogyó et al. 2014). Continuous, natural grasslands cover an almost 54,000 ha area within the 82,000 ha National Park. This large area is diversified by different wetlands, patches of alkaline marshes, fishponds, small croplands and forests (***www.hnp.hu*** accessed on 17/02/2017).

The Fennoscandian population of the LWfG has witnessed a dramatic decline from an estimated 10,000 individuals (early 20th Century) to 20-30 breeding pairs (2000's) (Jones et al. 2008). However, due to the continuous conservation efforts along the European flyway, a positive population trend is visible recently with more than 130 individuals (***www.piskulka.net*** accessed on 17/02/2017). We believe that the diet and habitat selection, migration, genetics, and behaviour of even such a flagship species were insufficiently studied in the past. In the framework of the LIFE10 NAT/GR/000638 "Safeguard the LWfG" project, intensive literature research, field and laboratory work were carried out in order to collect and summarize the information about the diet composition of the target Fennoscandian LWfG population (Bogyó et al. 2014, Valkó et al. 2014).

LWFG feeds on plant material, mainly grasses (*Poaceae*). At the staging sites in Finland, the species prefers to feed on Red Fescue *Festuca rubra*, Common Reed *Phragmites australis* and Slim-stem Reed Grass *Calamagrostis stricta* (Markkola et al. 2003), as well as on Soft-stem Bulrush *Schoenoplectus tabernaemontani* and Timothy-grass *Phleum pratense* (Markkola 2001). At the main staging site in Norway, the most important spring food source is the Creeping Alkali Grass *Puccinellia phryganodes* and in springs with late thaw, the Fourleaf Mare's tail *Hippuris tetraphylla* (Aarvak et al. 1996). In Estonia observations have shown that LWfG feeds on Rush-leaved Fescue *Festuca arenaria* in coastal meadows (Toming 2012).

2. Diet of the Lesser White-fronted Goose in Hungary – a literature review

During the migration period, LWfG uses natural flooded grasslands as staging areas, more than other goose species do (Markkola et al. 2003). Probably the food choice of the LWFG depends on food availability of the large open grasslands with newly sprouted vegetation along their migratory route (Toming 2012). In Hungary, the LWfG feeds in three habitat types (Bogyó et al. 2014), listed according to importance:

- short grazed – and freshly grown – alkalic steppe areas with adjacent alkalic meadows/wetlands
- pioneer/temporary mud vegetation - vegetation of wetlands and fishponds;
- agricultural lands

2.1 Field observations (1940-2009)

The LWfG are connected to the alkali short grassland associations *Festucion pseudovinae* during their stay in the Carpathian basin. This kind of steppe habitat is mainly located in Eastern Hungary, which explains the frequent occurrence of the species in this region (Sterbetz 1968, Sterbetz 1978). Unlike other goose species, the flock(s) of the Fennoscandian LWfG population usually uses a smaller area during their stay in Hungary and mostly feed in a single homogeneous flock (Lengyel et al. 2012). According to the observations of Sterbetz in 1978, the LWfG usually feed within a circle of 5-6 km (diameter) in the traditional sites of Eastern Hungary (Hortobágy, Biharugra, Kardoskút). He also stated that during early spring and wet autumn periods, LWfG do not leave their night roosting areas and feed on the same freshly grown mud vegetation. The only case when LWfG fly further than the distances mentioned above was when they mixed with other geese (presented in higher abundance). On the contrary, at the same time and place Greater White-fronted Geese (GWfG) were feeding within a circle of 10-20 km (diameter), sometimes up to 20-70 km (Sterbetz 1978). Summarizing his own data (200 observations) between 1940 and 1970, Sterbetz (1990) also concluded that LWfG were feeding mainly on alkali short grasslands (64%) and also on freshly grown mud vegetation of fishponds (18%) and freshly grown cereals (18%) in the traditional sites of eastern Hungary (Hortobágy, Biharugra, Kardoskút).

Kovács (1990) summarized his observations of the feeding habits of the Fennoscandian LWfG flock in 1989 in Hortobágy. The Fennoscandian flock (20-82 individuals) stayed on the Hortobágy fishpond no. V between 18/09/1989 and 6/10/1989. The daily routine of the birds was as follows: they grazed mainly on the alkali short grassland associations near the fishpond, but before the daily rest around noon they also fed on the drier mud surfaces of the pond (Common Barnyard grass *Echinochloa crus-galli* and Knotweed *Polygonum* spp.). It was also observed that the regular feeding outside of the fishpond(s) was replaced by grazing on the mud vegetation of the fishpond no. V, allowing enough food for the whole day.

Kovács & Tar (2004) concluded that the Fennoscandian population recently feeds on the drained fishponds and the surrounding short grazed alkali grassland-wetland mosaics, preferring the littoral zones with freshly grown vegetation. They noted that in the Dinnyés-lapos wetland (near the Hortobágy fishponds) LWfG preferred the littoral zone dominated by sandspurrey *Spergularia* spp.. Around the Hortobágy fishponds, autumn rains support the regrowth of the alkali grasslands (with dominating species of False Sheep Fescue *Festuca pseudovina*, Eastern Saltmarsh-grass *Puccinellia limosa*, Bulbous Bluegrass *Poa bulbosa*) that attract LWfG flocks. In the case of drier seasons, they also utilize the pioneer mud vegetation of the fishponds (e.g. Knotweed *Polygonum* spp., Sorrel/Dock *Rumex* spp., Common barnyard grass *Echinochloa crus-galli*). Very rarely, the Fennoscandian LWfG also feed on croplands (maize stubble, autumn cereals and rape), but only if they are mixed with other geese (mainly GWfG).

In the framework of the LIFE project "Conservation of the LWfG on the European migration route" LIFE05 NAT/FIN/000105 (2005-2009), geese were supported through providing safe, extensively cultivated croplands (maize and wheat) within the borders of the Hortobágy National Park (Ecsedi et al. 2009). These places attracted mainly Greylag Goose *Anser anser* and Common Crane *Grus grus* flocks, while LWfG only rarely visited these sites. These findings are in accordance with the former research of Sterbetz (1978).

2.2 Stomach content analyses in Hungary (1954-1990)

Sterbetz (1978) analysed the stomach content of 100 LWfG collected from 1954 to 1976 at Eastern-Hungarian stopover sites (Biharugra, Szegedi Fehér-lake, Hortobágy, Kardoskút and Orosháza). He stated that the LWfG are feeding mainly on alkali grasses in steppe habitats, while other goose species tend to be more and more connected to croplands. He also highlighted the importance of the decrease of the natural alkali grassland habitats. In the stomach content of 40 LWfG examined between 1954 and 1969 he found no traces of maize, while the stomach content of 60 LWfG examined between 1970-1976 contained maize only in a low frequency (8 individuals, 13.3%) and a very low amount per individual. For comparison, it is interesting to take a look on the GWfG stomach contents in the same publication: maize was found in the stomach content of 18 from 132 individuals (13.6%) examined between 1947-1969, while between 1970 and 1976 this percentage increased to 68.8% (88 from 128 individuals) (Sterbetz 1978).

Later, Sterbetz (1990) analysed the stomach content of another 103 LWfG individuals from Eastern-Hungarian sites (Hortobágy, Kardoskút, Békéssámson, Orosháza, Biharugra, Telekgerendás and the Szegedi Fehér-lake). A percentage of 65% of these were feeding on alkali steppe habitats, while 27% was feeding on freshly grown cereals, and 8% was feeding on the fishponds. The stomach content of the individuals feeding on alkali steppe habitats consisted mainly of alkali grasses (75.4%). The stomach content of the individuals feeding on freshly grown cereals and on fishponds also consisted mainly of alkali grasses (60.6% and 55.0%). The dominant species was the False Sheep Fescue in all of the examined LWfG stomach contents.

The stomach content analyses in the above mentioned papers have no indication on the origin (Fennoscandian or Western Main population) of the examined individuals.

3. Diet analysis of the Lesser White-fronted Goose in selected sites of the Hortobágy National Park for the identification of habitat requirements (2011-2014)

In the framework of the LIFE10 NAT/GR/000638 project, the Hortobágy National Park Directorate and the University of Debrecen, Hungary aimed to:

- identify the preferred feeding habitats of the Fennoscandian LWFG in the Hortobágy, and evaluate food availability;
- provide information about the diet of the LWfG in Hortobágy

Additionally, this research also provided information about the role of goose species in plant dispersal (Tóth et al. 2016). For a complex analysis of the diet selection of the LWFG, a field survey was conducted in the feeding habitats, where the percentage cover scores and total species lists of vascular plant species was recorded. Droppings of the LWFG were collected in order to estimate, which plant species were preferred by the geese from the species pools (total species list of vascular plants) of the feeding habitats. The size of the droppings was characterised, and then we concentrated droppings and germinated their

seed content. We compared vegetation of feeding patches and species found in the droppings to estimate diet selection.

The characteristic species of most alkali grassland types are widely distributed grass species with a wide range of humidity and salt tolerance: *Agropyron repens, Agrostis stolonifera, Alopecurus pratensis, Beckmannia eruciformis* and *Festuca pseudovina*. Alkali grasslands are mainly covered by several grassland species characteristic to Eurasian continental steppes and several endemics to the Carpathian basin. Large homogeneous stands of a single alkali grassland type can rarely be found; various types of grasslands form a heterogeneous mosaic along an uneven pattern of soil salt contents, relief and water availability. In a landscape characterized by alkali grasslands near the highest elevated plateaus with less vegetation, stands of *Achillea* alkali steppes are situated. Near the *Achillea* alkali steppes, but at lower elevations, typical Artemisia alkali steppe vegetation is located on soils with higher salt content (solonetz or solonchak) (Török et al. 2011). The lowest elevations are dominated by alkali meadows, while in the deepest depressions alkali marshes are situated. Cattle or sheep grazing is typical in all feeding habitats of LWfG.

3.1 Vegetation survey in the feeding habitats

We surveyed the feeding habitats of LWfG in Hortobágy in the spring; summer and autumn of 2012 and in the summer of 2014. We identified the most frequently used habitat types, which are open, intensively grazed grasslands:

- Alkali short grasslands dominated by *Festuca pseudovina* and *Artemisia santonicum* (Artemisio-Festucetum pseudovinae association).
- Alkali short grassland dominated by *Festuca pseudovina* and *Achillea collina* (Achilleo- Festucetum pseudovinae association).
- Heavily grazed, species-poor alkali wet meadows (Agrostio-Alopecuretum pratensis association.
- Open vegetation patches characterized by forb species (*Rumex cripus, Rorippa kerneri, Polygonum lapathifolium*) in alkali wet meadows.
- Open alkali grasslands (Puccinellietum limosae association) dominated by *P. limosa* and annual forbs (*Matricaria chamomilla, Lepidium ruderale, Myosurus minimus*).
- Temporal mud vegetation (in Kondás fishpond) characterised by pioneer weedy species (*Polygonum lapathifolium, Chenopodium* spp.) and aquatic plants (*Nymphoides peltata*).

In order to study food availability, we recorded the percentage cover of vascular plants in the most frequently used habitat patches in seven 2×2-m plots. In total, we recorded 81 vascular plant species in the feeding habitats. We found that the most frequent species in the feeding habitats were *Festuca pseudovina, Alopecurus pratensis, Juncus compressus* and *Rumex crispus* (for detailed species list and percentage cover in the habitats see Valkó et al. 2014).

3.2 Analysis of goose droppings

An alternative method for diet studies of threatened species is the determination of plant fragments in faecal pellets (Markkola et al. 2003, Karmiris et al. 2009). In order to evaluate the diet composition during spring and autumn migration we collected ca. 50 droppings of LWfG in each feeding habitat patch in Hortobágy in October 2011, April 2012, October 2012 and October 2013. As a control, we also collected droppings of other goose species (mainly GWfG, Greylag Goose and Red-breasted Goose *Branta ruficollis*) in the same feeding habitats. We have collected goose droppings during migration in the autumn of 2011, 2012 and 2013, as well as, in the spring of 2012. We searched for droppings in 6 sites, with more than 50 droppings from each site and each species/species group. During the three years we collected more than 700 LWfG droppings and more than 500 droppings from the "other Geese" category.

The droppings were dried for two weeks at room temperature. Then we measured dry weights, length and width of them. After the droppings were measured, they were concentrated on two different meshes according to the international protocol of ter Heerdt el al. (1996). Rough plant particles were retained on a coarse mesh (2.8 mm), while seeds and fine plant tissue fragments were retained using a fine mesh (0.2 mm). The used method enabled us to concentrate the samples by washing out fine mineral and organic particles and to reduce sample volume.

Goose droppings at the Rókás site, Hortobágy National Park, Hungary in April 2011.
© Dávid Bogyó/HNPD archive

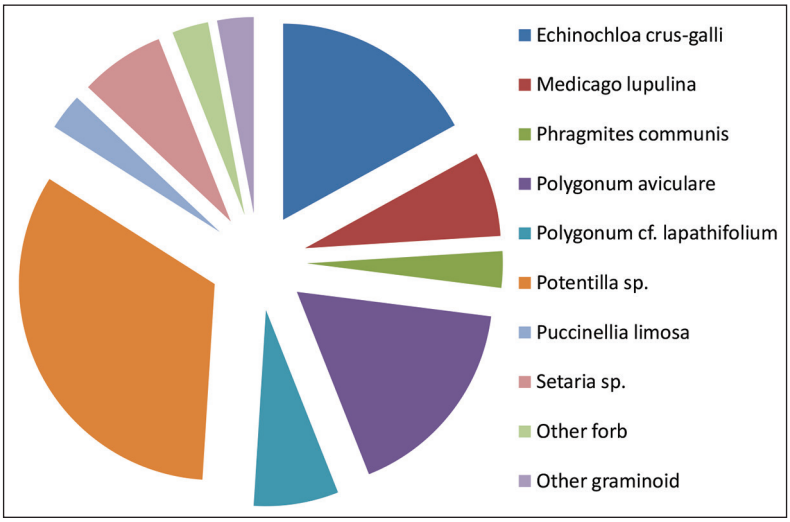

Figure 1.
Seed content in the Lesser White-fronted Goose droppings identified by mechanical sorting (following Valkó et al. 2014).

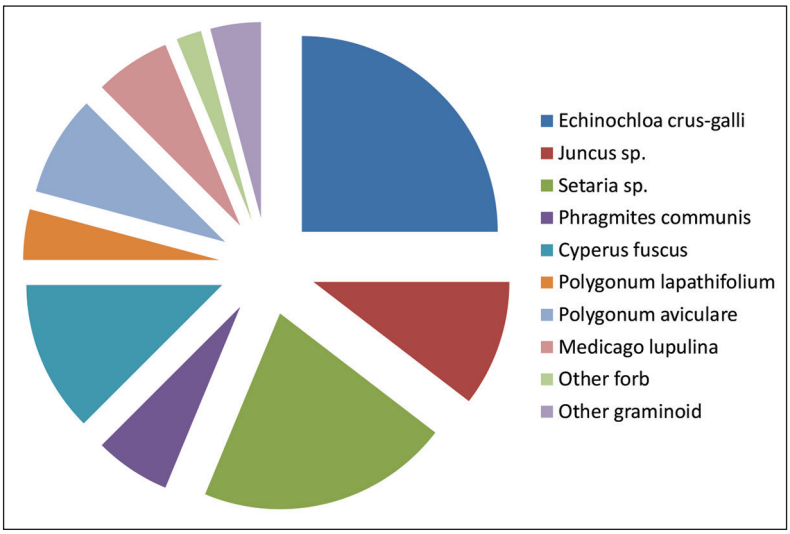

Figure 2.
Seed content in the droppings of other goose species identified by mechanical sorting (following Valkó et al. 2014).

3.3 Physical sorting of seed fragments

To enable the identification of seed fragments in droppings, we collected reference specimens of seeds for every species available at the feeding habitats. Seed fragments were retained either on the coarse or on the fine mesh after sample concentration were analysed using a Zeiss Stemi C-2000 high definition microscope. For species identification, besides the reference seed collection, we used also seed identification books (Schermann 1967, Bojnańsky & Fargašová 2007). This method is suitable for the detection of relatively large and hard-seeded species. The identification based on seed fragments enabled us to identify four forb and four graminoid species in LWFG droppings, while three forb and five graminoid species in "other geese" droppings, respectively (**Figure 3** and **Figure 4**).

3.4 Germination experiment

Before sample concentration, dry mass of 40 droppings from the same sample site and date were measured and then were pooled and germinated together. After the separation of plant tissue fragments by sieving, concentrated samples were put in water in order to make them more feasible for further processing. Samples were spread in a thin layer on the surface of steam sterilised potting soil in germination boxes. Samples were germinated under natural light conditions in a mobile plastic greenhouse using the method of ter Heerdt et al. (1996). The method is very effective and reliable to identify very small and germinable seeds which cannot be separated using mechanical separation methods (e.g. small-seeded species belonging to *Cyperaceae* and *Juncaceae* plant families). The germination was started in February, 2013. Samples were regularly watered and all germinated seedlings were counted and identified regularly. Unidentified seedlings were transplanted and grown till identification.

We found that 94% of germinated seedlings from LWfG droppings belonged to six species:
Chenopodium chenopodioides (Chenopodiaceae), *Cyperus fuscus* (Cyperaceae), *Echinochloa crus-gallii* (Poaceae), *Myosurus minimus* (Ranunculaceae), *Poa angustifolia* (Poaceae) and *Setaria viridis* (Poaceae). The most abundant species in LWfG droppings was *Echinochloa crus-gallii*, possessing more than 58% of total seedling number (**Figure 3**).

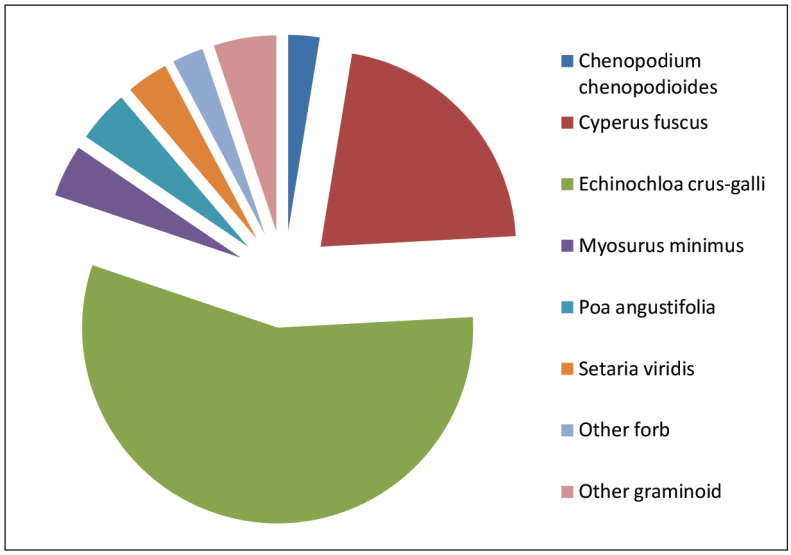

Figure 3.
Germinated seedlings from the droppings of LWfG (following Valkó et al. 2014).

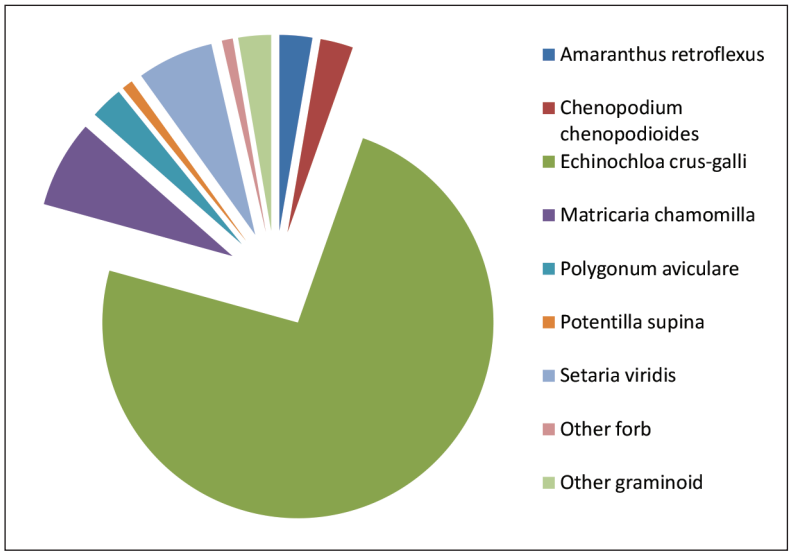

Figure 4.
Germinated seedlings from the droppings of other geese species (mainly GWfG, Greylag Goose and Red-breasted Goose) (following Valkó et al. 2014).

We found that 96% of germinated seedlings from droppings of other goose species belonged to seven plant species: *Amaranthus retroflexus* (Amaranthaceae), *Chenopodium chenopodioides* (Chenopodiaceae), *Echinochloa crus-gallii* (Poaceae), *Matricaria chamomilla* (Asteraceae), *Polygonum aviculare* (Polygonaceae), *Potentilla supina* (Rosaceae) and *Setaria viridis* (Poaceae). The most abundant species in LWfG droppings was *Echinochloa crus-gallii*, possessing more than 86% of total seedling number (**Figure 4**).

Summarizing the findings of this research project we conclude, that the most important feeding habitats of the Fennoscandian LWfG include:

- various types of shortgrass alkali grasslands (Artemisio – *Festucetum pseudovinae*, Achilleo – *Festucetum pseudovinae, Puccinellietum limosae*)
- alkali meadows (Agrostio – *Alopecuretum pratensis* and also weedy, degraded patches of alkali meadows dominated by *Rumex crispus*)
- temporary mud vegetation. LWFG preferred short and open grassland and meadow stands as feeding habitats.

We found that from the species' pool of the feeding habitats, mostly Poaceae (*Echinochloa crus-gallii, Poa angustifolia* and *Setaria viridis*) species and several Polygonaceae, Ranunculaceae and Cyperaceae seeds were found in the droppings. We could identify the species composition and amounts of seeds in the droppings, and we could make a rough estimation for the diet composition of LWfG. However, several species might be underrepresented in our analyses. There might be several species which are grazed by the geese but they mostly eat the vegetative organs of the plant, e.g. in case of grass species (*Festuca pseudovina, Agrostis stolonifera* or *Puccinellia limosa*).

For the management of open vegetation, extensive grazing by cattle or sheep is crucial in alkali landscapes. Grazing is necessary for the continuous removal of biomass and litter and also for maintaining short vegetation structure. It is also necessary to provide open muddy surfaces in fishpond systems to create suitable feeding habitats for LWfG. The species uses several grassland types for feeding; therefore it is crucial to provide a mosaic structure of shortgrass steppes, meadows and temporary muddy surfaces. Traditional grazing regimes should be implemented at the landscape scale to provide the mosaic habitat structure necessary for LWfG.

3.5 Field notes on the diet of the LWfG in the Hortobágy National Park and its surroundings (2011-2016)

During the current project from September 2011 until October 2016, Fennoscandian LWfG were observed mainly at two traditional sites: Hortobágy-fishponds and Rókás grassland (85 and 30 observations respectively) (**Table 1** and **Figure 5**). It is clear that these sites have the highest importance as roosting and feeding site for the Fennoscandian LWfG during their stay in the Hortobágy.

migration. During autumn migration, the Fennoscandian LWfG flock also feeds and roosts at other fishponds (Bivalyhalmi and Virágoskúti-fishponds) and adjacent areas (located ca. 12-18 km from the Kondás-fishpond).

In general, the Fennoscandian LWfG flock in the Hortobágy had a daily routine: In the early morning the flock leaves the roosting site (mainly Kondás) to feed at alkali grassland/marshland. During daytime they rest and drink again at the fishpond (mainly Kondás); and in the afternoon they usually feed at the pioneer

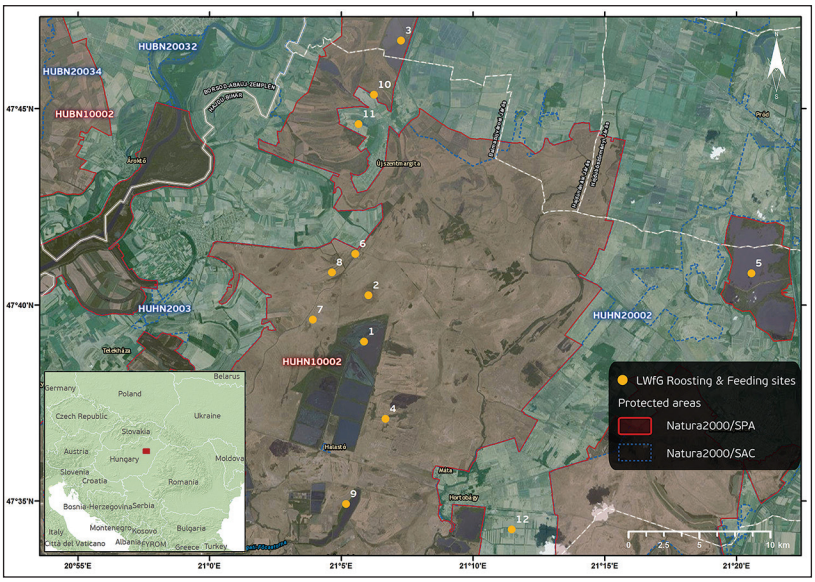

Figure 5.
Map of the roosting and feeding sites of the Fennoscandian LWfG in the Hortobágy, during the current project (09/2011 - 10/2016).
1. Hortobágy-fishponds,
2. Rókás,
3. Bivalyhalmi-fishponds,
4. Matyó-fenék and Vincze-fenék,
5. Virágoskúti-fishponds,
6. Cserepes-puszta,
7. Kecskés-puszta,
8. Boca-lapos,
9. Kungyörgy,
10. Nagy-szögi legelő,
11. Nyakas,
12. Borsós.

	Site	No. of observations	Average flock size	Spring phenology	Autumn phenology	Distance from HF (km)
1	Hortobágy, Hortobágy-fishponds (mainly Kondás fishpond)	85	38.79	23/03 - 21/04	13/09 - 22/10	-
2	Tiszacsege, Rókás (grassland)	30	40.63	21/03 - 21/04	17/09 - 01/10	1-2
3	Újszentmargita, Bivalyhalmi-fishponds	10	31.6	no obs.	29/09 - 17/10	14
4	Hortobágy, Matyó-fenék and Vincze-fenék (grass/marshland complex)	9	60.22	27/03 - 09/04	29/09	3-5
5	Balmazújváros, Virágoskúti-fishponds	7	2	no obs.	18/09 - 16/10	18
6	Tiszecsege, Cserepes-puszta (grassland)	3	48.67	no obs.	24/09 - 27/09	4
7	Tiszecsege, Kecskés-puszta (grassland)	2	4.5	10/04	21/09	3.5
8	Tiszacsege, Boca-lapos (grass/marshland complex)	1	36	no obs.	22/09	3.5
9	Hortobágy, Kungyörgy (grassland)	1	13	no obs.	01/10	6.5
10	Újszentmargita, Nagy-szögi legelő (grassland)	1	2	no obs.	03/10	12
11	Újszentmargita, Nyakas (grassland)	1	4	no obs.	02/10	11
12	Hortobágy, Borsós (arable fields)	1	3	20/03	no obs.	12

Table 1. *Roosting and feeding sites of the Fennoscandian LWfG in the Hortobágy, Hungary during the current project (09/2011 - 10/2016). Distance form HF (km): Distance from Hortobágy-fishponds (km)*

According to our field observations it is also clear, that the Fennoscandian LWfG almost never visit agricultural fields and have a very high preference to alkali grasslands, alkali meadows and temporary mud vegetation. The population almost never leaves the main roosting and feeding site (Hortobágy fishponds, mainly Kondás) and an area of 6.5 km radius measured from this site (**Table 1** and **Figure 5**). This is in accordance with the former findings of Sterbetz (1978), Lengyel et al. (2009) and Bogyó et al. (2014), and almost an exclusive trend in the spring

grasses of the mud-shores of the fishpond and leave the place again to feed at alkali grassland/marshlands nearby and in the evening they fly back to the roosting site (mainly Kondás). During the autumn season with decreasing daylight, the flock leaves the fishpond(s) for longer period(s). This kind of daily routine is often disrupted by White-tailed Eagles *Haeliatus albicilla* when the raptors attack resting waterbirds in the fishponds. The daily routine of the flock is similar in the autumn and spring migration period.

When the Fennoscandian LWfG were feeding on grasslands we observed a preference for halophytic grasses and „festuca associations" (*Artemisio – Festucetum pseudovinae, Achilleo – Festucetum pseudovinae, Puccinellietum limosae*). We also observed, that the LWfG usually prefer the more alkali patches within the alkali grasslands and marshlands. They graze usually continuously in a homogeneous flock, and during spring migration they also drink the available water of the alkali wetlands. Within the flock there is a "guarding" bird watching for possible threats. If the flock grazes undisturbed for a long period, the families or pairs move apart from each other.

3.6 Notes on the habitat use of the Western Main LWfG Population

During the years 2011-2016 at the Hortobágy National Park and its surroundings (Hajdú-Bihar and Jász-Nagykun-Szolnok counties), Hungary also hosted individuals from the Western Main Population at many different sites (number of observations: 448, **www.piskulka.net** accessed on 17/02/2017). These birds used a broader variety of habitats and a much larger area, following the huge flocks of GWfG coming into the Carpathian Basin from Siberia, usually after the 20th of October in autumn and leaving around mid-March in the spring. The individuals of the Fennoscandian population usually left the area to southern-European wintering sites by the 22th October and began arriving back by 21th March.

The daily routine of the Western Main Population individuals is similar to the GWfG. These LWfG individuals were usually feeding apart, at different agricultural fields. However, in recent years many goose flocks preferred well managed natural habitats instead of agricultural fields. For example, at the Nagy-Szik wetland habitat restoration site (sodic pan habitat, Hortobágy National Park, Balmazújváros) we observed LWfG 47 times during the project period, where they fed at short grazed halophytic vegetation (**www.piskulka.net** accessed on 17/02/2017). In the last years, we regularly observed 10 or more individuals of LWfG in mixed goose flocks, belonging to the Western Main Population that were not recorded previously.

4. Discussion

Hortobágy is a major stopover site for the the Fennoscandian LWfG population, however, the importance as a stopover and wintering site of the Western Main LWfG population is also becoming evident. Previous findings and our results strongly support, that the diet and habitat use of the species is very strongly connected to the halophytic grasslands and marshlands, with a preference of more alkali patches. We also found, that high grazing pressure as well as the partial presence of shallow water areas is a key factor influencing the feeding of the species.

In the future it is an essential task to manage the known feeding and roosting sites appropriately, in order to offer optimum habitat conditions for the LWfG. This requires constant effort (both in the terms of available personnel and financing) carried out by the Hortobágy National Park Directorate. We recommend focusing more intensely on the LWfG population shifting between different sites in the Hortobágy during its stay, especially during the autumn migration period. There is also a need to research the possible connection between food (availability), climate and the changing trends to the phenology of the Fennoscandian LWfG in the last 1-2 years. Lastly we consider important to research the feeding habits and habitat selection of the Western Main LWfG population in this area.

5. Acknowledgements

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View of the Hortobágy natural grassland. © Szilágyi Attila

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Grassland management at Evros Delta, a wintering habitat for the Lesser White-fronted Goose *Anser erythropus* in Northern Greece

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Natural grassland at Evros Delta National Park, Greece. © Roula Trigou/HOS

1. Introduction

The coastal grazing lands of the Evros Delta serve primarily as feeding and resting areas for several avian and mammalian herbivores, such as the Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG), the Greater White-fronted Goose *Anser albifrons* (hereafter GWfG), livestock (cattle) and other herbivores (Karmiris et al. 2011, Platis et al. 2013). Livestock grazing can influence the abundance and spacing of animal populations, as well as their feeding strategies (van der Graaf et al. 2002). Survival ability and reproduction success of many goose species are greatly influenced by habitat characteristics and vegetation structure; therefore, grazing may influence the population dynamics of geese, as well (Bos et al. 2005). Under appropriate management, livestock grazing can contribute towards an optimum habitat by keeping the vegetation height in relatively low levels (van der Graaf et al. 2002, Bos et al. 2005), and is thus, a suitable habitat management tool for the conservation, for avian herbivores in this area. In Evros Delta however, cattle graze freely in the same feeding habitats as geese and other wild herbivores, with unknown and possibly negative consequences both on vegetation dynamics and for the other herbivores. That's why it was an urgent need to design and implement a rational grazing management plan, which will quantify the cattle grazing effects on vegetation and wild herbivores, regulate the livestock grazing and increase the availability of the preferred forages for the herbivores. In the framework of the LIFE + project ("Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway", LIFE 10 NAT/GR/000638) this need was met in part by the special study of the wet meadows of the Evros Delta (Platis et al. 2013), where the grazing capacity, the grazing pressure, the herbage and halophytic production and other relative parameters in the study area were defined and described.

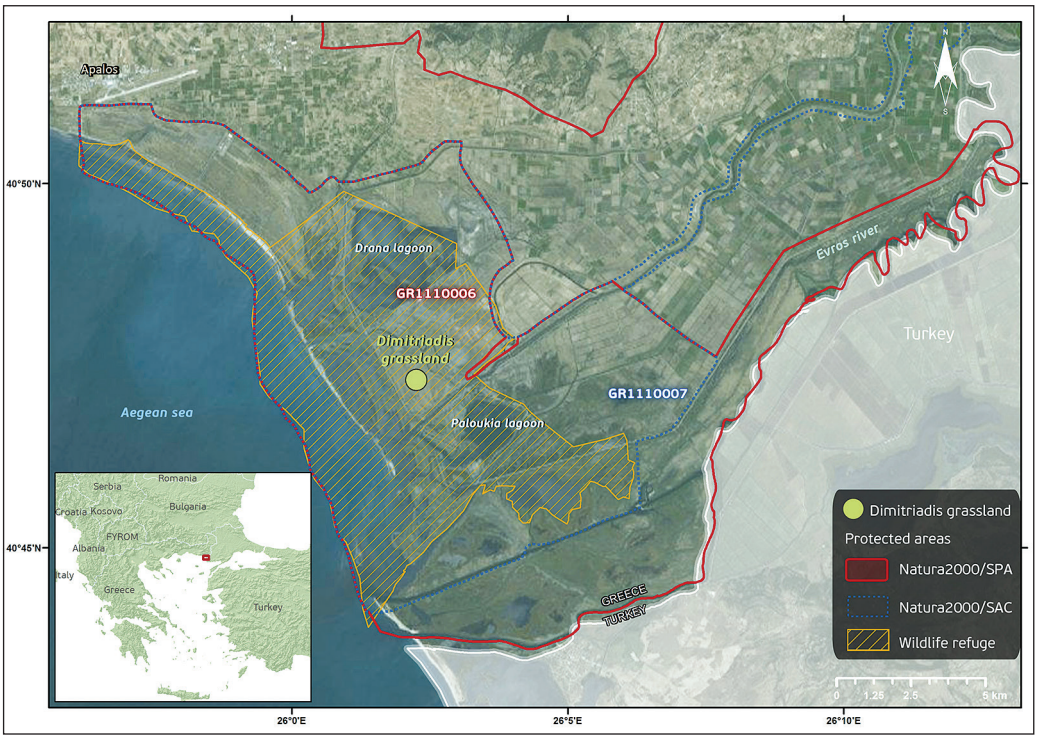
The study outlined the means and methods needed in order to improve the feeding and roosting conditions of the Fennoscandian LWfG population in the Evros Delta during the wintering period. During the implementation of this study, we aimed to increase the quantity of the heavily grazed grass-legume-forb patches and to decrease the high halophytic dominance by using mechanical methods (light ploughing with a tiller and a tractor) in three halophytic dominant sites, which subsequently were seeded with grasses and legumes. Systematic monitoring of the effects of the ploughing and seeding along with the herbivores' responses was undertaken in order to evaluate the success of the management practice (ploughing and seeding) and to propose further management actions incorporating the needs of wild and tame herbivores.

2. Study area and Methods

2.1 Study area

Dimitriadis" grassland (33.25 ha) constitutes the main feeding area for LWfG, GWfG, cattle and other herbivores in the Evros Delta. The entire area is dominated mainly by two vegetation communities (halophytic and grass-forb) forming a temporal dynamic mosaic due to many involved factors, such as water availability and quality, soil salinity, etc. Halophytic species, such as *Halimione portulacoides, Salicornia europaea* and *Limonium bellidifolium*, are the dominant species in this area. Grasses (mainly *Puccinellia festuciformis, Hordeum hystrix*, & *Poa* spp.) are the most valuable plants in the Evros Delta, as the major herbivore assemblages in this area, i.e. goose species, cattle, feral horses and European hares *Lepus europaeus*, use more intensively the grass communities and their main dietary items are the grasses (Karmiris et al. 2008, 2011). Other vegetation categories, which are encountered in these sites are legumes (mainly trefoils and medics), other forbs (with a great diversity of plant species, constituting only a minor portion of vegetation composition) and woody species (mainly *Tamarix* sp.), which grow either solitary or in small groups.

Cattle graze freely in this area (about 130 individuals) usually for 8-9 months yearly. The estimated grazing capacity in all Range Units was calculated as 950 AUM (Platis et al. 2013). However, grazing pressure is not uniform in the whole area – there are heavily grazed sites and others which are lightly grazed. More information on the study area can be found in the relevant study of the wet meadows in Evros Delta by Platis et al. (2013).



Map of the "Dimitriadis" grassland

Seeding by hand a mix of the two grasses Lollium perenne and Dactylis glomerata, and the legume Trifolium repens in a halophytic dominant site in "Dimitriadis' grassland (left photo). Afterwards, this area was light ploughed using a tiller and a tractor (right photo).
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The ploughed and seeded sites were fenced (November 2013), in order to protect the vegetation from cattle grazing.
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2.2 Methods

In the "Dimitriadis" grassland, restoration was carried out on three halophytic dominant sites (50 x 40m each) that were lightly ploughed with a tiller and a tractor and subsequently were seeded with a mix of *Lolium perenne, Dactylis glomerata* and *Trifolium repens*, at a seeding rate of 6kg/site, in the middle of November 2013.

Half of each site (50 x 20m) was fenced to protect the vegetation from cattle grazing during the following spring, summer and autumn. During spring of 2015, a quarter each of the protected grazing sites was unfenced, providing three types of protection from cattle grazing (i.e. two years protection, one year protection, no protection at all).

At the end of the 2014-2015 and 2015-2016 wintering periods, we evaluated the cover dynamics of the most important forage categories (graminoids, halophytes, legumes, other forbs and bare ground). Vegetation cover was assessed in 25 squared plots (0.25 m^2), randomly dispersed in each one of the treated and natural halophytic sites following the methods described in Cook & Stubbendieck (1986).

In order to evaluate habitat use, droppings were used as an indicator, which requires at least a 7-10 day acclimation period for the birds after arrival at their new habitat and another 2-3 weeks after that period for the accumulation of a sufficient number of droppings from the relevant areas. Along with vegetation data, goose droppings were counted in all range units and natural habitats during the 2014-2015 and 2015-2016 wintering periods. During the latter wintering period, only a few individuals from the main Fennoscandian LWfG flock that was present in Greece (about 30 individuals) wintered at Evros Delta, and only for a few days (**http://www.piskulka.net/observations**). Subsequently, the goose droppings counted during the 2015-2016 wintering period belonged mainly to GWfG and not to LWfG. In order to infer conclusions and to propose management guidelines concerning the LWfG specifically, the relative data of the 2015-2016 wintering period were excluded from further analysis, even though they followed the same trend with the 2014-2015 wintering period.

3. Results

3.1 Vegetation characteristics

Already from the first year after seeding, graminoids' cover was increased about eightfold in the seeded sites (about 40% of the overall area) that were protected from grazing, than in the natural halophytic sites which constituted the control group (about 5%). In contrast, the halophytic coverage was about half in the seeded and protected sites, for both one and two years (around 30% in both years), as well as in the seeded unprotected sites than in natural halophytic sites (61.4%). Legume coverage was almost doubled in the seeded sites (slightly above 5%) in relation to the control group (2.6%). Finally, no protection from cattle grazing at all, resulted in a significant increase of the cover percentages of bare ground (38.0%) in relation to the fenced sites (around 20%), as well as to the control group (29.3%).

3.2 Habitat use by geese

Geese used the natural grassland sites more intensively (3.1 droppings/m^2) than any other type of habitat in "Dimitriadis" grassland. Furthermore, the mean number of goose droppings (was about twofold higher in the seeded and fenced sites than in either of the seeded but not fenced or the natural halophytic sites. On the other hand, the use of the freely grazed seeded sites and the natural halophytic sites by geese was similar (1.1 and 0.6 dropping/m^2 respectively).

4. Discussion

Protection from cattle grazing either for one or two years following seeding proved to be a management practice that increased the relative cover of the preferred forage for geese and reduced the respective percentages of the halophytic species. Additionally, based on the mean number of goose droppings, seeding followed by protection from cattle grazing increased the use of these sites by the geese as feeding areas. However, absence of protection from cattle grazing had poor benefits (increase graminoids' coverage) and resulted in a twofold increase in bare ground. As observed, cattle activities (grazing, trampling, etc.) had a negative effect on the re-establishment, not only of the graminoids, but also of the vegetation in total, resulting in a large increase of bare soil surface. As a result, protection from cattle grazing is considered essential in order to improve the grassland during the first year after ploughing and seeding, but has no additional significant benefits concerning the coverage of the available forage categories for herbivores when this regime is maintained for another year (year two). This and the fact that cattle usually graze in the "Dimitriadis" grassland for about eight to nine months per year, protection from grazing is recommended during the first grazing period following ploughing and seeding (i.e. from March – April to November).

Halophytes were the dominant available forage category, as they constituted almost 3/5 of the total available food resources in the study area. Halophytes, despite their insubstantial value as forage for herbivores, might provide cover against predators and humans, which could be of particular importance to prey species, such as geese and hares (Karmiris et al. 2011). During

this study, geese and hares have been observed to use the halophytic patches in "Dimitriadis" grassland for roosting and shelter. These findings suggest that halophytes are probably not important as a feeding resource for geese and the other herbivores, but they may be of prime importance for their survival success and the protection against predators and humans. For prey species therefore, such as the LWfG, both available cover and food must be considered in conservational plans. At the moment, the role and importance of halophytes in the ecology of geese and other herbivores still remains unclear. Appropriate research on the role of the halophytic community in wildlife ecology will also contribute to the sustainable multiple use of the coastal grazing lands of the Evros Delta.

Several studies have shown that cattle grazing benefits *Anseriformes* species in the northwestern European coast, by reducing vegetation succession and maintaining a low vegetation height (van der Graaf et al. 2002, Bos et al. 2005). In Evros Delta, geese, along with hares, feral horses and cattle have also been recorded to use grass-legume-forb patches with low vegetation height more than halophytic ones with much taller vegetation (Karmiris et al. 2008, Karmiris et al. 2011, Grigoriadis 2014). Livestock grazing seems to be vital for geese and the other herbivores in Evros Delta by maintaining appropriate density and height of vegetation. Management practices focusing on increasing the availability of grasses, legumes and other forbs constitute a promising conservation tool for this ecosystem and its primary consumers. From this perspective, a higher grazing capacity could be achieved in this area, which would contribute towards a balance between herbivore numbers and food resources. However, when forage availability is limited, as it probably happens in years with high numbers of wild herbivores, cattle stock numbers should be kept at a relatively low level and livestock raisers should provide increased quantities of supplementary food. Additionally, placement of supplementary food at halophytic dominant patches throughout the study area, instead of at the grass dominant sites where the extra food is mostly placed today by the local herders, is expected to attract cattle and to distribute the grazing pressure more evenly. Regular estimation of both the availability of natural food and the number of herbivores is necessary during the cattle and the goose grazing periods, i.e. usually from April to November and from December to March respectively. The main food for goose species in the study area is cool-season C3 grasses (*Poa* spp., *Bromus* spp., *Hordeum* spp., etc.), which usually sprout in November. Because of the relatively limited availability of these plant species, cattle grazing and trampling should end by the end of November at the latest, in order to protect the preferred food resource for geese during the remainder of the wintering period. In Evros Delta, cattle are usually removed from the "Dimitriadis" grassland by the end of November and until March since natural forage is limited.

Target grazing by cattle (or other tame herbivores) on halophytes especially during late summer and autumn may further contribute to the reduction of halophytic dominance and height, in favor of geese and other wild herbivores. Specific research is needed in order to determine the effects of cattle and target grazing on vegetation composition and structure and how such grazing affects goose behaviour.

5. Acknowledgements

This research was carried out in the framework of the EU LIFE+ Project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway" (LIFE 10 NAT/GR/000638), which was funded by the European Commission and the Norwegian Environment Agency. The Forest Research Institute, Hellenic Agricultural Organization "DEMETER" receives financial support from the Hellenic Ministry of Rural Development and Food. The authors would like to thank Mrs. Eleni Makrigianni, Director of the Management Authority of Evros Delta National Park, and Andreas Athanasiadis (President of the Board of the National Park). Gratitude is also expressed to Vasilis Ilias, Panagiotis Ioannidis, and Anastasios Anastasiadis, personnel of the Management Authority of Evros Delta National Park, for their help in the field. We are also grateful to Ioakim Vasiliadis, Evangellos Havales and Dimitris Voyiatzis (Forest Research Institute) as well as Savvas Grigoriadis and Konstantinos Matzanas (Aristotelian University of Thessaloniki, School of Forestry) for their assistance in the fieldwork.

Dominance of grasses and droppings of geese in the seeded and protected from cattle grazing sites. One year following ploughing and seeding, the halophytic dominance was succeeded by a vegetation composition more attractive to geese and other herbivores. © Ilias Karmiris, November 2014

Geese feeding at the Dimitriadis grassland in Evros Delta. © Dimitris Kokkinidis

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Grassland management at Kerkini Lake, a wintering habitat of the Lesser White-fronted Goose *Anser erythropus* in Northern Greece

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1. Introduction

The European Fennoscandian population size of the Lesser White-fronted Goose *Anser erythropus*, hereafter LWfG, has been dramatically reduced during the second half of the 20th century (Jones et al. 2008, Fox et al. 2010). Until 2013, only 20-30 pairs (60-80 individuals) comprised the total population, according to the observation data at the Portal to the Lesser White-fronted Goose (**http://piskulka.net**, accessed 13/02/2017). The most important wintering habitat for the Fennoscandian LWfG is probably the grassland area surrounding the Kerkini Lake (an inland freshwater wetland in Northern Greece). LWfG usually stay there from early October to middle or end of December, although this period may be extended until January or even February (Lorentsen et al. 1998, Vangeluwe 2004, Karmiris et al. 2017). The other main wintering habitat for the Fennoscandian LWfG is the Evros Delta (the easternmost wetland in Greece, at the border to Turkey), which LWfG usually use for feeding and roosting during the remaining wintering period (for a few weeks to about two months). At the Evros Delta, LWfG usually forage in mixed flocks with other goose species, mainly the Greater White-fronted Goose *Anser albifrons*, a common quarry species in the area. Because of the morphological resemblance of the two species, and the popularity of hunting in the area, the probability of accidentally shooting LWfG individuals is considered high.

The relative cover and the nutritive value of winter forage, as well as interactions with other co-grazing herbivores are critical factors that directly influence the birds' distribution (Bos et al. 2005, Wang et al. 2013) and can thus be targeted for relevant conservation actions.

In order to provide habitat management advice that would encourage the LWfG to spend more time in the relatively safe area of Kerkini Lake, we studied whether (i) the relative cover of plant species participating in the diet composition of LWfG, (ii) the nutritive value of forage and (iii) the potential for competition with other herbivores, all which could influence the movement of the LWFG from Kerkini Lake to Evros Delta usually in the middle of the wintering period.

2. Study area

Kerkini Lake is a freshwater reservoir created in 1932, mainly for irrigation and flood control purposes, following the construction of a dam along the Strymon River, about 10 km southward of the border with Bulgaria. In 1982, a higher dam and dykes were constructed along the eastern lake coast. Kerkini Lake is included in a National Park, as a wetland of international importance (Ramsar), a Special Protected Area (SPA), where goose hunting in not permitted and a Wildlife Refuge where no hunting is allowed.

The study area was the grassland in the northern and eastern parts of the Kerkini Lake. In this area, two major habitats were identified: the marshy (no more than 300 - 400 m away from the shoreline) and the non-marshy habitat (more than 400 m away from the shoreline). Due to the lake's operation as an irrigation reservoir, its water level fluctuates by 5 m and its surface usually decreases from 75 km^2 to 50 km^2 yearly (highest levels in May - June and lowest in August - September). The marshy freshwater habitat is dominated by plant species adapted to grow under these conditions, such as *Echinochloa crus-galli, Paspalum paspalodes, Ranunculus* spp. and species of the *Cyperaceae* family. The remainder of the study area comprises non-marshy grassland dominated mainly by *Paspalum paspalodes, Poa trivialis* and *Xanthium strumarium* and is the main feeding area of about 2,000 free-grazing water buffaloes *Bubalus bubalis*, hereafter buffaloes.

3. Materials and Methods

The assessment of the relative use of the two available habitats (marshy and non-marshy ones) by the LWfG at Kerkini Lake was based on visual observations during the wintering periods 2012-2013 and 2013-2014. At the same time, the non-marshy habitat use by buffaloes was estimated using the faeces counting method (Litvaitis et al. 1996).

Fresh droppings from LWfG and buffaloes were collected at Kerkini Lake at the same time with habitat use estimation. The LWfG flock was observed using a telescope without causing disturbance and the exact feeding place of the LWfG were located. When the LWfG flock was not mixed with other goose species, in situ dropping collection took place. The dropping samples as well as tissues from the most common plant species presented in the study area were analysed using the method of microhistological analysis in order to estimate the diet composition of the studied herbivores. The relative frequency for each plant species identified in the herbivores' droppings was calculated as its frequency divided by the sum of frequencies of all species (Holechek & Gross 1982a). Microhistological analysis of droppings is the most frequently used method to estimate the diet composition of wild and tame herbivores (Paola et al. 2005). This technique causes minimal disturbance to animals in feeding studies of secretive and endangered species (Holechek & Gross 1982b), such as the LWfG. In this study, it was assumed that results from the microhistological analysis of LWfG droppings were reasonably accurate, because analysis was performed following all recommended techniques (Holechek & Gross 1982a,b, Alipayo et al. 1992).

Representative samples of grasses, grass-likes, aquatic species (submerged, emerged and amphibious species) and other forbs (all other broadleaved herbs present in the marshy habitat) were also collected in the middle of the annual staging time of LWfG at the Kerkini Lake (mid-November), as well as following

their departure from the area (end of December) for determination of their nutritive value. The samples were appropriately prepared and crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined (Goering & van Soest 1970, AOAC 1990, van Soest et al. 1991). In addition, relative cover (%) of those plant species, which were identified in the droppings of LWfG even in trace amounts (i.e. less than 1% of the total diet composition) was estimated during the whole period that LWfG usually stay at Kerkini Lake and was assigned to one of the two major forage categories available to LWfG in this area: (i) graminoids (grasses and grass-likes) and (ii) forbs (aquatic plants and other forbs).

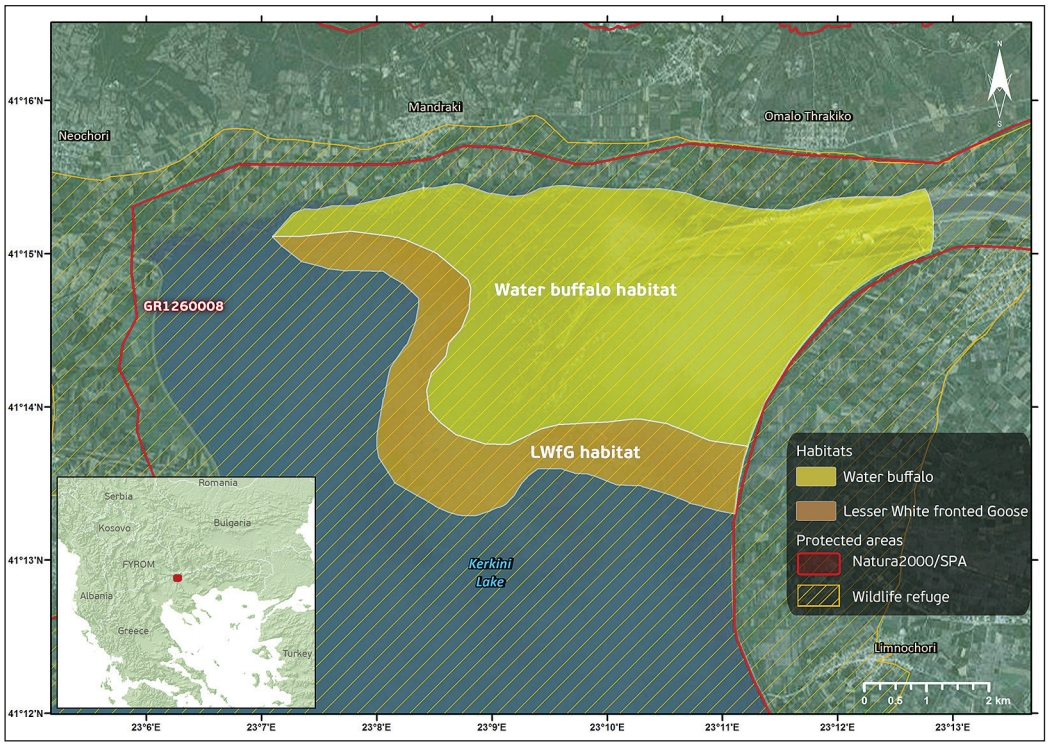

Figure 1.
LWfG and water buffalo habitats at Kerkini Lake, Northern Greece.

Marshy (left) and non-marshy (right) habitats at Kerkini Lake were the main feeding places of LWfG and buffaloes, respectively. Partitioning of habitats and foods reduces the possibility for negative competitive interactions between these herbivores, facilitates their coexistence and ensures greater utilisation efficiency through multiple use of the vegetation, maximizing both biological diversity and economical viability.
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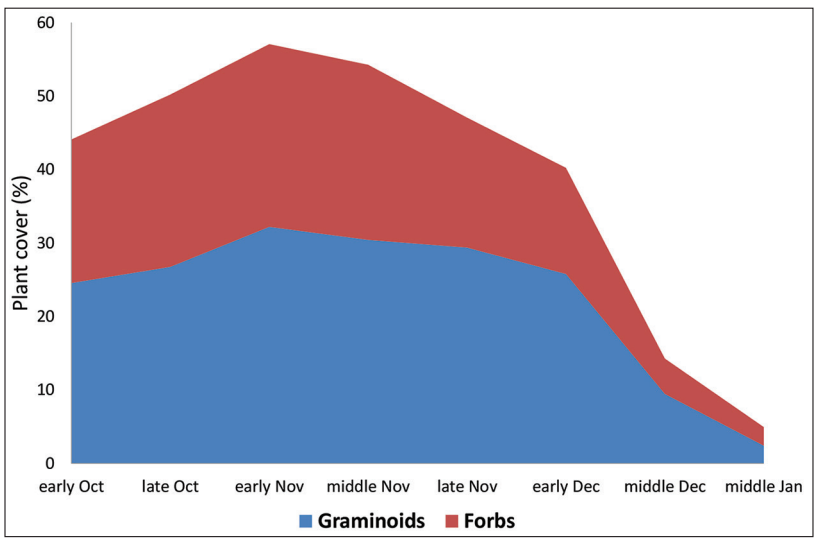

Figure 2.
Temporal changes in relative cover (%) of graminoids and forbs participated in the diet composition of LWfG at Kerkini Lake from early October 2013 to the middle of January 2014.
During this study, LWfG departed from Kerkini Lake in the middle of December, i.e. at the time when relative cover of LWfG's forage was minimized.

4. Results

The feeding habitat of LWfG at Kerkini Lake was the marshy grassland from below the water line (less than 5 cm deep) to 300 – 400 m away from the shore (100%, n = 69). Buffaloes mainly grazed in the non-marshy area (n = 10.6 faeces/plot/15 days), more than 400 m away from the lake's shoreline (**Figure 1**). On the contrary, the average use of the marshy grassland (the main feeding habitat of LWfG) by buffaloes was very limited (n = 0.6 faeces/plot/15 days). LWfG departed from Kerkini Lake in mid-December when the relative cover proportions of the two major forage categories declined substantially in the main feeding habitat of LWfG at Kerkini Lake (**Figure 2**).

The nutritive value of forage categories did not change significantly between periods in 10 out of 16 comparisons performed ($P < 0.05$). Significant differences between periods were found only for CP of forbs, NDF of other graminoids (marginal significance) and forbs, ADF of grasses (marginal significance) and forbs and ADL of forbs. Based on these findings, the nutritive value of LWfG forage can be considered more or less stable between periods with a few exceptions.

Graminoids (especially the grass *Echinochloa crus-galli*) comprised the main food of LWfG, which made up about the 70% of the LWfG total diet composition. Aquatic plants and other forbs comprised about a quarter of the diet composition of LWfG. On the other hand, the main food of buffaloes was the aboveground biomass produced by *Cynodon dactylon, Paspalum paspalodes* and other species growing in the non-marshy habitat, as well as supplements provided by the farmers.

4. Discussion

A clear differentiation of the main feeding habitat and the foods of LWfG in relation to these of buffaloes was observed in this study. Consequently, the potential competitive relationships between these herbivores is highly minimized. Conclusively, competition for food or habitat resources between LWfG and buffaloes is absent or at least very weak, as these herbivores feed on different plant species growing in different habitats, confirming the mainstay of ecological theory about the occupation of unique feeding niches by coexisting herbivores (Chesson 2000).

During the study period, the LWfG departed from Kerkini Lake when the relative plant cover of natural foods fell to a very low level, while the nutritive value of the major plant categories remained more or less constant during the two periods studied with a few exceptions. These findings support the conclusion that it is food supplies and not the nutritive value of forage that plays the major role in the feeding habitat choice and the movement pattern of the wintering LWfG. Given that food resources (mainly graminoids) are provided to LWfG and the marshy habitat is protected from flooding during the period that LWfG stay at Kerkini Lake, it is very likely that the birds will remain longer at Kerkini Lake and less in Evros Delta, which will contribute to further minimization of the theoretical risk of accidental shooting of LWfG at the latter wintering habitat. Grassland management at the Kerkini Lake is therefore of high research priority regarding LWfG conservation.

Grassland management should target upon the enhancement of LWfG food resources by managing water level and flooding to facilitate growth of preferred plant species, or alternatively by seeding appropriate plant species, mainly cool-season grasses as they provide alternative food for other goose species especially during the critical winter months (Percival 1993, Vickery & Gill 1999, Madsen et al. 2014). We propose that seeding is not applied in the non-marshy habitat in order to avoid: (i) attracting LWfG individuals outside of their main feeding habitat i.e. the marshy habitat, which is considered as a relatively safe area for wintering LWfG, (ii) utilization of the seeding plants aboveground biomass by buffaloes, and (iii) emergence of negative interactions between LWfG and buffaloes. In addition, in order to delay flooding in the seeding areas for as long as possible, we propose that these areas are located at the upper parts of the marshy habitat, where flooding occurs at a later time in relation to the lower elevation parts near the shoreline. Furthermore, seeding would need to be applied each year during late September – early October, i.e. before the arrival of the LWfG at Kerkini Lake in order to minimize disturbance. It is important, that the seeding process does not disturb or destroy any of the natural vegetation, which is valuable for LWfG; therefore, ploughing and/or tillering of the soil surface prior or after seeding should be avoided. The dam at the southern part of the Kerkini Lake was built in 1982 and since then is operated primarily for crop irrigation and flood control of agricultural land southern to lake, while the protection from flooding of the marshy and non-marshy habitat surrounding the Kerkini Lake plays a second role to the dam operation. As a result, the main feeding habitat of LWfG is periodically flooded for about 7-8 months (i.e. usually from January-February to August) each year. Flooding makes the marshy habitat inhospitable for the LWfG, and therefore it should be avoided during the period that the LWfG are present at Kerkini Lake (i.e. usually from October to late December, but this period may be extended until the end of the wintering period). Furthermore, water withdrawal from the marshy habitat should occur not later than the end of August, i.e. about 1-1.5 months prior to the arrival of the LWfG at Kerkini Lake, in order for the various plant species to have had adequate time to grow sufficiently and provide food for the LWfG upon their arrival.

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Habitat restoration for the Lesser White-fronted Goose in the Hortobágy National Park, Hungary

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Figure 1.
*Military map of the former surface of the Hortobágy-fisponds (III. Military Survey of the Habsburg Empire (1869-1887)) with the synchronized view of a recent topographical map showing the area covered by the fishponds today (**mapire.eu** accessed on 17/02/2017, Tímár et al. 2010).*

1. Introduction

The Hortobágy National Park is the largest (more than 82,000 ha) and the oldest (established in 1973) national park in Hungary. It is a World Heritage Site, a Ramsar Site, an Important Bird Area and a Natura 2000 SPA and SAC site. The area is characterized by alkaline and non-coastal sodic and saline soils as well as by loess soils. As a result of its geological origin, soil and climatic conditions, the character of the landscape is treeless and completely flat. Continuous, natural grasslands cover an almost 54,000 ha area within the national park maintained by extensive grazing of cattle, sheep and horses. This large area is diversified by patches of alkaline marshes, fishponds, small croplands and forests (**www.hnp.hu**, **http://whc.unesco.org/en/list/474**, both accessed on 17/02/2017).

The most important driving factor affecting natural habitats in the Hortobágy National Park is water. Historically, the landscape was formed by the flooding of the Tisza River and its tributaries. The natural water bodies (remnants of the former riverbeds, sodiac pans, marshes, alkaline meadows) form a complex mosaic together with the dry steppe areas and the other wetlands, like fishponds. This system is changing from time to time depending on the actual water conditions. In some areas during spring, where only waterbirds can cross the large shallow water covered areas, a dry grassland with grazing Hungarian grey cattle can be found in the summer (Aradi & Gőri 2010). This complexity support a very rich avifauna. It is one of the most important bird staging and breeding areas in Eastern Europe, with approximately 350 bird species observed recently (Ecsedi 2004).

The Hortobágy National Park fishponds were mainly created during the first half of the 20th century. The largest fishpond system is the Hortobágy fishponds (also known as "Hortobágyi Öregtavak" = Old (fish) ponds of Hortobágy) with ca. 1,750 ha area in total. Within this system one of the largest fishpond of Hungary, the Kondás-fishpond with a surface of more than 400 ha can be found. These fishponds were created mainly by the destruction of the lowest and most alkalic wetlands of the Hortobágy, formerly consisting important staging areas for waterbirds (**Figure 1**).

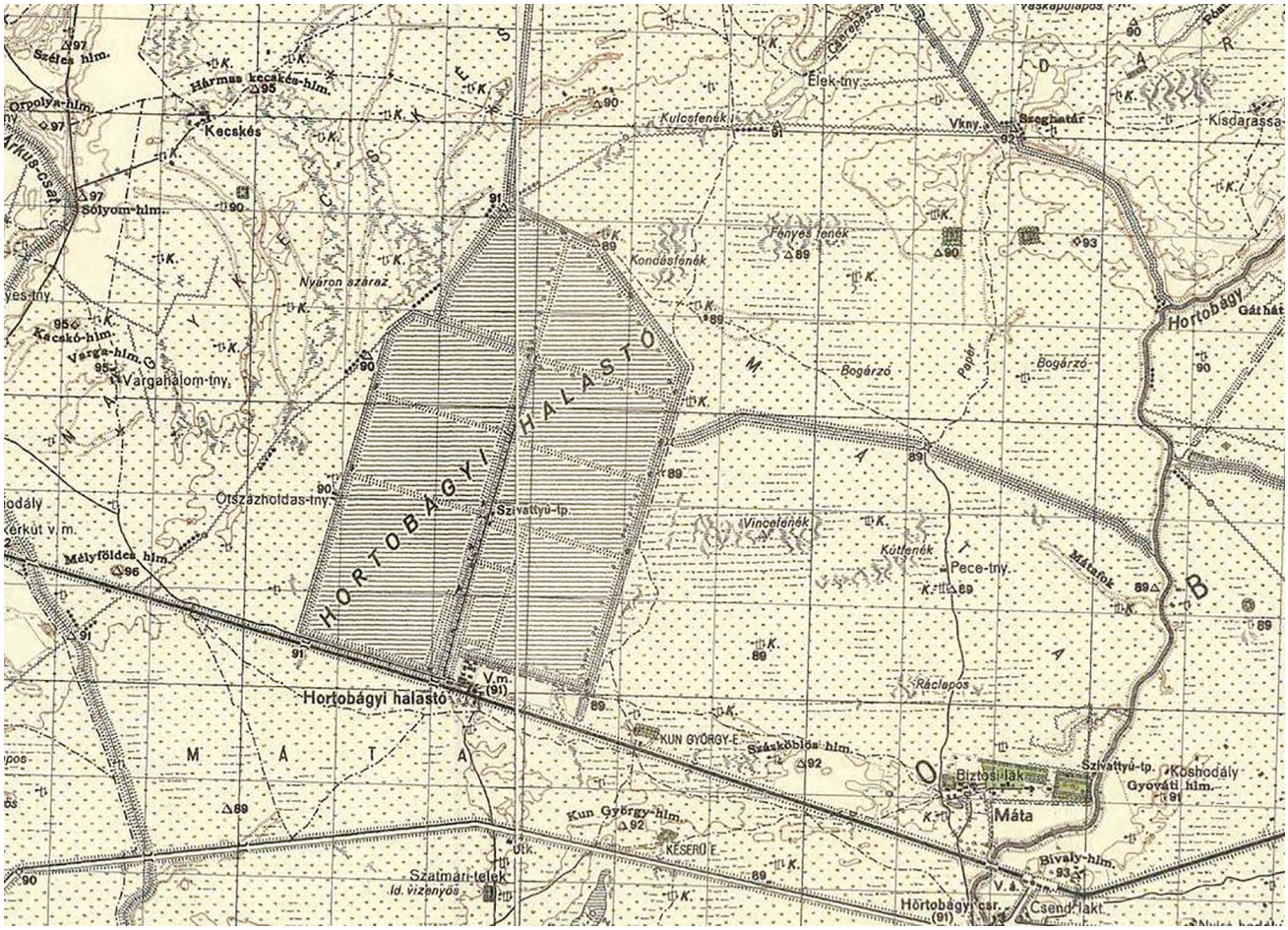

Figure 2.
Military map of the Hortobágy-fishponds, 1941.
*The Kondás-fispond was not built at that time, wetlands, like the „Kondásfenék" and „Kulcsfenék" are still existing north from the fishponds (**mapire.eu** accessed on 17/02/2017).*

The first (southern) ponds were created during the World War I (1914-1918) using the labour of prisoners of war, while the last one – Kondás-fishpond - was created during the 1950's (**Figure 2**). Currently, the Hortobágy fishponds are extensively managed by fishermen, and are surrounded by thousands of hectares of undisturbed wetland and grassland areas, offering excellent conditions for wildlife (Ecsedi 2004, Aradi & Gőri 2010, Végvári et al. 2015).

The Hortobágy fishpond system is an important breeding area of numerous endangered bird species, and it is one of the most important staging sites of the migrating waterbirds in the Carpathian Basin. The Hortobágy National Park serves as the largest stop-over site of the Common Crane *Grus grus*, with a peak number of 100,000-130,000 roosting birds. The Hortobágy fishponds and especially the Kondás fishpond, host up to 70,000 Common Cranes (Végvári & Barta 2015, Végvári pers. comm.). The fishponds also serve as roosting and feeding sites for mixed goose flocks and mainly Greater White-fronted Goose *Anser albifrons*, hereafter GWfG. Recent counts reveal that up to 30-40,000 GWfG use the area (Végvári et al. 2015). Besides the quantity of migrating birds, the diversity of the avifauna is also impressive: more than 300 species of birds were observed only on the Hortobágy fishponds (Ecsedi 2004).

The habitat use of the Fennoscandian Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) population in the Hortobágy National Park concentrates to these fishponds and their adjacent grasslands and marshlands since the mid 1990's (Lengyel et al. 2009, Bogyó et al. 2014). Former observations show that the LWfG mainly used the Hortobágy fishponds V, VI and Kondás fishpond. In recent years, overgrowth of the vegetation (mainly Common Reed *Phragmites australis* and bulrush *Typha* sp.) resulted in habitat degradation, mainly in Fishpond V. The open water surface of this fishpond almost disappeared by the 2000's and was targeted by habitat restoration works summarized in the present paper (**Figure 3**).

In the framework of the EU LIFE+ Project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway" (LIFE10 NAT/GR/000638), the Hortobágy National Park Directorate proceeded with habitat restoration and management actions in order to provide ideal habitat conditions for the Fennoscandian Lesser White-fronted Goose population during its stay in the Hortobágy National Park.

Figure 3.
*Aerial photographs of the Hortobágy-fishpond no. V., where A refers the year 2005, while B refers the year 2013 after the vegetation management works were finished (**fomi.hu/maps.google.com** both accessed on 17/02/2017).*

2. Habitat restoration progress

The habitat restoration consisted of two major parts:
(I.) appropriate water management and
(II.) vegetation management.

I. Appropriate water management

Appropriate water management begun in autumn 2011 in the Kondás fishpond and Fishpond VI (**Figure 4**), while following vegetation management actions (autumn of 2012) suitable water management in the Fishpond V also took place.

The Hortobágy National Park Directorate (HNPD) discussed the water management proposals with the local Hortobágy Fish Farm Co. (the fishing company using the lakes for fishing) in order to obtain consent. The water levels of the Kondás-fishpond, Fishponds V and VI (685 ha in total) were regulated during autumn and spring migration in order to provide optimal mosaic habitat conditions. The LWfG flocks traditionally use a habitat mosaic at Hortobágy that includes fishponds and regularly grazed short grasslands. The optimal water level during the LWfG migration is shallow in the largest lake (Kondás-fishpond) where LWfG can find safe feeding (fresh mud vegetation) and resting areas. Shallow water (0-50 cm), as well as the timing of the management imitates the water levels and dynamics of the former sodiac marshes and pans that existed in the area. Reduction of the water level began by the end of the summer, while refilling began in the end of December, every year. At the same time, in Fishpond V and VI, traditionally higher water levels provided a safe resting place for the geese. These fishponds (Kondás-fishpond and Fishponds V and VI) have a total water volume of 7.5 million m^3, which is transferred there through two local water channels (Nyugati Main channel and Halastói channel) from the Tisza river. To regulate water levels in the fishponds, HNPD experts need to work together with the local water service provider (Tiszamenti Regionális Vízművek Co.) to transfer this amount of water in time, water quality and quantity. This water management has an annual fee of ca. 63.500 EUR, paid generally by the HNPD from the annual budget. Since 2014, there is a fee takeover by the state offered to the fishpond managers (except the period from December to February). However, until 2021 this seems to be reduced gradually year by year (Gov. Decree 115/2014). This means that this kind of management needs careful planning and strong support by the HNPD itself in the future.

II. Vegetation management

The planning of the vegetation management started in 2011 with a stakeholder consultation (Hortobágy Fish Farm Co., local authorities & the HNPD), and permission given by the local nature conservation authority to proceed was granted in January 2012. During the extreme (sometimes -15°C or even less) winter of 2012, 40 ha of reed and bulrush were cut on the frozen surface of the Fishpond V. According to the initial management plan, the pond would be subsequently drained in order to provide machinery access for vegetation management. However, dense vegetation prohibited water drainage and as a result a 200 m drainage channel was dug using an excavator in order to allow drainage of the pond (May 2012).

Pond drainage was followed by disk-harrowing the remaining vegetation (old reed and bulrush). However, because of the dense layer of dust and plant matter, harrowing was abandoned following sinking and destruction of the machinery. Alternatively, two caterpillars were used to trample and destroy remaining vegetation above and below ground (August 2012). The total managed area (through cutting and trampling in the winter and summer periods listed above – mainly overlapping

Figure 4.
*General map of the Hortobágy-fishponds (**fomi.hu** accessed on 17/02/2017/HNPD).*

areas) totals up to 50 ha. Fishpond V was immediately flooded and filled to its maximum level in order to prevent any vegetation from re-emerging, since reed and bulrush in particularly are not able to survive flooding (White 2009). A minimum cover of 20-30 cm and 80-100 cm of water is recommended for reed and bulrush respectively. The winter conditions that followed resulted in the freezing of Fishpond V, which further contributed to reed and bulrush destruction.

Further vegetation management was conducted in the Kondás fishpond in January and February of 2014, where 11 ha of reed and bulrush were cut mainly along the fishpond shoreline in order to prevent it from entering the lake bed, thus reducing the available open water surface. Vegetation cutting continued after the breeding period was complete and an additional 2 ha of vegetation was removed from the Kondás island surface in order to provide a safe (from predators) and ideal (fresh mud-vegetation) staging site for the LWfG. A total of 63 ha of vegetation were managed in the Hortobágy Fishponds. Also in the framework of the LWfG LIFE+ Project, the HNPD built a hide on the shore of the Kondás fishpond. The Kondás fishpond itself is a very large fishpond (401.4 ha) and the observation towers and hides are situated on the southern shores in order to get a better view of the goose flocks if they use the eastern and northern part of the lake.

Vegetation management in the Hortobágy-fishpond no. V. using a „Seiga harvester" during February 2012. © János Tar/HNPD archive

Channel excavation during May 2012.
© Dávid Bogyó/HNPD archive

Cutting and trampling reed and bulrush with a caterpillar in the dry lakebed in the Hortobágy-fishpond no. V. during August 2012 .
© Dávid Bogyó/HNPD archive

3. Results and Discussion

Regular monitoring in the Hortobágy National Park showed that since 2011 and following the initiation of the restoration and management actions, the Fennoscandian LWfG population as well as the Western Main LWfG population used the restored areas and the adjoining grasslands frequently during their autumn and spring migration. In these protected areas the LWfG can find optimal and safe (limited disturbance, no hunting or illegal killing of waterbirds) conditions for feeding and resting, while monitoring is facilitated by the new infrastructure built (hide).

The most significant change in habitat conditions is considered the management of Fishpond V (124.6 ha). Before the vegetation and water management, only 15-20 ha of open water surface remained within the lakebed. The dense reed and bulrush vegetation, covering this lake was not suitable for any migrating waterbird including goose species. Following the winter of 2012/2013 a growing open water surface was made available, measuring ca. 70 ha recently (**Figure 3**). The changes resulted in a growing trend in the numbers of migrating and nesting waterbirds. First, Eurasian Coots *Fulica atra, Anas* and *Aythya* species started to use the new open water surface. The first flocks of geese were observed in 2013, mainly GWfG (flocks over 300 individuals) and Greylag Geese *Anser anser* (flocks over 350 individuals with juveniles). The first LWfG, a single adult individual in the Fishpond V was observed in 2014 (the first observation since 2003), while additional observations of 1-2 individuals were made in 2015 and in 2016 (**www.piskulka.net** accessed on 17/02/2017, HNPD database). During migration, the goose flocks reached a maximum of 2,000-3,000 individuals in Fishpond V in 2015 and 2016. Besides LWfG, GWfG and Greylag Geese, Red-breasted Geese *Branta ruficollis* were also using Fishpond V as a resting site. Additionally, formerly disappeared colonies of the rare Whiskered Tern *Chlidonias hybridus* and Black-necked Grebe *Podiceps nigricollis* were re-established, together with Ferruginous Duck *Aythya nyroca* nesting.

The appropriate water management in the Kondás fishpond (401.4 ha) also resulted in better conditions during migration: mud banks offered freshly grown vegetation for the LWfG and other geese, while mud islands within the huge undisturbed fishpond offered an optimal resting place. The Fennoscandian LWfG used this fishpond as a feeding and resting site in every migration season of the project. The peak number of the LWfG was observed in September of 2015, when 131 LWfG were observed in a single flock (**www.piskulka.net** accessed on 17/02/2017, HNPD database). During March of 2016 we observed LWfG feeding and resting on the managed Kondás-island (**www.piskulka.net** accessed on 17/02/2017, HNPD database).

In Fishpond VI a high water level was maintained almost throughout the project period (2011-2016). The only exception for lower water levels was for rarely occurring fishing activities, that took place outside of the LWfG migration periods. Water management offered suitable resting place at this traditional LWfG site and prevented the overgrowth of the vegetation in the fishpond lakebed. Regular monitoring confirmed that LWfG used the open water area of the Fishpond VI in 2013 and 2015, when 3-12 LWfG were observed.

Summarizing, the actions carried out in the framework of the LIFE+ Project it can be concluded that safe and favourable staging sites were provided for the LWfG at the Hortobágy National Park. The continuation of the appropriate water management described here is considered essential, together with periodical minor vegetation management actions. HNPD will be responsible for these actions, as it is described in the Hungarian National Action Plan produced during the same LIFE+ Project (Bogyó et al. 2014). This type of habitat management is not only beneficial for the Fennoscandian LWfG population, but also for the Western Main LWfG population, from which individuals are observed more frequently in the recent years.

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Panoramic view of the Hortobagy National Park habitats. © HNPD

Impact of hunting activities on waterfowl at the Evros Delta, Greece

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1. Introduction

Hunting is widely practiced all over the world and its origins can be tracked down to early civilizations (Heberlein & Ericsson 2005). However, during the 20th century, as living conditions improved and hunting arms and ammunitions became more efficient, hunting pressure, especially on waterbirds, increased considerably. At the same time, living conditions for waterfowl changed dramatically as great proportions of wetlands were drained or polluted. As a result, numbers of waterfowl and many other species decreased and a number of them were subsequently included in lists of threatened or vulnerable species (IUCN redlist, Red Data Book etc). It has been estimated that hunting in Europe accounts for the killing of 11 million ducks and a quarter of a million geese each year (Kear 2005). Direct and indirect impact of hunting on birds has been identified as one of the major threats for many waterfowl including the Lesser White-fronted goose *Anser erythropus*, (hereafter LWfG) (Jones et al. 2008), one of the most threatened waterfowl species in Europe. The direct impact of hunting on waterfowl includes accidental shooting whereas indirect threats include lead poisoning (through ingestion of lead shots), collision with overhead power cables and disturbance especially from human activities (Kear 2005, Baldassarre & Bolen 2006).

The Evros Delta is one of the largest wetlands in Greece, consisting of natural or semi-natural and agricultural habitats. It is a wetland of international importance especially for wintering waterfowl and the most important wintering area in Greece for all goose species including the LWfG, swans Cygnus sp. and certain species of ducks *Anas* sp. (e.g. Mallard *Anas platyrhynchos* and Teal *Anas crecca*) (Handrinos et al. 2015, Vangeluve 2005). Evros Delta is the one of the two wetlands where the main flock of the Fennoscandian population of LWfG winters in Greece (the other one is Kerkini Lake) (Panagiotopoulou et al. 2009). Evros Delta is also the most popular wetland for wildfowl hunting in Greece (Kazantzidis 2009). Despite the negative ecological impact on habitats, hunting has received little attention from a research point of view and a permanent monitoring scheme of the hunting activity is still missing in Greece.

Consequently, monitoring of hunting and the evaluation of its impact on waterfowl and especially the wintering population of the LWfG at Evros Delta are considered of crucial importance. This has been investigated in the framework of the LIFE+ «Safeguard the Lesser White-fronted Goose» project and is presented here.

The research period of the present study coincided with two important management decisions related to hunting that have been put in effect in Greece. Firstly, hunting of the Greater White-fronted Goose *Anser albifrons* (hereafter GWfG) was banned from the beginning of the 2012-2013 hunting season in all Special Protected Areas (SPA) where LWFG winters in order to avoid accidental shooting. At the same time, the most popular goose hunting spot at the Evros Delta, the Kalavos area, still remains outside of the SPA boundaries, and therefore is unprotected. Secondly, the use of lead shot for bird hunting was banned in all Greek wetlands since the beginning of the 2013-2014 hunting season.

2. Study area and methods

2.1 The study area

The Evros Delta (40° 52' N, 26° 00' E) is situated in the northeastern part of Greece (Thrace) (**Figure 1**), on the border with Turkey. It covers an area of about 9,500 ha that includes salt marshes, coastal lagoons, reed beds, scrub, wet and dry grasslands, as well as, farmland inland. Due to various human interference during the last 50 years (especially drainage), the ecosystem changed considerably and natural habitats are restricted in narrow zones along the river and the coastal zone. However, it is still very important for wildlife and it has been included in the list of the Ramsar sites, is considered an Important Bird Area and has been declared as National Park and, a part of it, a SPA (Portolou et al. 2009). Additionally, a part of the delta has been characterized as a wildlife refuge where hunting in not allowed. In the remaining area (outside the wildlife refuge) hunting is allowed and mostly takes place during the early morning and afternoon hours until dark from the 15th of September until the 10th of February (149 days in total), while, for four waterfowl species and during our research period the hunting season was closed on the 31st of January (Mallard, Teal, Pochard *Aythya ferina* and Gadwall *Anas strepera*).

2.2 Methods

The direct and indirect impacts of hunting at the Evros Delta were assessed as follows:

2.2.1 Number of hunters and their distribution

The number of hunters was recorded following a predetermined route; in order to cover the largest possible area in the minimum possible time. Hunters' numbers and distribution were recorded during the morning hours. Recordings were executed in random sampling days following a stratified sampling method during 2012-2013 (n=17) and 2013-2014 (n=16) hunting seasons.

2.2.2 Hunting intensity

Assessment of hunting intensity was realized by recording the number of gunshots in a hunting day. Gunshot counts were executed in random sampling days throughout the hunting season and during three hunting periods (14 in 2012-2013, 27 in 2013-2014 and 11 in 2014-2015) in two areas ("A" and "B") (**Figure 1**). Area A covers the area with the highest hunting pressure (the southern part of Evros Delta), whereas "area B" (at the central and eastern part of Evros Delta National Park, or Kalavos) covers

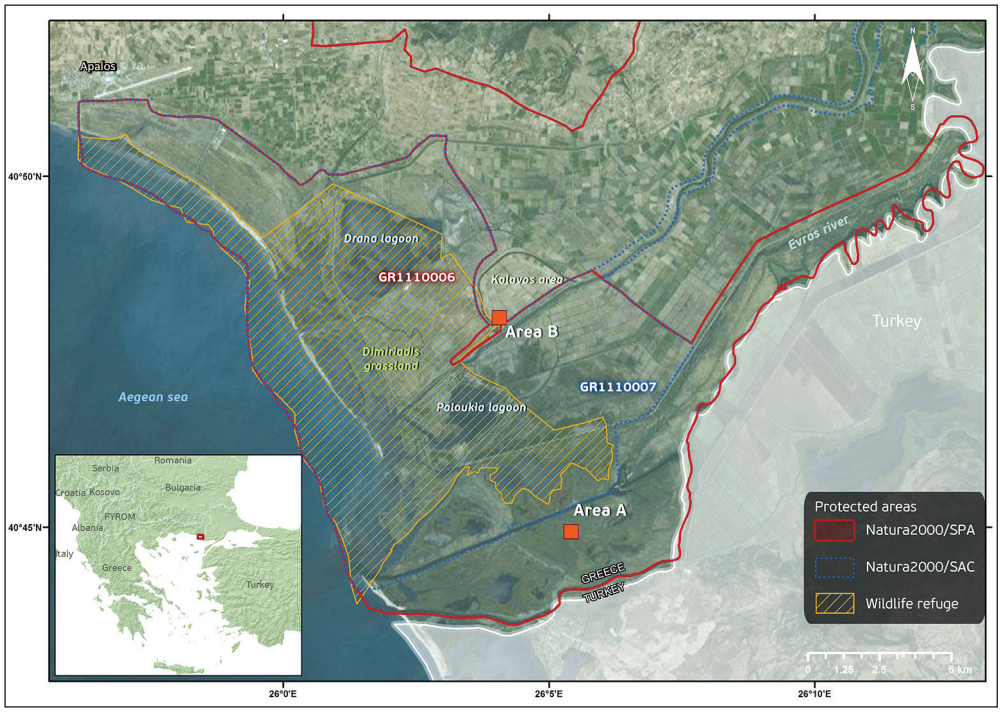

Figure 1.
Evros Delta, Greece.

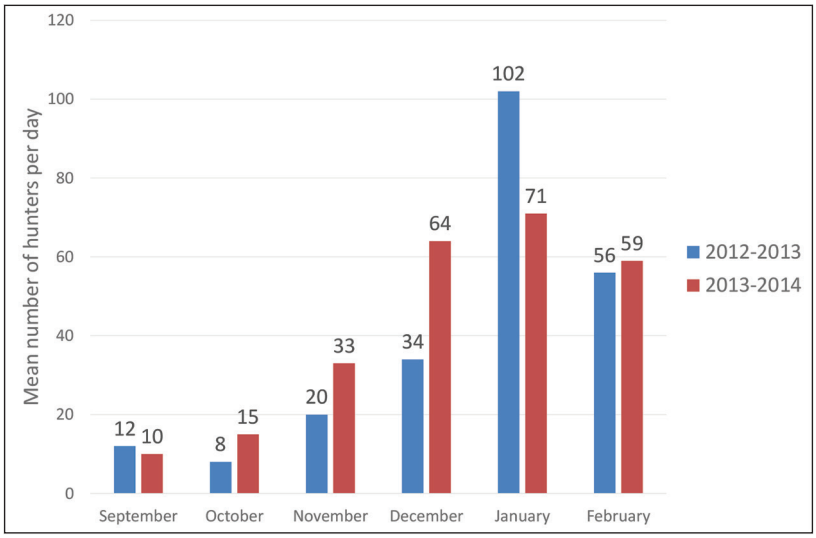

Figure 2.
Daily number of hunters/month during the hunting seasons 2012-2013 and 2013-2014 at the Evros Delta, Greece.

the area where most of the hunters hunt geese. Gunshot counts in that area ("B") started at the end of December because, prior to that time, hunting was not practiced there due to very low goose numbers. Gunshots were recorded at 15 minute time intervals for approximately four hours in the morning and four hours in the evening. In each sampling day the number of hunters hunting in the area was also recorded in order to estimate the number of gunshots each hunter fires in a day.

2.2.3 Hunting bag monitoring

Monitoring of hunting bags consisted of the recording of the number of shot birds by hunters randomly encountered at the Evros Delta during morning hours in randomly selected dates throughout the hunting season (eight checking days in 2012-2013 and 17 in 2013-2014).

2.2.4 Amount of lead (Pb) deposited at Evros Delta

Estimation of the amount of Pb from lead shots that was deposited during the hunting season was made by combining the following data:

- number of hunters/day
- number of gunshots/hunter/day
- number of hunting season days (149)
- technical characteristics of cartridges and shots (size, type)

In order to describe these characteristics, empty (recently used) cartridges were collected from the hunting grounds. The type of cartridge (lead or steel) and size of shots was recorded.

2.2.5 Lead shot ingestion

Goose stomachs were analyzed for lead shots ingestion. The stomachs were willingly provided by hunters during hunting bag control. In total, 18 stomachs of GWfG and one of Greylag *Anser anser* were analyzed.

3. Results

3.1 Number of hunters and their distribution

A mean number of 47.2 hunters/day (n=802) was recorded during the 2012-2013 hunting season, while during the 2013-2014 hunting season, the mean number of hunters/day was 49.3 (n=788). Most hunters were recorded in January during both seasons (**Figure 2**). In regards to hunter numbers, hunting was more intense from December to February (64.9 hunters/day in 2012-2013, 65.0 hunters/day in 2013-2014), whilst it was much lower from September to November (13.33 hunters/day in 2012-2013, 19.2 hunters/day in 2013-2014) (**Figure 2**). Furthermore, hunting was more intense in the eastern part of the study area (74.8% of the recorded hunters during both hunting seasons) (**Figure 3**). In this part of the Evros Delta, hunting begun from the opening of the hunting season and reached its peak in January. In other parts of the Evros Delta hunting was very low until November. From December until February hunting took place also around the Drana lagoon and the Kalavos area.

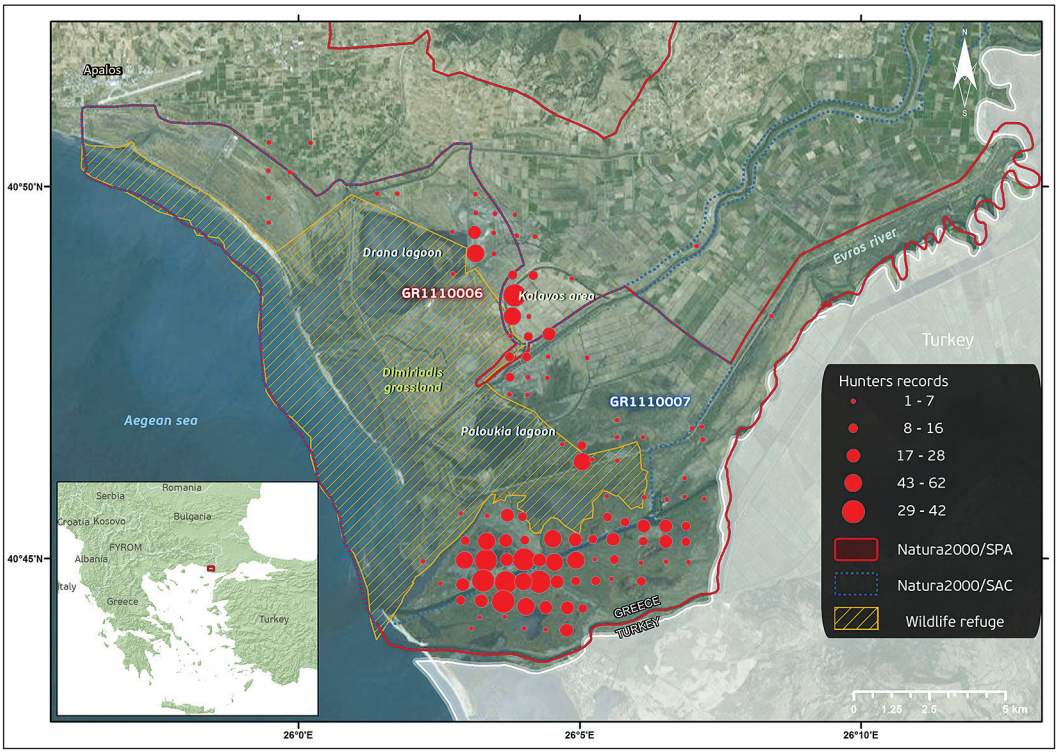

Figure 3. *Distribution and number of hunters recorded during hunting seasons 2012-2013 and 2013-2014 at the Evros Delta. Red dots indicate the number of hunters in each site.*

Hunter at the Evros Delta, Greece. © Daphne Toli/HOS

3.2 Hunting intensity

3.2.1 Gunshot counts

During the 2012-2013 hunting season, at "area A" the mean number of gunshots/day was smaller than that at "area B" whereas during the following two seasons it was higher (**Table 1**). The mean number for gunshots/hunter/day ranged from 7.4 to 10.8 during the three hunting seasons studied.

Hunting season/Area	Area A	Area B	Mean number of shots/hunter/day
2012-2013	**352.5**	**498.0**	**9.5**
2013-2014	**445.6**	**309.8**	**10.8**
2014-2015	**297.7**	**154.2**	**7.4**

Table 1. *The number of gunshots recorded at the two areas (A and B) during three hunting seasons and the mean number of shots each hunter fired per day at the Evros Delta, Greece.*

In regards to all three hunting seasons, January was the month where most gunshots were recorded at both areas "A" and "B", followed by December (**Figure 4** and **5**).

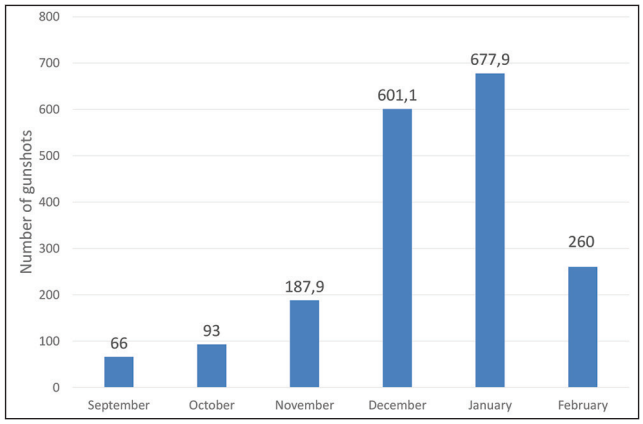

Figure 4. *Mean number of gunshots per day at "area A" (southern part of the Evros Delta) during the hunting seasons 2012-2013, 2013-2014 and 2014-2015.*

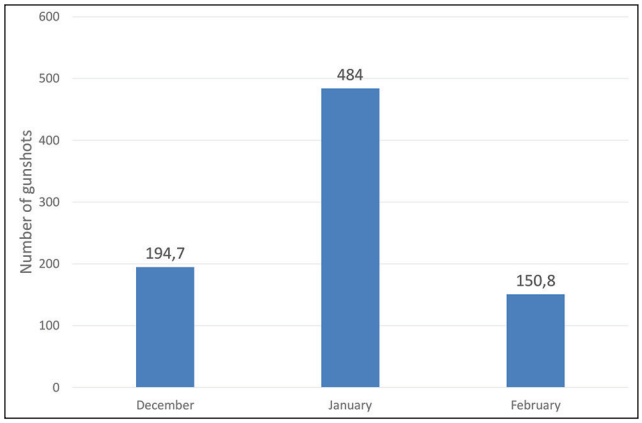

Figure 5. *Mean number of gunshots per day at "area B" (Kalavos area) during the hunting seasons 2012-2013, 2013-2014 and 2014-2015.*

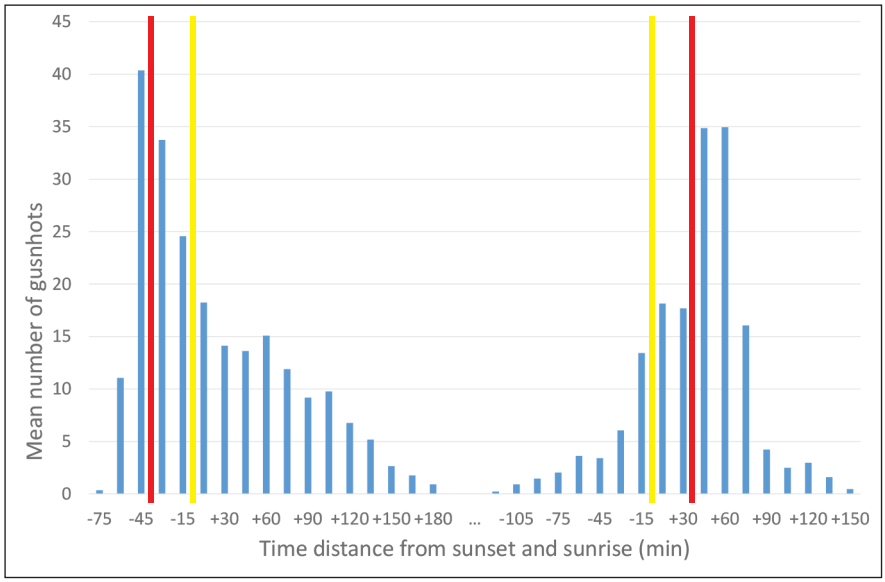

Figure 6.
Time distribution of all gunshots recorded during the hunting seasons 2012-2013, 2013-2014 and 2014-2015 at "area A" during a day.
The yellow lines marks the sunrise (left) and sunset (right).
Gunshots distributed beyond the red line are gunshots shot outside the permitted time limits (30 min before sunrise and 30 min after sunset).

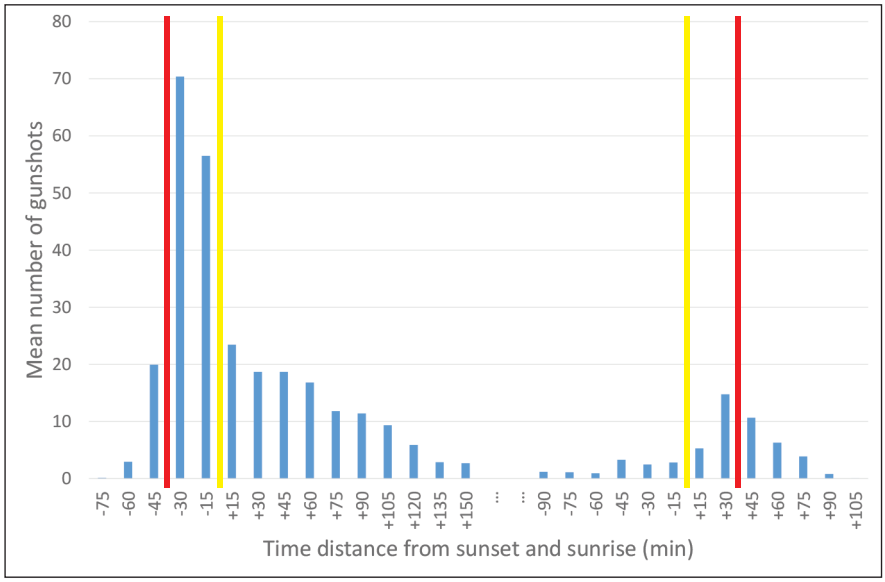

Figure 7.
Time distribution of all gunshots recorded during the hunting seasons 2012-2013, 2013-2014 and 2014-2015 at "area B" during a day.
The yellow lines marks the sunrise (left) and sunset (right).
Gunshots distributed beyond the red line are gunshots shot outside the permitted time limits (30 min before sunrise and 30 min after sunset).

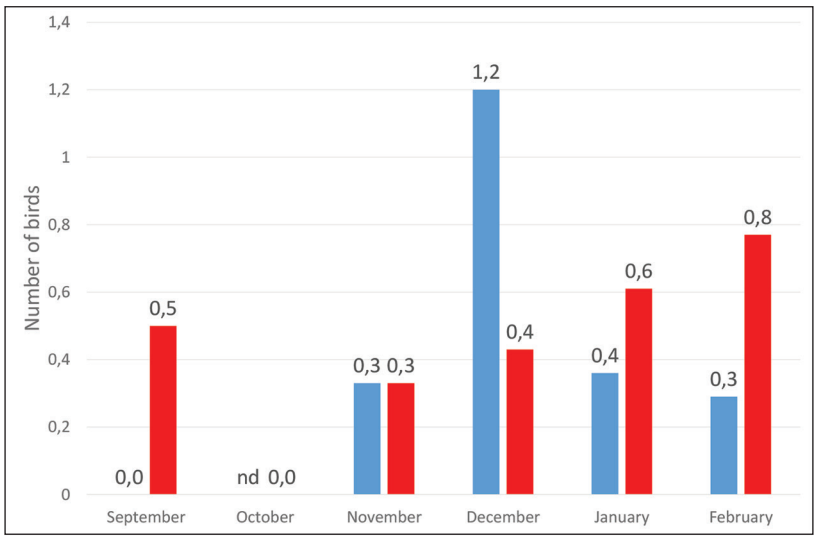

Figure 8.
Mean number of shot birds per hunter during the hunting seasons 2012-2013 and 2013-2014 at the Evros Delta, Greece.

Regarding time distribution of hunting at "area A", and during the three hunting seasons (from 2012 to 2015) hunting was more intense 60 minutes before sunrise and up to 60 minutes after sunrise (morning count) and 30 minutes before sunset and up to 75 minutes after sunset (evening count) (**Figure 6**).

In "area B", hunting was more intense 45 minutes before sunrise and up to 60 minutes after sunrise (morning count) and 60 minutes before sunset and up to 75 minutes after sunset (evening count) (**Figure 7**).

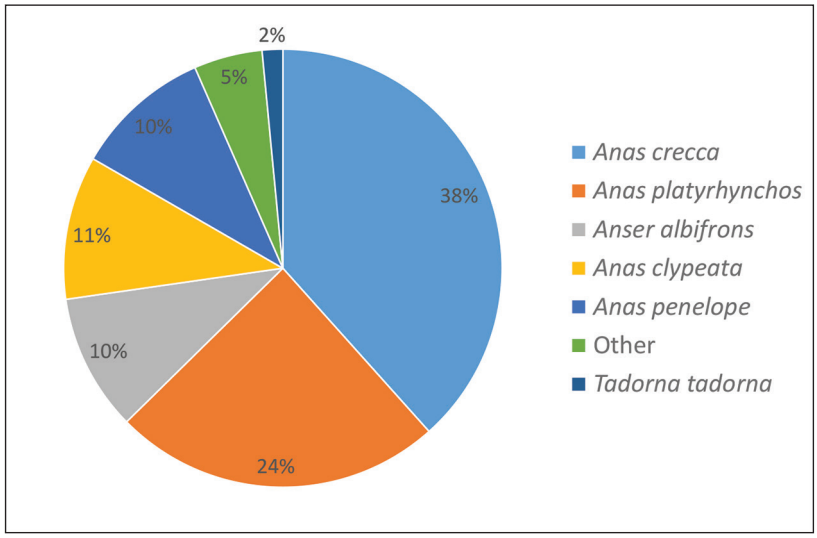

Figure 9.
Percentage of shot bird species recorded in hunting bags during the hunting seasons 2012-2013 and 2013-2014 at the Evros Delta, Greece.

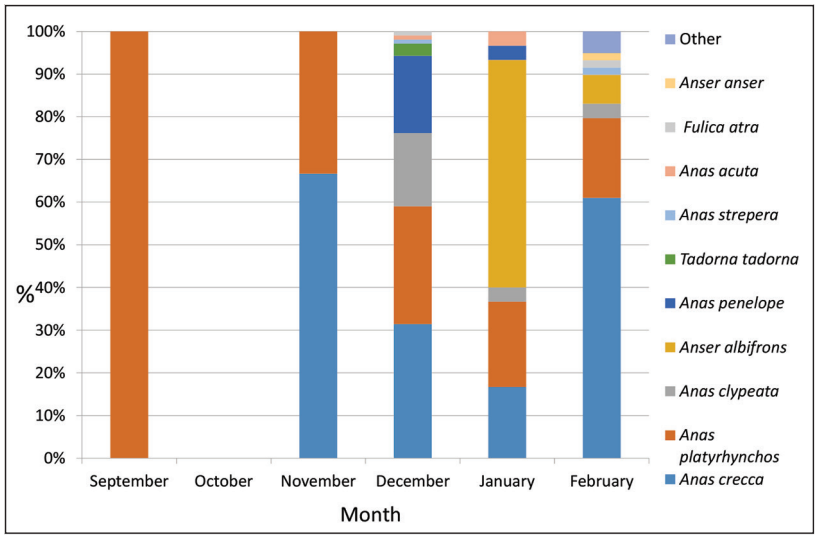

Figure 10.
Shot species percentages per month according to hunting bag monitoring during the hunting periods 2012-2013 and 2013-2014 at the Evros Delta, Greece.

3.3 Hunting bag monitoring

During the 2012-2013 hunting season, the hunting bags of 57 hunters were checked. The mean number of shot birds/hunter/day was 0.44. During the 2013-2014 hunting season, 103 hunters were checked and the mean number of shot birds/hunter/day was 0.54.

The highest number of birds/hunter/day was recorded in December 2012 (1.2 birds) followed by February 2013 (0.8 birds). No hunters with shot birds were found in October (**Figure 8**).

According to the results from both hunting seasons (2012-2013 and 2013-2014) the most commonly shot birds were the Eurasian Teal (38.4%) followed by the Mallard (24.2%) and the GWfG (10.1%) (**Figure 9**). In total, 11 wildfowl species and one hybrid (Mallard X Pintail *Anas acuta*) were found in hunting bags (**Figures 9** and **10**). Additionally, one wader was also recorded (Common Snipe *Gallinago gallinago*). Monthly variations were also recorded among the shot species. While Mallard and Teal were recorded in hunting bags throughout the hunting season, GWfG were shot especially during January (**Figure 10**).

Amongst the 198 shot birds that were found during hunter checks, 2.5% were killed illegally as they were protected species (Ferruginous Duck *Aythya nyroca*, Greylag Goose *Anser anser* and Common Shelduck *Tadorna tadorna*). Additionally, thirteen birds (mostly Mallards) were found shot outside the hunting season (27.1% of all Mallards shot during the hunting seasons 2012-2013 and 2013-2014).

3.4 Estimation of lead deposition at the Evros Delta

Throughout the 2013-2014 hunting season, cartridges from seven sampling areas around Kalavos were collected (n=361). Cartridge type No 2 and No 3 (mainly used for goose hunting) constituted 26.9% of the entire sample, while type No 4, No 5 and No 6 (mainly used for duck hunting) constituted 59.7%. Cartridges with steel shots (9.3%) were only found during the last month of the hunting season. Cartridge collection during 2014-2015 hunting season from the same area (Kalavos) revealed that hunters adapted better to the non-lead shot use in wetlands legislation as 43.5% of the number of cartridges collected (n=623) contained steel shots. In total, from all hunting grounds of Evros Delta in 2014-2015, used cartridges containing steel shots represented a percentage of 35.8% only (n=815).

A total of 2.5 tons of lead were deposited at the Evros Delta during the 2012-2013 hunting season and 2.7 tons during the following year, corresponding to approximately 38 million lead pellets spread in the areas. Especially at Kalavos (core area for

Greater White-fronted Geese in grassland at the Evros Delta, Greece. © Savas Kazantzidis, November 2016

goose species including the LWFG), the amount of lead that was deposited during the 2012-2013 hunting season was estimated at 0.3 tons whereas during the hunting season 2013-2014 was estimated at 0.2 tons (3.6 million lead pellets).

3.5 Lead shot ingestion

Two out of 18 stomachs of GWfG (11.1%) contained one lead pellet each. No pellets were found in the Greylag's stomach that was examined.

4. Discussion

4.1 Number of hunters and their distribution

Although Evros Delta is the most popular wetland among Greek hunters, hunting activity (especially regarding the number of hunters) was much lower than that of earlier years (Kazantzidis 2009). During the 2004-2005 hunting period, the mean daily number of hunters in the same area was over double (133±149) and during 2005-2006 almost the double (100±135) compared to the present studied period. This reduction could be attributed to the recent economic recession in Greece as hunting is a costly activity. Additionally, weather conditions during the studied period were only occasionally ideal (low temperatures and strong winds) for waterfowl hunting. During the 2012-2013 hunting season, the mean temperature was 12.2°C and the wind ranged from 1 Beaufort to 3 Beaufort. The mean daily temperature dropped under 3°C for 16 days only. As a result, high numbers of hunters and shots were rarely recorded. Similar weather conditions prevailed during the 2013-2014 hunting season (mean temperature 11.4°C, wind 1-3Bf) and only for 10 days the mean daily temperature dropped under 3°C (**http://penteli.meteo.gr/stations/alexandroupolis/**, access date: 20/02/2017).

4.2 Hunting intensity

Hunting activity (number of hunters and shots), was higher during the winter months and peaked in January, during both

Cartridges with steel shots used at the Evros Delta, Greece. © Ioakim Vasiliadis, February 2015

hunting seasons studied. This period coincides with the arrival of high numbers of waterfowl for wintering including geese and the LWfG that usually arrive in late December/early January and depart in early March (Kazantzidis and Naziridis 1999, Panagiotopoulou et al. 2009). Hunting activity was higher very early in the morning and in the afternoon as wildfowl is more active during that period of the day (leaving the roosting sites to the feeding grounds and inversely). A large percentage of shooting took place during hours outside the legally permitted time limits (more than 30 minutes before sunrise and more than 30 minutes after sunset) and therefore in conditions of almost absolute darkness. As a result, especially at Kalavos site, the risk of accidental shooting of protected duck and goose species (including the LWfG) was very high. The discrepancy between mean number of shots fired by each hunter versus actual hunting bag clearly indicate that a large number of birds would leave the site with gunshot pellets in the body.

4.3 Composition of the hunting bag

There was big difference between the mean number of shot birds/hunter/day recorded during the present research and the corresponding number that was estimated during 2004-2007 (1.82 birds/hunter/day, Kazantzidis 2009). This is likely to explain

the lower number of hunters during the present research period. The species mostly shot, Teal and Mallard, account to almost two-thirds of the hunting bag. This figure is similar to that recorded in to other Mediterranean wetlands, e.g. Camargue (southern France) (Mondain-Monval et al. 2009) and Po Delta (Italy) (Sorrenti et al. 2006). The fact that protected species were recorded in the hunting bag indicates that it is difficult for hunters to distinguish correctly the species and especially during the poor light conditions before sunrise and after sunset.

4.4 Lead deposition at the Evros Delta

The majority of cartridges used at the Evros Delta during the research period contained lead shots despite the fact that their use have been banned in Greek wetlands for wildfowl hunting since 2013. The main reasons, according to hunters, are the higher price and reduced efficiency of steel shot compared to lead. Nevertheless, hunters seem to get accustomed to using them probably due to the increased number of hunters' controls by the pertinent authorities (Forestry Service) in the framework of the LWfG LIFE project. The amount of lead shots that has been deposited at the Evros Delta is similar to other wetlands (e.g. at the wetlands of Victoria in Australia a quantity of 0.035 tons/km2 was deposited in 1990 (**https://www.environment.vic.gov.au/__data/assets/pdf_file/0022/32494/Use_of_lead_shot_in_cartridges_for_the_hunting_of_waterfowl.pdf**, access date: 15/5/13) while at the Evros Delta during the study period 0.026 tons/km^2 was deposited).

4.5 Lead shot ingestion

Although the number of goose stomachs analyzed is considered low (n=18), ingestion of shot pellets was recorded. During 2004-2008 in a sample of 22 stomachs of GWfG collected from the same area, lead shots were found in four of them (18.2%) (Kazantzidis & Karmiris 2009). In all cases, one shot was found in each stomach indicating that any impact to the birds is not, at least, fatal (lead is poisonous independent of amount, but birds may die in case they ingest more than two pellets, Guy-Noel 2006). However, even small quantities of lead may affect the proper function of certain tissues as well as behavior. Furthermore, analysis for lead presence in 192 GWfG and 170 LWfG droppings collected in Kerkini Lake and Evros Delta during 2013-2015 was negative (no signs of Pb originated from lead shots was recorded, Aloupi et al. 2015). Thus, the impact of lead ingestion on geese it is difficult to estimate as a larger sample is needed.

The shooting of protected wildfowl species and the concentration of hunters at the boundaries of SPA 'Evros Delta' near the area where LWfG and other geese forage, highlights the need to adopt additional measures to further limit the possibility of LWfG being shot. We consider that efforts to enhance hunter awareness in order to avoid shooting protected species and with the use of non-lead shots should be a high priority in the coming years. In addition, the continuous monitoring of hunters' bag and maintenance of the GWfG hunting ban within the SPAs where the LWfG has been recorded, are considered essential and of high priority to safeguard the LWfG in Greece and to minimize the risk of killing protected species.

5. Acknowledgements

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Goose flock in the cultivated fields of Evros Delta. © Alexandra Demertzi/HOS

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A Smart Patrol System for safeguarding the Lesser White-fronted Geese in Greece

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The SPS Remote Unit in Evros Delta. © Alexandra Demertzi/HOS

1. Introduction

Illegal killing and disturbance caused by uncontrolled hunting activity have been identified as key factors that have led to the alarming population decline of the Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) (Jones et al. 2008). An urgent conservation measure for safeguarding the remaining wintering areas of LWfG in Greece was to provide effective means and methods for the surveillance and patrolling of these areas. The Smart Patrol System (SPS) was developed within the framework of the LIFE + project "Safeguarding the Lesser White-fronted Goose in key staging and wintering sites within the European flyway" and is a complete patrolling scheme combining state of the art technologies with on-the-ground patrols, that tackles illegal killing and human disturbance at the staging and wintering sites of the LWfG in Greece. Technology as advanced remote controlled cameras has been increasingly used worldwide to tackle the illegal killing of animals. Although no clear references for the use of outdoor remote surveillance in the prevention of poaching are available, there are many examples for the use of remote and other technologies using sensors (day light and infra red cameras) in the prevention of wildlife crime (Ortolani 2016, IUCN 2016, WWF 2015) mainly in Asia and Africa for the protection of tigers and rhinos especially. Additionally, advances in reporting and monitoring tools are now available (cybertracker[1], SMART[2]) that facilitate data collection and analysis. Smart patrol systems, are introducing a preventative approach in areas of implementation, and aim to secure habitats by eliminating any deliberate harming activity towards wildlife before it happens (Nurse 2016). It is the first time that an outdoor wildlife surveillance system supported by ground patrolling unit operates in Europe, which allows immediate action on wildlife crime. We present here the components, results, capabilities and limitations of the SPS as a novel wildlife patrolling system.

[1] **https://www.cybertracker.org/**

[2] **http://smartconservationtools.org/**

2. Study area and methods

2.1 Area specific patrolling systems

The Smart Patrol System (SPS) was implemented at the two core areas where the LWfG feed and roost during the winter period in Northern Greece. Extensive monitoring and historical data has indicated the Kerkini Lake and Evros Delta as the two most important areas for the species in Greece (Panagiotopoulou et al. 2009). Both areas are National Parks and contain Special Protected Areas (SPA) where goose hunting is not permitted, and also Wildlife Refuges (WR), where hunting is banned. At the Evros Delta, hunting is allowed at the easternmost and northern part of the Delta, while hunting at Kerkini Lake is not allowed. Nevertheless, illegal killing and disturbance have to be controlled at all times during the wintering of the LWfG in Greece in order to ensure safe feeding and roosting areas for the species.

In the Kerkini Lake, the SPS system comprises a Remote Site, in which two sensors (CCTV cameras), optical and thermal are installed at a 10m height. They are powered by solar panels and are operated by a Control Center that guides a manned Mobile Unit to relevant incidents where illegal shooting and/or disturbance are suspected (**Figure 1**). In the Evros Delta, the SPS system can survey a much larger area using two sets of thermal and optical sensors installed at 8 m and 15 m height respectively, and are also operated by a Control Center that guides a manned Mobile Unit (**Figure 2**). In both areas, the sensors used are located inside the WR in order to cover the largest possible surface of the area LWfG use during their stay. For that reason, all existing LWfG monitoring data were taken into account in order to identify the optimum positioning of the sensors, while also exploiting the local terrain that would allow the installation and necessary measures needed in order to limit vandalism.

2.2 Technical Specifications and Function

The SPS of the Kerkini Lake and the Evros Delta were designed based on the concept of discrete operational units that when combined through telematics, comprise a complete surveillance system. The main operational units of the SPS are the Remote Unit, the Control Center, and the Mobile Unit. The Remote Unit is located in the core of the Wildlife Refuge (WR) in both areas; it is powered by solar panels and surrounded with a 2 m wired fence. The unit consists of a double sensor camera, a visible-light sensor (DLTV) and an infrared thermal sensor (IR) intended for outdoor use and located on a 9m high tripod, as well as supporting safety system to prevent vandalism and sabotage (**Figure 3**). The model used is a FLIR PT-Series multisensor camera system on a pan/tilt platform mounted on a medium-duty fixed pedestal mount, which allows the camera to rotate on a 360° angle at 0,1° to 70° per second speed (**Figure 4**). The PT-series is both an analog and an IP camera, which produces videos that can be viewed over a traditional analog video network or that can be streamed over an IP network using MPEG-4, M-JPEG and H.264 encoding. The system operates through an IP network, and via Ethernet transfers data (video,

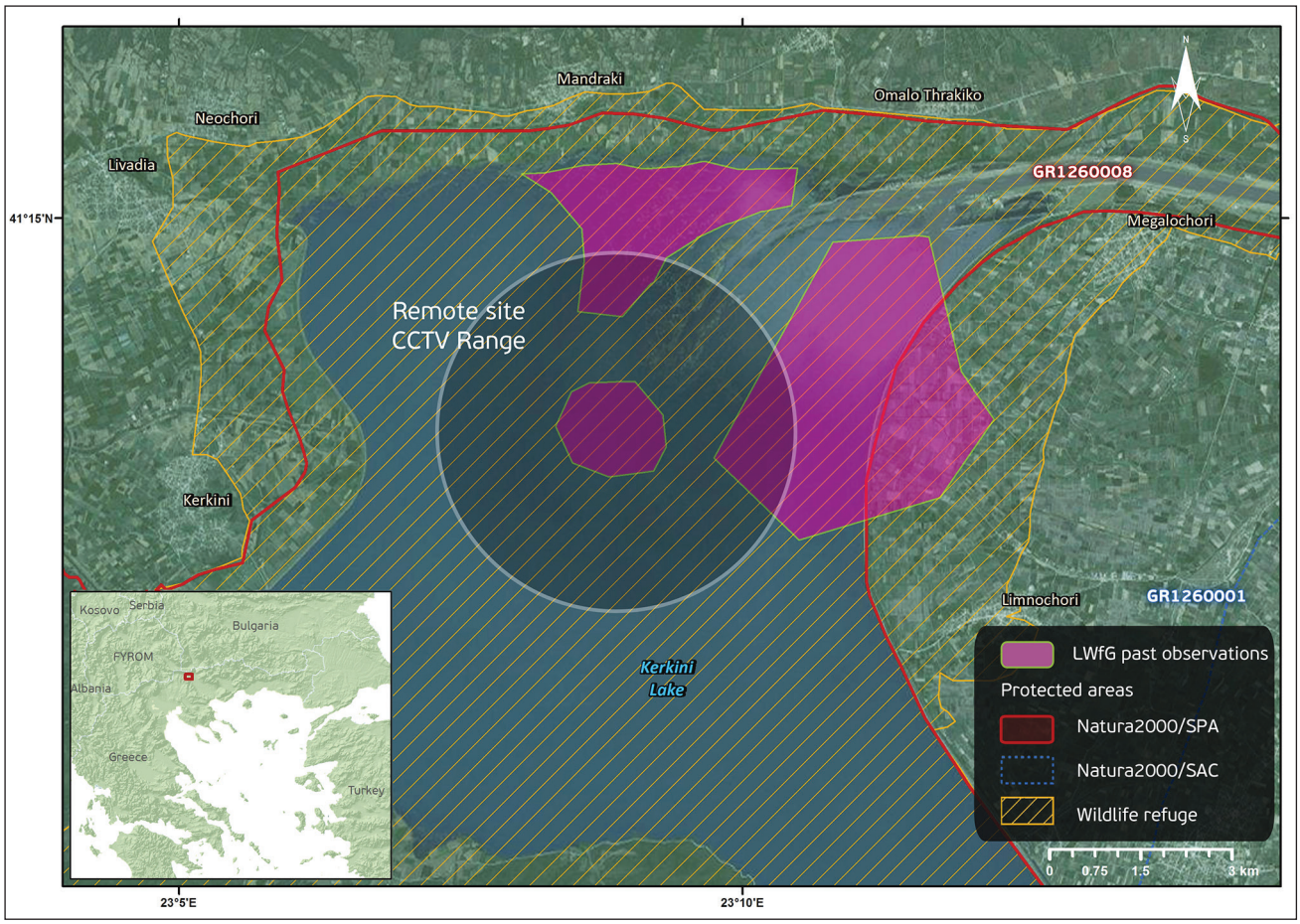


Figure 1. *SPS CCTV range in Kerkini Lake. The roosting site of the wintering LWfG is completely covered, while the Mobile Unit covers the areas out of range.*

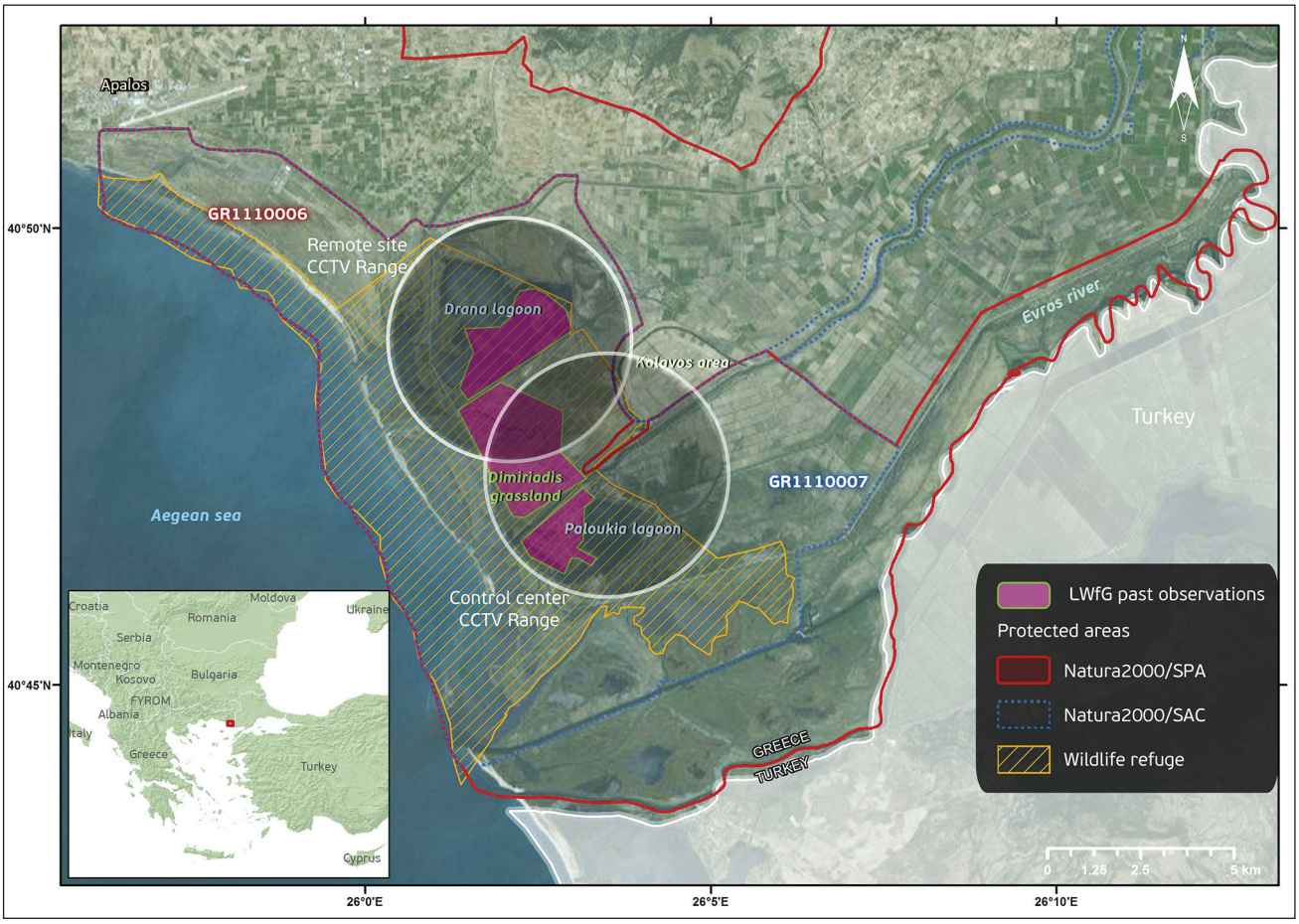


Figure 2. *SPS CCTV range in Evros Delta. The sites where LWfG have been found wintering are almost completely covered. Visibility can be significantly reduced in bad weather conditions; in this case Mobile Unit covers larger areas.*

images, location) to the main PC unit placed at the Control Center. An alarm system with a smaller camera (model Axis P3364-VE 6mm), movement detectors and a GSM Alarm are also installed and once triggered, with a text message through GSM modem (Global System for Mobile Communications, originally Groupe Special Mobile) warns the operator that there has been a perimeter breach.

Video and images from the Remote Site are streamed live in the Control Center, which controls the CCTV cameras through microlink antennas and can support also remote control when internet connection is established (Kerkini Lake). At Kerkini Lake, the Control Center is placed at the Management Authority's premises while in Evros Delta, the Center is placed within the WR and it is equipped with a full alarm system in order to prevent theft and vandalism.

Both Centers are equipped with a VHF station (Icom IC-E2820) able to communicate with the Mobile Unit patrolling the area

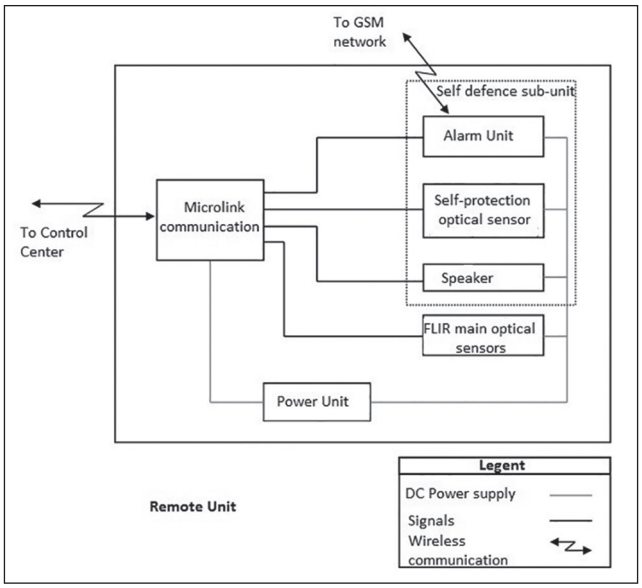


Figure 3. *Architecture of system's components at the Remote Unit.*

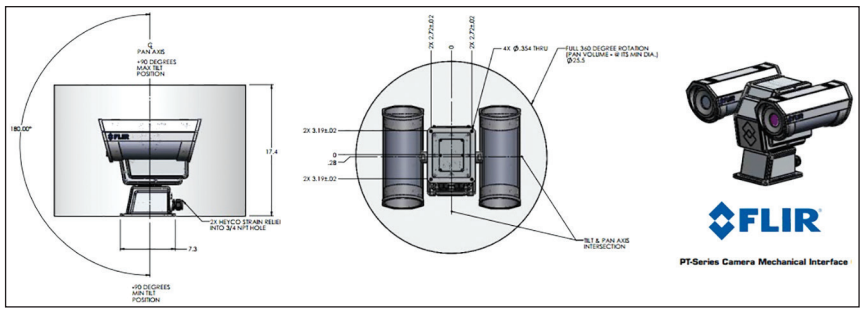


Figure 4.
FLIR PT-Series camera Pan and Tilt technical specifications, FLIR 2012. © FLIR

The Remote Sites in Evros Delta (left). The system is installed on a lagoon islet, allowing access only by boat, in order to safeguard the system from vandalism. The remote site in Kerkini Lake (right) is installed by the river mouth, an area not easily accessible by car that also floods in spring and summer. © Alexandra Demertzi/HOS

and geolocate the vehicle in order to be able to guide the patrol unit to any location/incident through satellite maps. Live video is processed in the Control Center by the FLIR Sensors Manager (FSM), which is the user interface software interacting in the network of sensors. FSM works as a client of Nexus Sensor, which is the connectivity platform that allows the management of the sensors (Nexus Sensor Server connected to the physical devices). Other than the CCTV that connects via the Nexus Server to the FSM, customized applications like VHF geo-location, a geo-referenced map for the user to navigate and the database that stores the videos are also connected. The video database (nDVR) records continuously during the use of the CCTVs, simultaneously from both sensors (IR and DLTV), which offers the advantage to use recorded videos as potential evidence in case of an illegal incident (**Figure 5**).

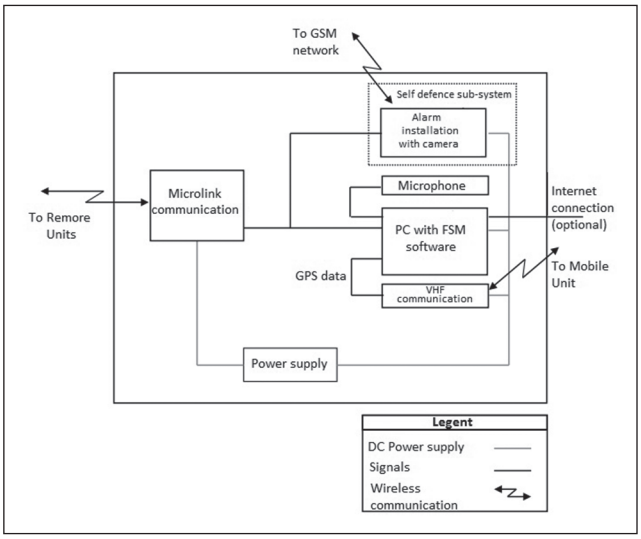


Figure 5. *Architecture of system's components of the Control Center.*

The SPS offers the potential of surveillance of medium range (2.2 km radius) in conditions of low light, absolute dark, fog or smoke with passive image acquisition. The IR cameras can produce a moving image from the infrared spectrum, where the thermal differences in the objects are interpreted as a contrasted image of the actual object (dark areas-warm/bright areas- cold). When the camera operates in a cold or warm environment, the higher the thermal contrast of a targeted object is, the easier it can be spotted in that environment. For the operator to detect and identify objects within the range of the camera, the sharpness of the produced image in relevance to the distance an object plays vital role. The sharpness of the IR or DLTV cameras is evaluated by the "Johnson's Criteria" which define the maximum distance a camera allows the operator to be able to Detect, Recognize and Identify the surveillance target, with more than 50% possibility (**Figure 6**).

The third component, the Mobile Unit, is a 4x4 vehicle equipped with VHF, a mounted GPS unit and a portable device (tablet) with GPS tracker. The GPS tracker, records the patrol route while displaying the WR and SPA boundaries and bearing sophisticated data collection software customized to fit the needs of each area. During a a regular shift, a Mobile Unit is manned with a Forest Service employee, an accompanying SPS warden responsible for data collection, and a trained SPS warden in the Control Center directing the Mobile Unit. At the beginning of the patrol, the Mobile Unit covers the area for an initial estimation of human presence during which, the Forest Service employee performs checks on passing by vehicles and individuals. Since

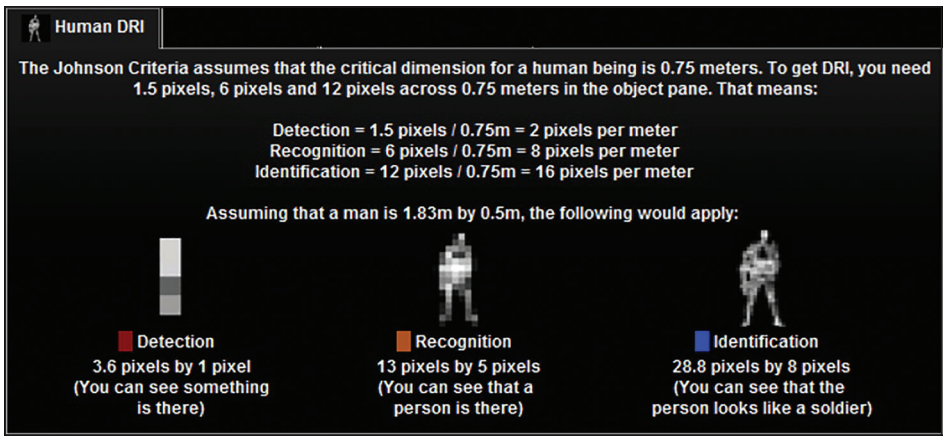


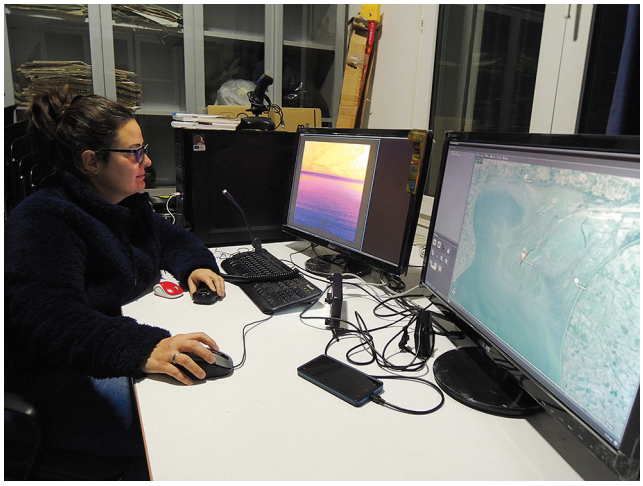
Figure 6.
Example of Johnson Criteria in detecting human presence in the surveyed area.
© www.ev3000.com, accessed on 15/03/2017

the main focus is hunting and illegal killing activity, priority is given to hunters and areas close to WR in order to ensure legality and hunting law compliance. At the Control Center, the second warden inspects the area via CCTV aiming to identify individuals and vehicles moving within the system's range and informs the Mobile Unit of their exact location through VHF. The geographical location of the Mobile Unit can be monitored by regular automatic updates on the SPA/WR map integrated to FLIR Sensors Manager software at the Control Center. All incidents are recorded in the respective protocol, along with wildlife species encounters, livestock presence and position of the LWfG flock in the area.

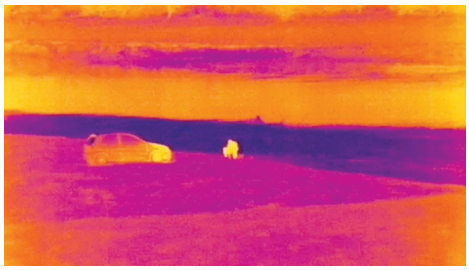
3. Results

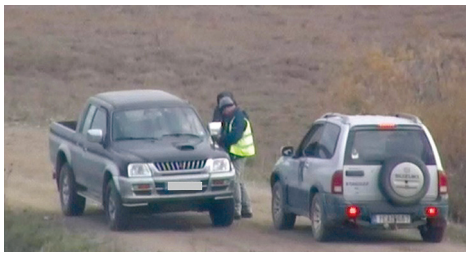
3.1 Hunting activity and human presence within the wildlife refuge

The SPS installation in the Evros Delta was completed during 2014 and in the Kerkini Lake during 2015. Hunting activity was restricted outside the wildlife refuge with most hunters respecting the boundaries of the protected area. Although the number of confirmed illegal incidents was small (see also Demertzi et al. 2017, present edition), there were some incidents recorded by the SPS relevant to hunting before or past the legal hours, where various hunters went on shooting under conditions of no visibility. Other than hunting, data was collected concerning all human activities taking place near the LWfG roosting and feeding sites, in order to assess the potential disturbance of those. Illegal fishing was recorded in numerous occasions both in Evros Delta and Kerkini Lake, within the WR and outside the legal fishing period. Similarly, tourist groups were observed crossing the WR boundaries and approaching very near to the LWfG roosting and feeding areas. The prohibition of unauthorized vehicle use within the WR that was enforced in January 2015 in Evros Delta, offered a solution to the uncontrolled traffic within the WR, although during the following wintering period (2015-2016) the ban was mostly ignored. At Kerkini Lake, the SPS also recorded vehicles approaching the Strymonas river mouth for eco-touristic purposes, even though it is the primary roosting site for the LWfG in the area.



Control Room in Kerkini Lake Information Center (up). The warden guides Mobile Unit towards a point of interest via satellite map where the position of the unit is being displayed live. © Lavrentis Sidiropoulos/HOS. Mobile Unit in Kerkini Lake (down). The Forest Service employee observes the LWfG flock with telescope. © Sevastiani Liouza/HOS





CCTV patrol snapshots in Kerkini Lake and Evros Delta during 2016. Top left: Tourists at Strymonas Mouth, Lake Kerkini. Top right: Illegal fisherman spotted with the thermal sensor at Strymonas Mouth, Kerkini Lake. Bottom left: Mobile Unit performs a check on a passing by vehicle in Evros Delta as seen with the daylight sensor (DLTV). Bottom right: A hunter spotted with the DLTV near Kalavos in Evros Delta. © HOS

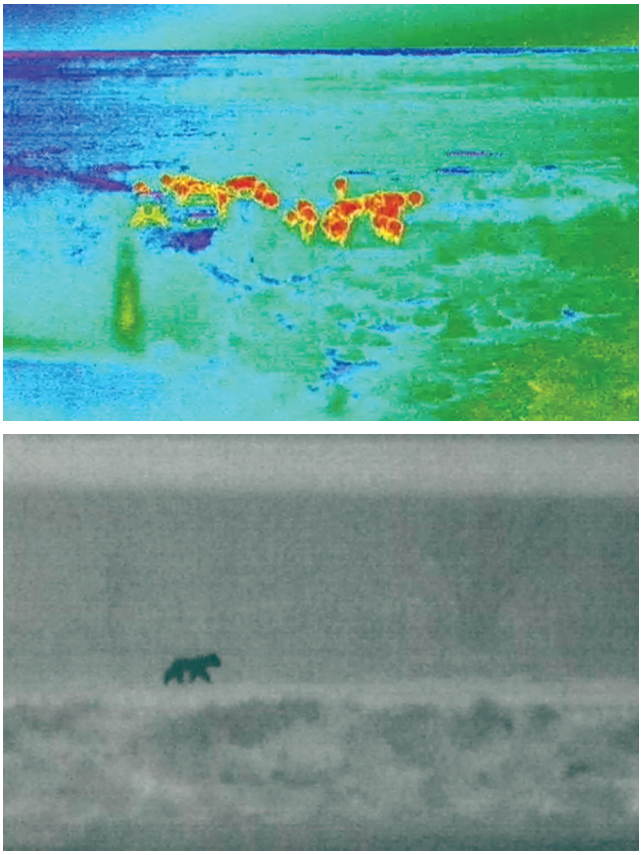
3.2 Wildlife and livestock presence

The SPS offered the opportunity to monitor wildlife presence and especially predators' movements such as the Golden Jackal *Canis aureus* and Red Fox *Vulpes vulpes*, which may act as a natural disturbance factor to the wintering population of the LWfG.

Both in Kerkini Lake and Evros Delta, Golden Jackals were recorded in small numbers by the CCTV system, circling roosting flocks of geese yet without any predation incidents being recorded. In the Kerkini Lake at the Stomio area, 4 Golden Jackals were recorded on 22/12/2015, moving simultaneously close to the goose flocks causing some disturbance, meanwhile in Evros Delta the presence of Golden Jackals was frequent in Dimitriadis field, the primary roosting area for the LWfG.

Livestock found in the Kerkini Lake included mainly water buffaloes, cows, sheep and goats. The LWfG were often observed feeding close or amongst water buffaloes suggesting no negative interaction, although the continuously growing number of cattle grazing at the same area as the geese raises questions regarding the carrying capacity of the area. Sheep and goats were recorded grazing at different areas than the LWfG and even though the presence of a shepherd with 2-3 dogs was frequent, no negative interaction was recorded by the SPS unit. In the Evros Delta, the presence of cattle was regular in the Dimitriadis field although the numbers recorded during the two years of fully operational SPS were relatively small (30-80 cows and 2 buffalos). Presence of sheep and goats was also frequent, yet only observed in small numbers grazing near Kalavos area (SPS 2014-2015, 2015-2016).

Even though the system was designed to prevent illegal killing and safeguard the critical habitats of the LWfG in Greece, it has proven to help also in monitoring the overall human presence in those areas. It is worth mentioning that during its operation in Evros Delta, the patrol team spotted the outbreak of a fire, recorded illegal immigrants and prevented a boat theft. Additionally, in various occasions relevant authorities were informed on the presence of diseased or wounded protected species and illegal fishermen or recorded the movements of a crustacean smuggling network (**Table 1**). In the Kerkini Lake, the SPS identified local tourist agents as well as individuals approaching sensitive areas for eco-touristic purposes and recorded illegal fishermen at Stomio area. The Mobile Unit recorded and managed illegal shooting within the WR whilst very often shootings past the legal hunting hour could be heard (see also Demertzi et al. 2017, present edition).



Livestock and wildlife as seen with the thermal sensor in Evros Delta. Cattle in Dimitriadis grassland. Two cars can also be distinguished parked in front of the cows (up). A Wildcat Felis silvestris close to the eastern pumping station at the Evros Delta (down). © HOS

Table 1.
Events recorded at Evros Delta during SPS patrols and action taken. The two events from Kerkini Lake were recorded during remote system check (accessing the system via Internet). Data form 2014-2016

	Area	Event	Date	Authority Informed
1	**Evros Delta**	illegal imigrants	3/12/2014	Border Police
2	**Evros Delta**	5 illegal fishermen	21/12/2014	Coast Guard
3	**Evros Delta**	1 dead White-fronted Goose	18/1/2015	Management Authority
4	**Evros Delta**	Attempt of boat theft	20/1/2015	Management Authority
5	**Evros Delta**	Fire	15/2/2015	Fire Department
6	**Evros Delta**	Illegal fisherman	28/11/2015	Coast Guard
7	**Evros Delta**	Illegal fisherman	29/11/2015	Coast Guard
8	**Evros Delta**	Illegal fisherman	3/12/2015	Coast Guard
9	**Evros Delta**	Illegal fisherman	13/12/2015	Coast Guard
10	**Evros Delta**	Dead White Pelican RINGED	28/12/2015	Management Authority
11	**Evros Delta**	Shot Dalmatian Pelican	10/1/2016	Management Authority
12	**Evros Delta**	Wounded Flamingo	30/1/2016	Management Authority
13	**Evros Delta**	Crustaceans Smuggling	2/2/2016	Coast Guard
14	**Evros Delta**	3 Illegal fishermen	14/2/2016	Coast Guard
15	**Evros Delta**	Crustaceans Smuggling	18/2/2016	Coast Guard
16	**Evros Delta**	Wounded Dalmatian Pelican	28/2/2016	Management Authority
17	**Kerkini Lake**	Trapped Dalmatian Pelican	15/5/2016	Management Authority
18	**Kerkini Lake**	Illegal fisherman	8/9/2016	Management Authority

3.3 Technical challenges of using new technology

Since the SPS is an innovative patrolling system designed from the ground, as expected, it has faced some technical difficulties concerning mainly the Remote Units. Regular maintenance of the system is required to ensure longevity and avoid damages. Especially in the Evros Delta, which is a coastal wetland, the salinity of the environment and the strong wind have proven demanding for the equipment, which often needs to be cleaned thoroughly with deionized water and regularly receive coats of protective paint. Remote Units both in the Kerkini Lake and the Evros Delta may be inaccessible during certain periods, which in turn may lead to delays in replacing faulty components. Early examination and maintenance during accessible times can foresee equipment failures. Another limitation of the system is the medium radius (≈2.2 km) of the cameras, which allows full surveillance only at the core of the LWfG habitat in both areas (Stomio in Lake Kerkini and Dimitriadis grassland in Evros Delta). Extended patrols of the Mobile Unit further are required in order to ensure compliance with hunting law over the areas outside the cameras' range. The overall patrol cost ranges from 200 - 250 euros per day, covering personnel and petrol, which can be adjusted to the already running patrol routines performed at the relevant areas, in order to minimize costs and maximize operability.

4. Discussion

The Smart Patrol System is a novel and effective method of tackling illegal killing and human disturbance at areas that host protected species such as the LWfG. When the means and personnel are limited, technological advances can bridge the gap of constant protection and conservation of such areas by strategically employing resources to the exact place and time needed. The added possibility of internet connection, also gives the opportunity for the area to be remotely monitored, thus allowing a continuous cover of the areas from any access point. Through the two years of operation of the SPS in Evros Delta, the SPS wardens expressed the feeling of accomplishment and effectiveness to their work since they were able to circulate in the area not randomly but in a purposeful way. The surveillance allowed targeted checks on individuals moving within the camera range, hence lowering the patrol cost (mainly fuel) and human effort due to hours spent in adverse weather conditions.

The use of electronic protocols with the support of customizable applications for each area (Cybertracker software), improved data accuracy and consistence, hence through analysis it has been made possible to adjust patrolling plans accordingly. Wardens spent less time collecting and processing data, since basic information (date, position, and time) is logged automatically and data fields are given in the form of selections (one-tap-movement). Moreover, GPS tracking and VHF communication increased safety during patrols and overall operability. It has to be mentioned that apart from all technological advances, human factor and experience plays a crucial role to the overall venture. The wardens that participated during in the SPS as well as in the relevant training seminars are the key element of the SPS success. Their commitment and knowledge gained can forward conservation efforts for the LWfG and expand the SPS concept to other areas.

In conclusion, the functioning of the SPS both in Kerkini Lake and Evros Delta safeguarded the LWfG effectively, by limiting illegal killing incidents to the peripheral zone of the roosting and feeding sites of the species. Many local people became aware of the SPS existence and seem to avoid the area under surveillance, whilst hunters present in the project sites were continuously informed by the Mobile Units on the presence of LWfG throughout the wintering season. The complete SPS scheme can promote conservation efforts in any sensitive area, where the main site in need for further protection measurements allows an unobstructed view from all angles. Ideally, sensors can be installed in wetland ecosystems and open land, with limitations in hilly or mountainous areas where clear view is limited for at least 2km radius.

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A combined patrolling scheme for safeguarding the Lesser White-fronted Goose in Greece

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1. Introduction

The dramatic decline of the Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) Fennoscandian population, during the last decades, demands drastic actions along the European flyway in order to safeguard it from extinction. Hunting activity and disturbance, are considered main threats for the species (Jones et al. 2008) and take place in at least one wetland (Evros Delta) in Greece, during the LWfG wintering period, hence the direct threats of accidental shooting and disturbance need to be addressed. The possibility of illegally killing the species is increased as LWfG resembles the Greater White-fronted Goose (*Anser albifrons*, hereafter GWfG), a more common, and legally hunted goose species in Greece. Moreover, waterfowl hunting takes place during adverse weather conditions (strong winds, snow, low temperatures), early in the morning or late in the afternoon, when waterfowl moves between the roosting and feeding sites. At that time visibility is low and the possibility of accidentally shooting an endangered species like the LWfG is high. In order to protect the wintering population of the LWfG in Greece the Hellenic Ornithological Society (HOS / BirdLife Greece), within the framework of the LIFE+ Project "Safeguarding the LWfG Fennoscandian population in key wintering and staging sites within the European flyway", planned and executed an innovative patrolling system at the three main wintering areas of the species in Northern Greece. Combined patrol teams of the Forest Service and the HOS were formed and were supported by innovative technologies in order to enforce hunting law compliance and minimize disturbance.

2. Study area and methods

Patrolling took place in the three main areas where the LWfG have been found wintering during the past 30 years; Kerkini Lake, Ismarida Lake and Evros Delta (**Figures 1-3**). During 2011-2012 the overall patrolling process was designed, while all the necessary communications with the respective Forest Services were established. Patrolling took place from the 2012-2013 wintering season and continued through the following winter periods (2013-2014, 2014-2015, and 2015-2016) with provision of another patrolling season during 2016-2017 (which is not incorporated in this article).

2.1 Wintering sites of LWfG and protection status

a) Kerkini Lake:
The overall surface that includes the Lake and Krousia Mountain covers an area of 27,713 hectares. It is an Important Bird Area (IBA – GR020, GR021), a Special Area for Conservation (SAC – GR120001), 70% is characterized as Special Protection Area (SPA –GR126008) and 87% is characterized as Wildlife Refuge (WR). The primary roosting and feeding sites of the LWfG are found within the WR and the SPA (**Figure 1**).

b) Ismarida Lake (Mitrikou):
The surface covered by the National Park measures 18,217 hectares and includes Ismarida Lake, Karatza, Xirolimni, Alyki, Ptelea and Elos Lagoons. It is characterized as an IBA (GR 010), SAC (GR 1130009) while, 84% of its surface is an SPA (GR 1130010), and 36% WR (mainly at the perimeter of Ismarida Lake and the

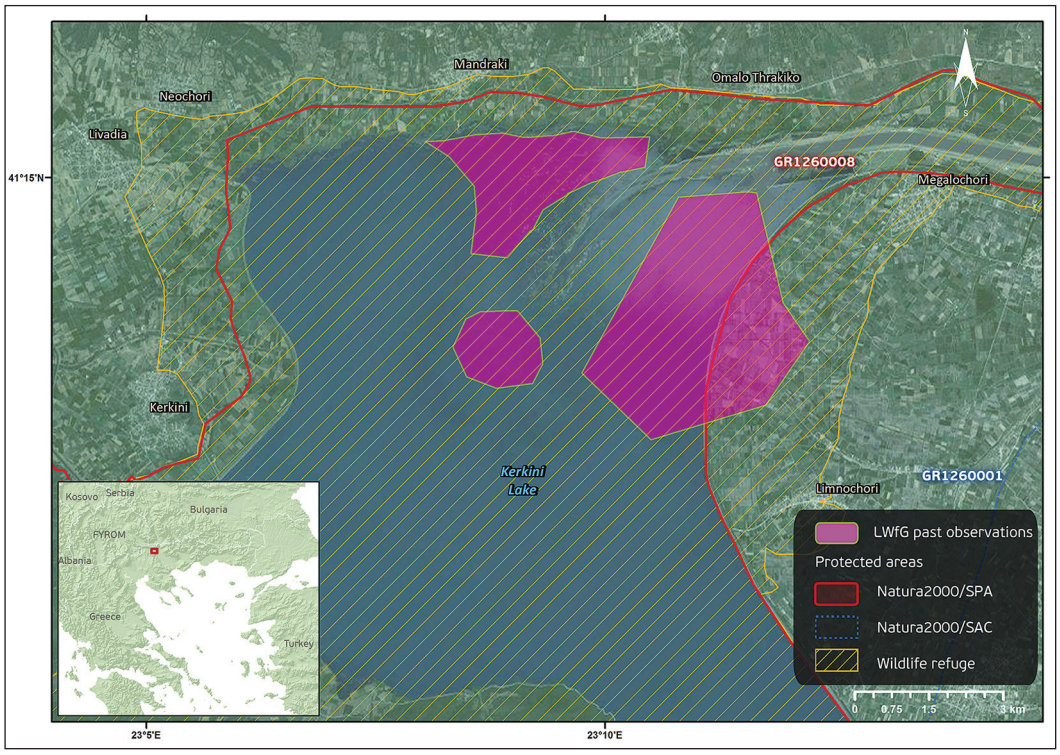

Figure 1.
Kerkini Lake. The areas where the LWfG have been found feeding and roosting (pink polygons) are completely protected by the national and EU legislation.

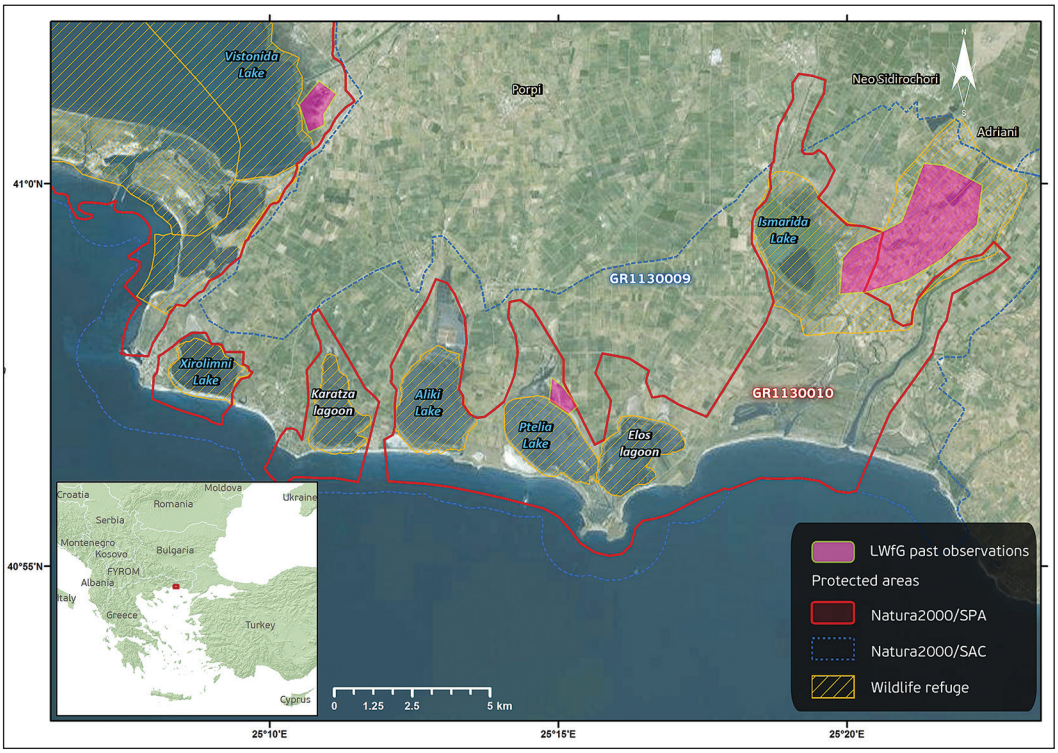

Figure 2.
The wider area of Ismarida Lake where the LWfG were observed in the past.

Lagoons). The LWfG haven't been observed in the area since 1999, nevertheless, due to the frequency of the species in the area in the past it is considered an important wintering area for the LWfG (Kazantzidis & Naziridis 1999). The main roosting and feeding sites were located at the east-north part of the lake (**Figure 2**).

c) Evros Delta:
The Greek part of the Delta covers an area of 12,558 hectares and includes the coastal lakes of Skepi and Nymfon and the Drana, Paloukia and Laki Lagoons. It is listed as an IBA (GR006), 67% of the National Park is characterized as SPA (GR 1110006), 52% as a SAC (GR 1110007) and 29% is characterized as a WR (Portolou et al. 2009). The LWfG distributed in the past in the Dimitriadis meadow and Paloukia Lagoon, with a few reported sightings within the area of Kalavos. During the recent years the flock is recorded almost exclusively in Dimitriadis meadow. The areas where the LWfG are primarily found roosting and feeding are within the WR and the SPA. However, the Kalavos area that is in close vicinity to Dimitriadis meadow, is outside the protected areas and is a popular goose hunting place (**Figure 3**).

The pertinent authority for the management of natural environment (forest, wetland, grassland, etc.) and wildlife in Greece is the Forest Service. Additionally, there is also a private Body of Game Wardens of the Greek Hunting Federation and its local affiliates, supervised by the Greek Ministry of Environment and Energy and focused on enforcing hunting regulation. Cooperation was established between the Forest Service and the Hellenic Ornithological Society (HOS), for the planning of joint patrols. During the research period at least 48 Forest Service employees participated in the LWfG patrolling scheme in all three areas.

2.2 Patrol Plan design and implementation

Each patrol scheme was dictated by the patrol plan produced at the end of the previous patrolling period. It included a short analysis of the results of the previous season, discussed problems encountered and proposed solutions for the upcoming wintering period. Although the program distinguished between day, afternoon and night shifts, it did not specify the dates of the patrols for discretion reasons. Exact date and time of the patrols were confirmed within the week, focused on days with favorable hunting conditions and intensified when the LWfG were present in the area.

In Kerkini Lake, patrolling begun in early October and ended in March. Since hunting activity in Kerkini is relatively low, each patrol had a 4-hour duration starting one hour before sunrise or ending one hour after sunset. In Evros Delta, although the LWfG usually arrive in late December – early January, patrolling began during November and was completed in March. Since the Evros Delta is one of the most popular waterfowl hunting sites in Greece an increased level of control was foreseen for that period. 8-hour patrols were scheduled starting at fixed hours and adjusted when needed (5:00 -13:00 & 15:00-23:00). In Ismarida Lake, patrols had a more investigative role, as to ascertain hunting intensity and to regulate hunters' presence in the area. A fixed number of 10 patrols per wintering period were performed, with 4-hour duration starting before sunrise and/or ending one hour after sunset. In all three areas, patrols were scheduled with priority on weekends and during periods when hunting is usually more intense (late December - early February). Night shifts in Kerkini Lake and Evros Delta were also programmed to take place, during favorable nights (full moon, low temperatures, snow and frost) for hunting or when there were suspicions of illegal killing.

During the 2012-2013 and 2013-2014 wintering seasons, the patrol units in Evros Delta and Kerkini Lake were supported by one 4x4 vehicle at each site for the stop-and-search checks on vehicles and hunters encountered on route (Mobile Unit). A handheld GPS was used to track the location of the unit and the exact place a check was performed, while data were collected with conventional sheet protocols, designed in the Microsoft

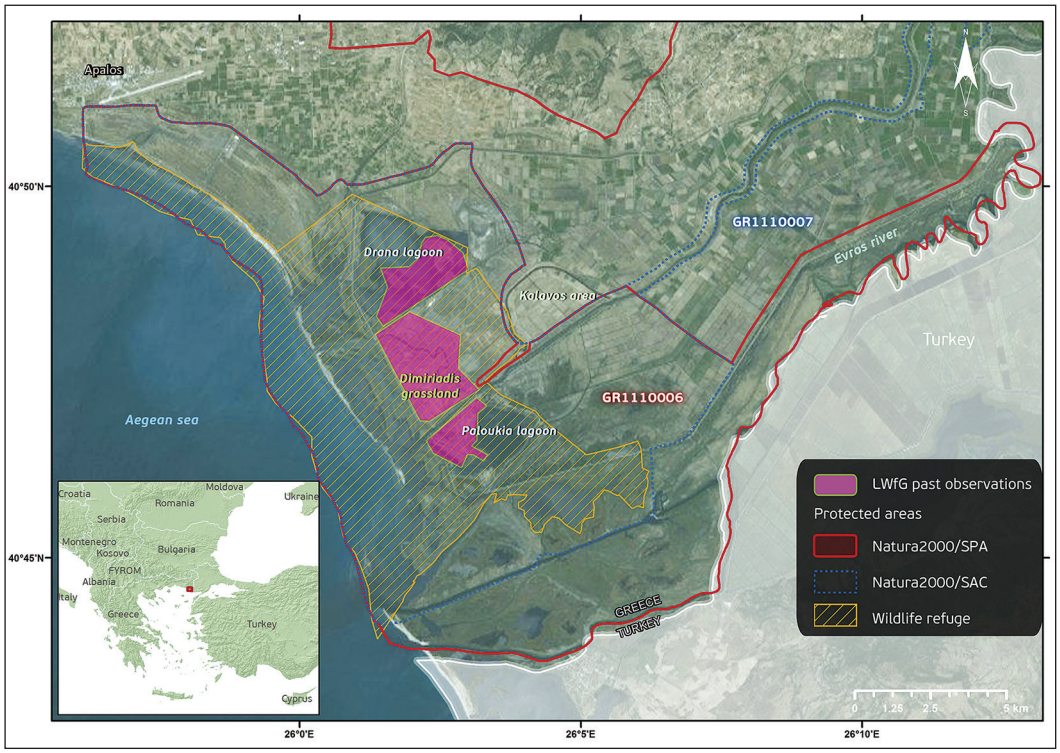

Figure 3.
The Evros Delta. The LWfG are regularly observed in Dimitriadis meadow during January-February.

Excel software. On 2014-2015 an electronic protocol (e-protocol) was introduced, produced via the Cybertracker software (**www.cybertracker.org**). The e-protocol functions as a database producing protocols in the form of an application able to be installed in any smart-device operating in Android environment. For that purpose, the patrol units of each area were equipped with tablets with a built-in GPS sensor and the customized e-protocol for that area. Information such as location, beginning-end of the patrol (exact point/time), route recording, time and date, which are also simultaneously the id of each data entry and subsequently the patrol's id, are automatically stored (**Figures 4 & 5**). Data regarding performed checks, the type of activity of the individuals encountered, legality and action taken are stored in the Check field along with the coordinates and time of each meeting. When a set of patrols is completed, data are transferred in a Windows PC where they can be further processed with the Cybertracker software in order to export comprehensible reports in various formats (Microsoft excel, arcGIS database, Google Earth etc.). During 2014-2015 and 2015-2016 wintering period in Kerkini Lake, the Smart Patrol System (SPS) operated in full and the mobile unit was guided by the CCTV system, able to survey the main LWfG areas (Demertzi et al. 2017). By design, the mobile unit was manned by a Forest Service employee and a warden of the HOS responsible for data collection.

3. Results

3.1 Overview

In all three areas, and during the period 2011-2016 a total of 621 patrols took place, resulting to 1,718 checks of 2,279 individuals, 1,513 of which were hunters. During the 2014-2015 period alone, 846 people were checked within the three areas, with 750 of them being checked in Evros Delta from mid-November until early March (17/11/2014-09/03/2015). In a regular patrol an average of 2.76 checks were performed, during which 3.66 individuals were checked. This observation results mainly from the high number of visitors recorded in Evros Delta (**Table 1**). During the two years the SPS was fully operational in Evros Delta and Kerkini Lake, a rise on the number of checks can be observed (**Figure 6**), which can be attributed to the technological updates incorporated in the patrol scheme, as well the overall patrol operability.

Figure 4.
Screenshots of the SPS application used as e-protocol during patrols.

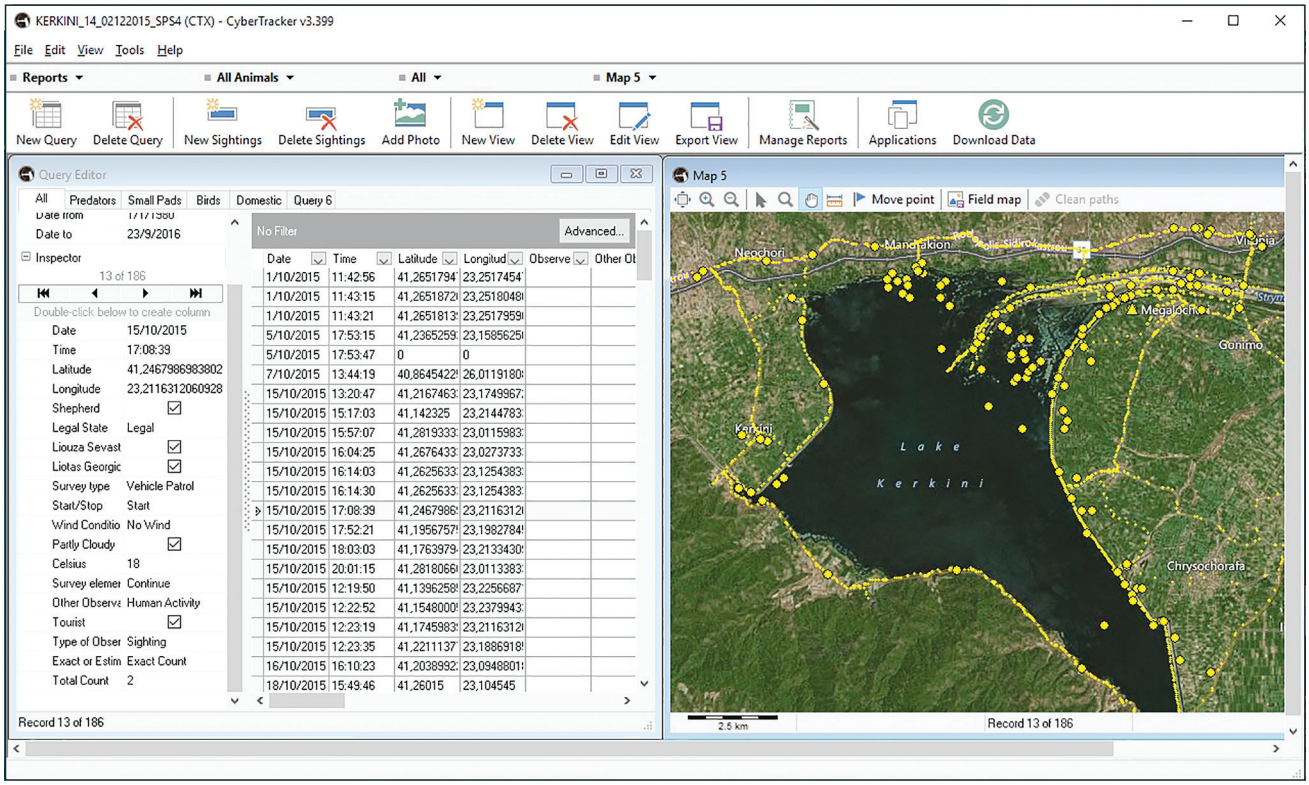

Figure 5. *A screenshot of a Cybertracker report as downloaded by the tablet. The first table (left) contains information of a single data line 15/10/2015 17:08:39), the second table contains each point taken during patrol and the map shows the stops (yellow dots) and the track the patrol unit followed.*

Clockwise starting from top left:

the SPS warden using the Cybertracker app. in Kerkini Lake, 3.2.2016
© Lavrentis Sidiropoulos/HOS;

the forest service officer checks a passing vehicle while the HOS warden collects data, 8.1.2015;

the HOS warden in Evros Delta communicates with the control center, 12.12.2014;

a Management Authority employee checks the area of Ptelea lagoon for possible goose flocks while the forest service officer scans the areas for vehicles, 11.2.2016
© Alexandra Demertzi/HOS

At Kerkini Lake human presence was higher on December with January following. During 2012-2016, a total of 242 individuals were checked at the area, with 88 (36.4%) of them being hunters. Most frequent users of the area were visitors and tourists from other parts of Greece or foreigners (wildlife photographers, birdwatchers etc.). At Evros Delta, human activity was recorded at its highest on January, subsequently to the fact that it is a popular hunting area for waterfowl species. A total of 1,351 (69.89%) hunters were checked from the overall 1,933 individuals encountered in the area. Other users were fishermen and tourists. At Ismarida Lake, since the number of patrols was limited to 10 per wintering period (January-February), the main users targeted for checks were hunters. A total of 104 individuals were checked with 94 of them being hunters (90.4%). Most other users encountered at the area were shepherds and farmers.

The number of hunters recorded by the patrol team in Kerkini Lake was much lower compared to the number observed in Evros Delta and similar to that recorded in Ismarida Lake. Although the maximum number of people checked in Evros Delta was recorded during the 2014-2015 season, it was during 2013-2014 that most hunters were checked in the same area. Due to the weather-dependent character of hunting, fluctuations in the numbers of checked hunters recorded are expected when conditions are not favorable comparing year to year results. The number of illegal incidents that resulted in complaint filings was low, with a total of 12 cases recorded and 14 in which no perpetrator was identified (**Figure 7**). Regarding the character of illegalities relevant to hunting activity being recorded, most frequent was hunting inside the Wildlife Refuge area, followed by hunting past legal hours (more than half an hour after sunset or before sunrise) and hunting without license or with a temporary hunting receipt (**Figure 8**).

Year	Evros Delta	Kerkini Lake	Ismarida Lake	TOTAL
Patrols			**Total**	**621**
2012 - 2013	40	33	10	83
2013 - 2014	96	80	10	186
2014 - 2015	76	78	10	164
2015 - 2016	90	88	10	188
Checks			**Total**	**1718**
2012 - 2013	17	5	13	35
2013 - 2014	373	1	6	380
2014 - 2015	407	45	42	494
2015 - 2016	594	184	31	809
People			**Total**	**2279**
2012 - 2013	60	9	13	82
2013 - 2014	529	2	11	542
2014 - 2015	750	47	49	846
2015 - 2016	594	184	31	809
Hunters			**Total**	**1423**
2012 - 2013	57	8	13	78
2013 - 2014	505	2	11	518
2014 - 2015	432	31	39	502
2015 - 2016	357	27	31	325

Table 1. *An overview of the patrols during the 4-year period 2012-2016.*

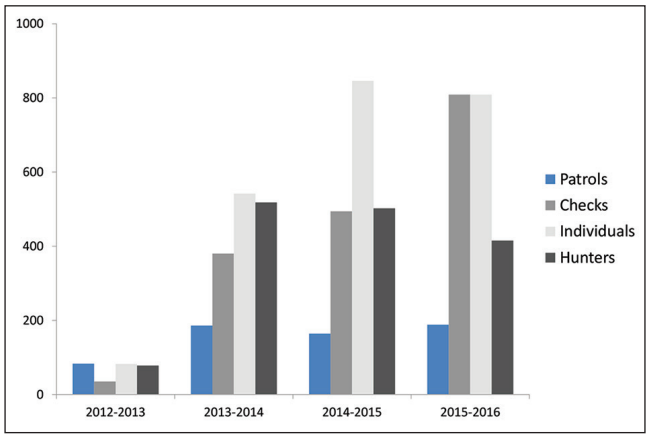

Figure 6.
Overview of the total number of patrols, checks and individuals checked during 2012-2016 at the three project areas (Evros Delta, Kerkini and Ismarida Lakes).

Figure 7.
Total number of incidents regarding hunting activity recorded in the three study areas (Evros Delta, Kerkini and Ismarida Lakes) during 2012-2016.

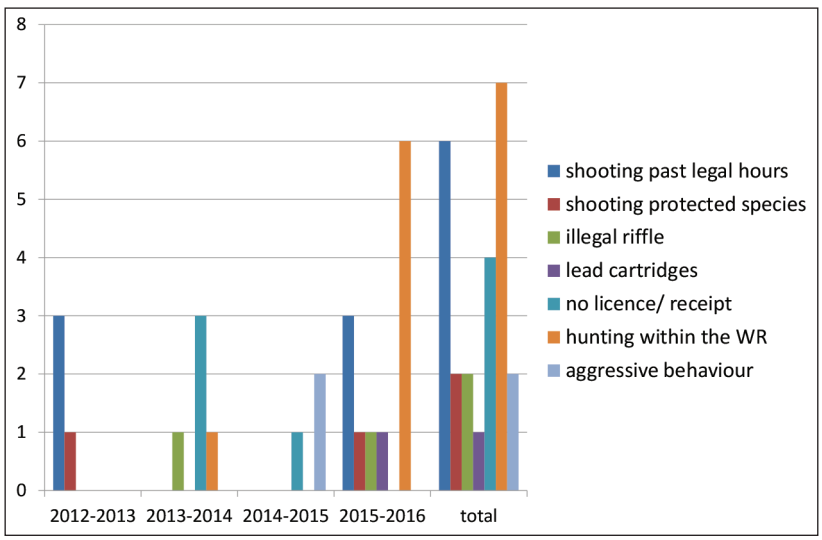

Figure 8.
Types of violations recorded in the three study areas (Evros Delta, Kerkini and Ismarida lakes) during 2012-2016.

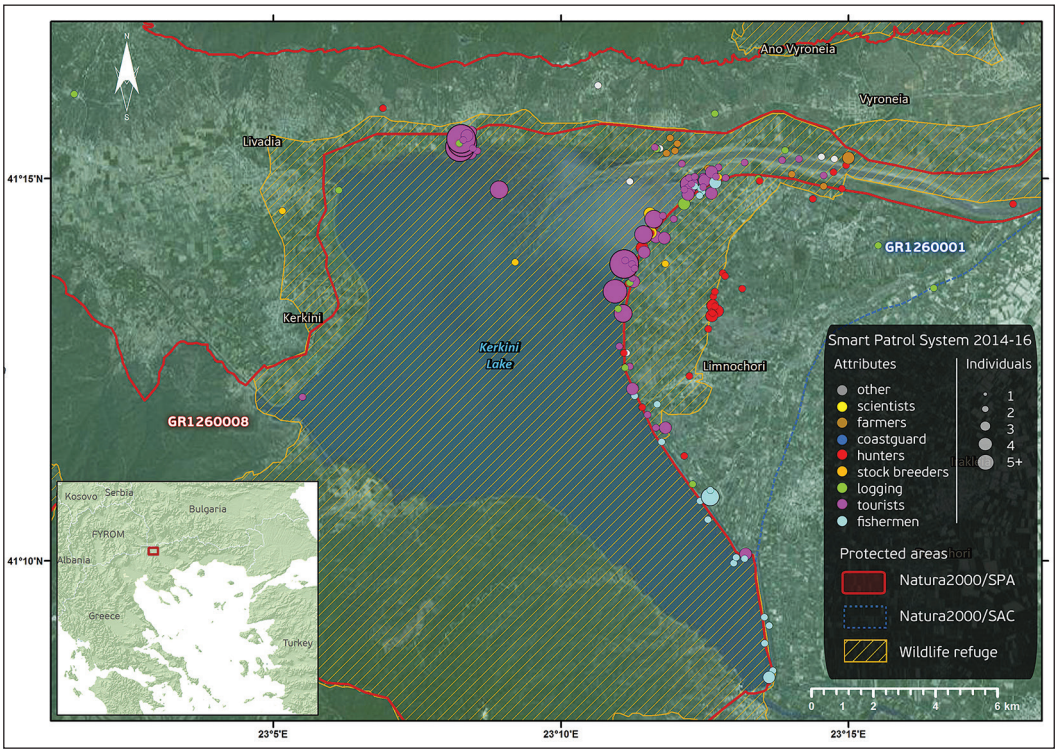

Figure 9.
Distribution of individuals encountered by the Mobile Unit during 2014-2016 at Kerkini Lake. Hunters encountered within the WR were legally passing through the area.

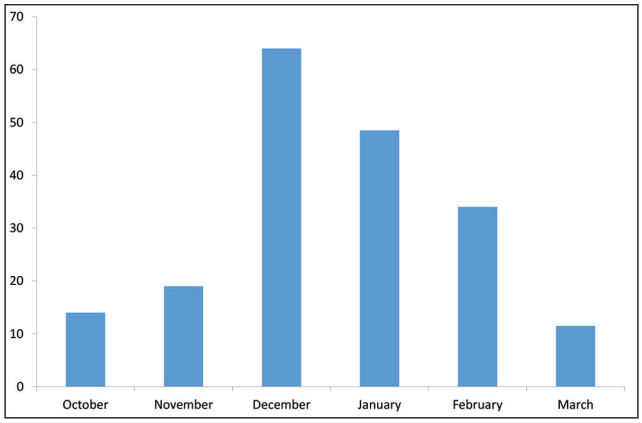

Figure 10.
Average number of checks performed by month in Kerkini Lake. Data from 2014-2015 and 2015-2016 (166 patrols) are included only.

3.2 Kerkini Lake

In the wider area of Kerkini Lake, during the period examined, a total of 279 patrols have taken place, which resulted in 3 complaints filed and 7 incidents regarding illegal killing, where the poachers were not identified. Hunting activity remained at the perimeter of the protected area, at a relatively safe distance from the roosting and feeding sites of the LWfG. A significant number of tourists and visitors were recorded in the area and in two cases 4x4 touristic vehicles were recorded by the CCTV system close to the roosting site (2015-2016) (**Figure 9**).

Human presence reached its peak in December (**Figure 10**), was more frequent during afternoon hours (14:00-18:00) and less during morning hours (6:00-11:00). During late afternoon-night shifts, human presence was very little. Similarly, hunting activity followed this trend with most hunters being checked in December during afternoon hours.

Staff from Ismarida Lake Management Authority during patrol, January 2014. © Manolia Vougioukalou/HOS

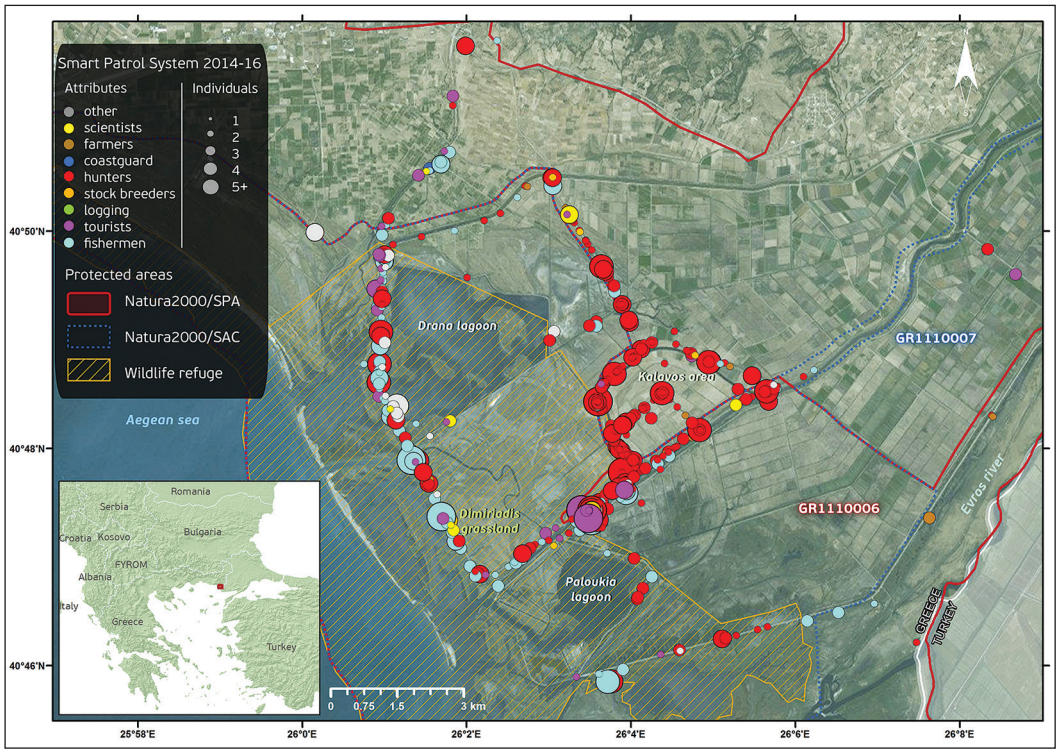

Figure 12.
Distribution of individuals encountered by the Mobile Unit during 2014-2016 at Evros Delta. Hunters found within the WR were crossing the area and not hunting at the time of the check.

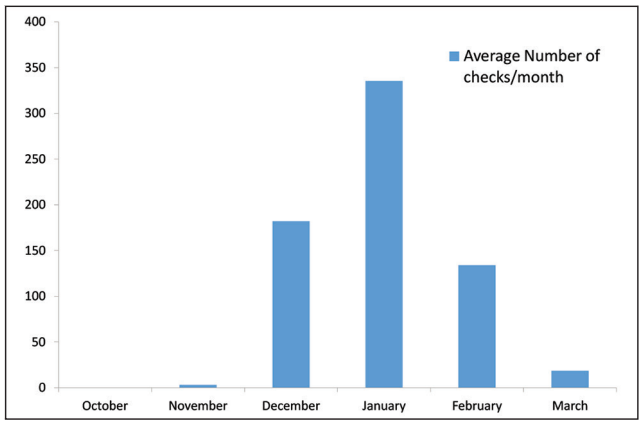

Figure 11.
Average number of checks performed by month in Evros Delta. Data from 2014-2015 and 2015-2016 (166 patrols) are included only.

3.3 Evros Delta

During the four-year period, 302 patrols took place in Evros Delta, 1,261 hunters were checked (**Figure 11**) resulting to six complaints filed, while another three incidents were recorded without possible identification of the poachers. The complains concerned hunters with riffles able to bear more than the legal limit of 3 cartridges (2), hunting outside the hunting period (1), hunting using lead shots and aggressive behavior (1), hunting without a hunting license (1) and an illegally killed Dalmatian Pelican (*Pelecanus crispus*) by an unknown person.

The most frequent activity observed in the area was hunting past the legal hour, recorded both from the Mobile Unit and through the CCTV. Hunting activity was restricted to the perimeter of the protected area (**Figure 12**), although cartridges were also found within the WR. Similarly, during an investigative search within the WR in Evros Delta and where the LWfG have been found wintering, empty cartridges were found (March 2016) indicating poaching when the patrol team was not present in the most sensitive area for the species. Human presence and subsequent hunting activity increased from December until February with a peak in January. Morning hours (6:00–12:00) were recorded to have the most visitors, followed by afternoon hours (14:00-18:00). Movements of people and vehicles during night patrols (23:00-5:00) were insignificant. Even though movement within the WR with unauthorized vehicles is prohibited since January 2015, many still defy the ban.

The new observatory built during the project, overlooking Ismarida Lake. © Roula Trigou/HOS

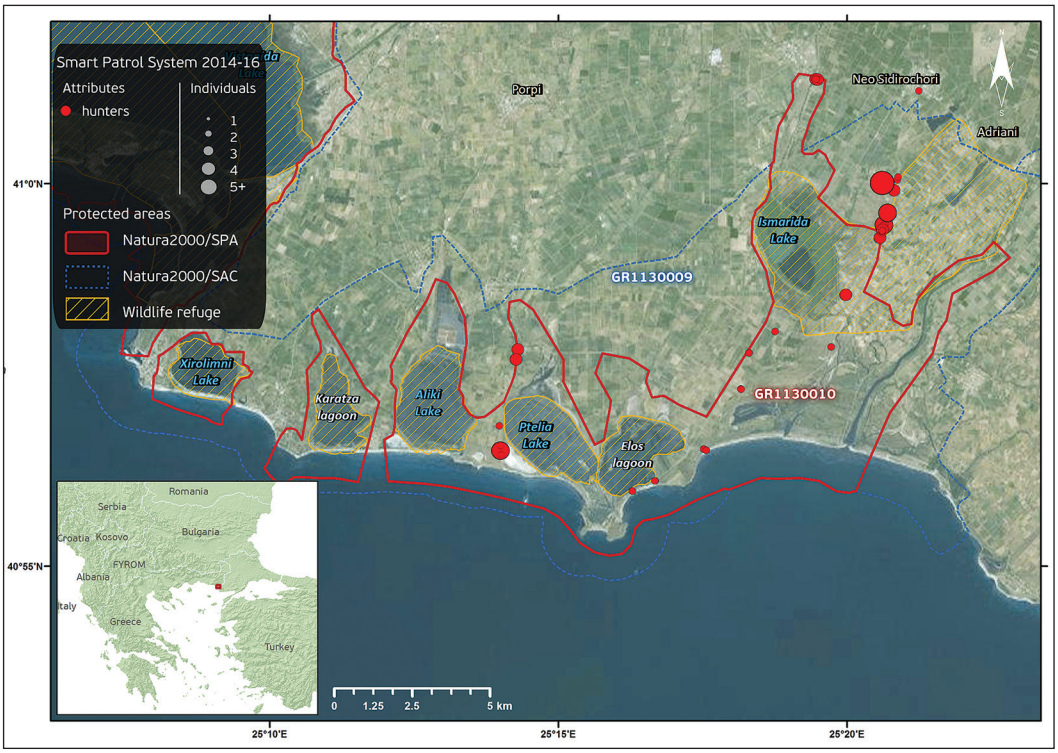

Figure 14.
Distribution of individuals during patrols 2014-2016 at Ismarida Lake and the wider area. The patrol team was focused at the area with the higher hunting activity.

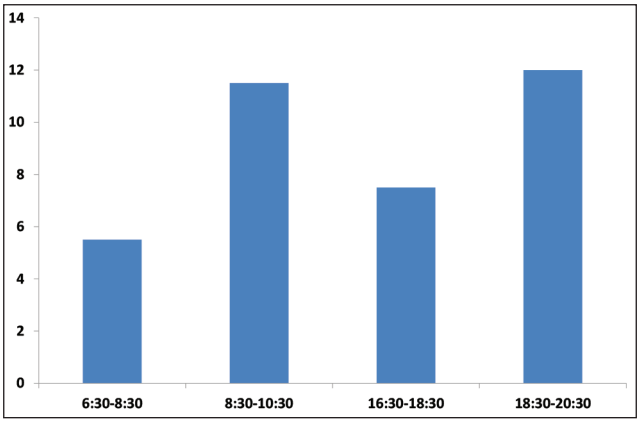

Figure 13.
Average number of checks performed in Ismarida Lake during morning and afternoon patrols. (Data from 2014-2015 and 2015-2016 only).

3.4 Ismarida Lake

Ismarida Lake and the wider area were patrolled each winter period during January and February with 10 4-hour shifts. A total of 40 patrols took place, 94 hunters were checked, resulting in two filings of complains against 2 poachers shooting within the WR and with lead shot (2015-2016), (**Figure 13**). A common issue observed among the hunters was that many were found hunting with temporary receipts of license payment to the Forest Service and not the actual license, which provides photographic identification. Cases of hunting past legal hours mainly one hour after sunset, were also reported in the area. Hunting activity was increased during late afternoon hours (18:30-20:30) and late morning hours (8:30-10:30) although changes are noticed from year to year and additionally patrolling is recommended. Hunters were also found here, restricted at the peripheral zone of the WR (**Figure 14**).

Monitoring the Evros Delta goose sites. © Alexandra Demertzi/HOS

Figure 15. *Exact location of old cartridges found within the critical wintering area of the LWfG in Evros Delta, Dimitriadis meadow. Data collected with Cybertracker (custom protocol) in March 2016.*

4. Discussion

The targeted patrolling has increased awareness not only among the relevant authorities participating in the scheme, but more importantly, among the everyday users of the respective areas. The low number of complaints in relevance to the total number of hunters checked at the three project areas, as well as the illegal incidents recorded by the patrol teams are an indicator of the relatively low frequency of illegal shooting and killing taking place in the areas where the LWfG have been found wintering. On the other hand, incidents like those reported at Kerkini Lake where systematic illegalities took place, probably from the same individuals; require vigilance from the authorities especially near those areas. Equally important, the poaching evidence found inside the WR in Evros Delta at the most important wintering site for the LWfG in the area (Dimitriadis meadow) consist a substantial threat for the species that has to be dealt with (**Figure 15**). Hunting past the legal hours that has been observed through monitoring hunting activities in Evros Delta (Kazantzidis et al. 2014) and was recorded in all three areas, presents various difficulties in controlling it since the perpetrators cannot be identified by the patrolling units, unless there is very close proximity. Undoubtedly, it can result in accidental shooting of a protected species since it is very difficult to distinguish almost any wildfowl species at low visibility conditions. As seen in the case of Evros Delta (Kazantzidis et al. 2014), 2.5 % of the birds found during hunting bag checks were protected. In order to prevent this type of illegal shooting, controlled entry and exit to and from the area can be considered.
Nevertheless, the SPS has acted as a preventive measure against all kinds of illegal actions since local people (hunters, fishermen, and villagers) acknowledge the existence of the CCTV systems hence avoid the core of the WR where those are found. Worth mentioning is that the cooperation of an NGO such as Birdlife Greece with the local Forest Services supported the exchange of information and experience and promoted legality in these areas during winter period, by ensuring modern means to be available for the Forest Service employees at all times. Combined patrols of various Authorities (MA and Forest Service or NGOs) can overcome technical and economical obstacles, whilst the knowledge exchanged can lead to successfully tackling illegal killing. During the patrol programing, the Management Authorities and HOS exchanged information regarding possible poaching activities and regulated the program in order to maximize presence and coverage of the respected protected areas. A complete patrol scheme in highly sensitive environments can support conservation efforts when and if the relevant authorities are able to take advantage of the new means and cooperate towards the desired target. Additionally, a zero-tolerance attitude during patrol is expected to progressively limit illegal actions and subsequently the threat of illegal killing.

A shot Dalmatian Pelican found in Kalavos area, Evros Delta by the Mobile Unit 2015-2016, 10/01/2016. © Panagiotis Gkinis/HOS

5. Acknowledgements

The combined patrols took place in the framework of the LIFE10 NAT/GR/000638 project, co-financed by the European Commission and the Norwegian Environment Agency. Many people were involved in the patrolling scheme during the period 2012-2017. Special thanks to all the HOS wardens and the personnel of Nestos Delta, Lakes Vistonida, Ismarida Management Authority that participated in the patrols, for their effort and persistence through difficult weather and demanding hours. We would also like to thank the Forest Services of Sidirokastro, Stavroupoli and Alexandroupoli for their support and useful advice during patrol programming. We also thank the Forest Directorate of Evros prefecture for their commitment on carrying on the protection of Evros Delta wildlife. We would also like to thank the Management Authorities of Kerkini Lake and Evros Delta National Parks for their guidance and support.

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HOS warden monitoring Kerkini Lake during patrol. © Alexandra Demertzi/HOS

Patrolling to safeguard a species on the brink of extinction in Bulgaria: the case of the Lesser White-fronted Goose

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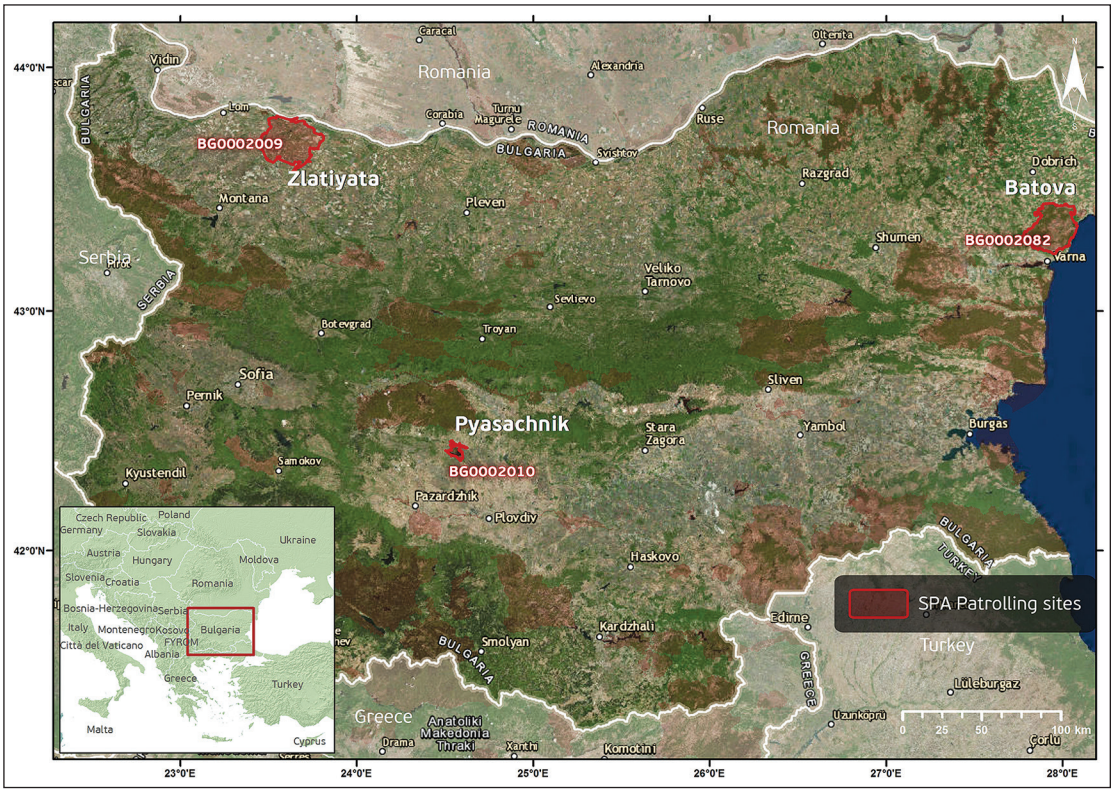

Figure 1. *Special Protected Areas (SPAs) where a joint patrolling scheme was employed.*

1. Introduction

The causes for the unfavorable conservation status of the world population of the Lesser White-fronted Goose (*Anser eruthropus*, hereafter LWfG), are still not entirely understood due to the remaining knowledge gaps regarding distribution, movements and population size. According to the first Species Action Plan, the main causes for the rapid decline of the population are the loss of suitable habitats and hunting pressure in the wintering sites (Madsen 1996). The most severe hunting pressure occurs in Russia, Kazakhstan and China, and influences more than 95% of the global LWfG population. In Bulgaria the main threats identified so far are illegal shooting, usage of pesticides and rodenticides in the foraging fields, and disturbance in the roosting and foraging sites (Simeonov & Dereliev 2011). Out of the forementioned threats, the illegal shooting seems to affect the wintering population of the species in Bulgaria the most. The present study reports the results of an action towards the prevention of illegal killing of goose species developed for the purpose of the LIFE+ Project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in wintering and staging sites whithin the European flyway". This action has been implemented at three model project sites in Bulgaria. These three, which all are Special Protected Areas (SPAs), are the "Pyasachnik reservoir" BG0002010, "Zlatiyata" BG0002009 and "Batova" BG0002082 (**Figure 1**). We aimed to develop a permanent patrolling system for long-term and sustainable management of species in protected areas in Bulgaria.

2. Study area and methods

2.1 Survey period and frequency

Patrolling in the field was carried out at least once per month during the official waterfowl hunting days (1st of October – 31st of January) between 2012 and 2015. In Bulgaria hunting is only allowed in the weekends throughout the season, while during January it is also allowed on Wednesdays.

2.2 Methods

Patrolling started at sunrise and continued until the end of the hunt in the area at midday. We visited known hunting fields, patrolling in pre-determined routes. We checked any car or hunter observed either from stationary points or along the route in the boundaries of the SPAs. Hunters were checked for abiding the hunting regulations including having a valid hunting licence. Patrolling was conducted by representatives from both Bulgarian Society for the Protection of Birds (hearafter BSPB) and relevant authorities responsible for monitoring adherence to hunting and biodiversity legislation – Reginonal Forestry Diractorates (RFD) and/or Regional Inspectorate of Environment and Waters (RIEW). The RFD are responsible for the implementation of Law for Hunting and Game Preservation and RIEW is responsible for the implementation of the Bulgarian Biodiversity Law.

2.3 Legal framework of the patrolling action

Inspectors from the Regional Forestry Directorates (RFD) have exceptional rights to to stop and search hunters' bags and cars. Hunting in Bulgaria is permitted during daylight anywhere except for the protected areas or where prohibited by different legislation acts. Attracting devices such as sound devices, artificial deckoys, hides and hunting from vehicles in motion are forbidden. Hunters have to follow additional rules when they are comitting a group hunt. The hunt in these occasions is limited to a particular area, called a hunting area, that is fixed for each hunting party. All the hunters involved have to hunt only within its boundaries, follow a particular hunting plan and to be included in a special hunting list that is attested by the person in charge of the hunting party.

A technical protocol was filled during each patrol shift between the patrolling team. An administrative act (a legal document that charges monetary fine to an offender) was followed in the case of violations.

Check of the hunting license by Regional Forestry Directorate (RFD) – Plovdiv representatives during patrolling event in SPA "Pyasachnik reservoir", 30/11/2013. © BSPB

3. Results

Patrolling was conducted in the period October 2012 – February 2015. A total of 35 days of patrolling were carried out, separated into 4 seasons (2012/2013, 2013/2014, 2014/2015 and 2015/2016) for the three project sites. The number of patrols was distributed almost equally between the project sites. No serious violations of the legislation were proven during the joint patrolling.

3.1 SPA Pyasachnik reservoir

Altogether 16 patrolling missions were performed at the site. The patrols were almost equally distributed between seasons – six checks in the first season, when the scheme was initiated, three checks in each of the following two seasons and four patrols in the 2015/2016 hunting season. During the entire project (4 seasons) 100 hunters were checked for their licenses and hunting bags. No serious violations were found, except for hunting by an adolescent person in the last season. In total, 55 cars were searched for transport of illegally shot birds. Seventeen hunters and 5 cars were registered on average per patrol in SPA Pyasachnik reservoir SPA. Nevertheless, on two occasions, illegal fishing activities were registered within the SPA; in one of these cases the poachers were caught when trying to leave the area. An administrative Act was filled in this case and a fine was laid. However, illegal shooting is still a case in this site. One incident outside the open season was registered by BSPB volunteers within the SPA when two persons were observed shooting at Greater White-fronted Geese *Anser albifrons*. The case was reported to the RFD for further investigation and measures. Nevertheless, hunting pressure within this site was found with low intensity in comparison to the past when hundreds of hunters were utilizing the area. A total of 10 persons from RFD and RIEW took part in the patrols.

3.2 SPA Zlatiyata

During the four seasons of joint patrolling 14 checks were performed. The patrols were more intensive in the first two seasons when 10 of the 14 checks were performed. During the patrols only eight hunters and five cars were observed and checked within this site. The hunting pressure here was found negligible probably because the area is huge and hunting geese in small numbers was not "cost and effort" efficient for the hunters who preferred in this case to shoot wild boars. No violations were registered. Seven persons from RFD and RIEW took part in the patrols.

3.3 SPA Batova

During the four seasons of joint patrolling, 13 checks were performed in Batova. Eight joint patrols were performed in the first two seasons and five patrol checks were conducted during the last two seasons. Hunting activity in this site was almost absent as only three cars were observed and checked during the whole period. No violations were registered.

4. Discussion

Despite the low hunting and illegal shooting activity registered during the patrolling in the project sites, this action is considered to be the most effective approach towards the conservation of the LWfG on the ground. Legal procedures and action plans are yet not applicable to countries with high level of bureaucracy and low level of law enforcement. The outstanding effect of the patrolling should be considered not by the results themselves, but through the involvement of the state authorities in the action and fostering them to commit the needed conservation steps. Yet there is still a lot to be done so that the patrolling becomes a national scheme rather than just a project effort, but the baseline efforts are already undertaken and patrolling is transposed to other areas with strong evidences for its efficiency and necessity in the future.

Generally, it is believed that the rapid decrease of the Lesser White-fronted Goose population is due to the loss of habitat and the intensive hunting along the migration and staging sites (Madsen 1996). On a global scale, the present species' status is still a matter of discussions because of considerable lack of knowledge. On a regional level, pesticides, shooting and disturbance are the main threats for the LWfG registered in Bulgaria (Simeonov & Dereliev 2011). According to the draft of the national action plan for the LWfG in Bulgaria, the magnitude of the hunting and hunting pressure is critical for ensuring the species

Control of the hunting party "Lyuben" by RFD – Plovdiv for the people limit in the license and hunting area boundaries in SPA "Pyasachnik Reservoir", 18/01/2015. © BSPB

favorable conservation status. In cases of illegal shooting and disturbance, birds are forced to leave roosting and/or foraging sites and thus fly in less optimal areas, or miss the chance to forage in the most suitable territories that might affect their survival (Bechet et al. 2004). Disturbance and illegal shooting activity alters species behaviour and fitness to the environmental conditions and has been registered as one of the most severe threats to another endangered species in Bulgaria, the Red Breasted Goose *Branta ruficollis* (**http://bspb-redbreasts.org/**). LWfG is also an accidental victim of hunting activities, because of the species resemblance to the Greater White-fronted Goose and thus the hunting is recognized as one of the main reasons for species population decrease worldwide (Jones et al. 2008). So far, 10 cases of shot LWfG were registered in Bulgaria since 1890 (BSPB 2016). Most likely the numbers are higher than the registered cases since hunting pressure in the main goose staging areas in Bulgaria (Black Sea coast) is much more intensive than what registered in the project sites. Furthermore, because of the LWfG resemblance to the Greater White-fronted Goose, it may remain unidentified or misidentified when shot. Also, it is unlikely that a hunter would admit intentional or unintentional kill of an endangered species, which would lead to misleading information about the real number of shot LWfG. Patrolling as a special action towards the prevention of illegal killing of goose species developed for the purpose of the LIFE10 NAT/GR/000638 project was consequently transposed to other areas in Bulgaria. Heavy hunting pressure and eight administrative acts for violations were compiled by BSPB / institutions joint-patrols in Shabla, Durankulak (5 cases) and the Burgas lakes (3 cases) altogether in only one season (2015/2016).

The elongation of this action and its regular implementation in the main foraging and roosting sites for geese in Bulgaria will ensure the protection of the globally threatened LWfG. The joint patrolling needs to be incorporated in protected sites and SPAs in order to ensure legal approach for its implementation and more in-depth participation of the relevant authorities in the patrols. Thus, by handing over the organization and implementation of the patrolling schemes to the authorities, risks for the LWfG and other threatened bird species will be minimized in time and space.

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National Action Plans for the Lesser White-fronted Goose in Greece, Bulgaria and Hungary

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The first LWfG NAP stakeholder consultation meeting in Athens, Greece, 2013. A second meeting took place in Thessaloniki in 2015, that included a wider range of stakeholders. © HOS

1. Introduction

National Action Plans (NAPs) are a key tool used to coordinate and ensure national implementation of International Species Action or Management Plans, which are the guiding international frameworks for the conservation, recovery and/or sustainable management of a species. As International Plans are the result of an agreement between all the relevant range states and stakeholders, the overall goals, results and activities therein are usually formulated in a more general nature on flyway level. Following the agreement and adoption of a new International Plan, an adaptation of these general results and activities is often necessary on the national level in order to take into account specific national circumstances and legislative frameworks to ensure their direct relevance and subsequent implementation. Priorities also often vary between countries depending for example on the prevailing main threats to a species as well as previously implemented conservation/management actions and the status of conservation and hunting legislation etc. (Mikander 2015). NAPs are therefore used to "translate" International Plans to the national level, including the establishment of national species goals and targets as well as the formulation of more concrete national activities with specific details regarding the implementing national organizations, timeframes and available human and financial resources.

Under the African-Eurasian Migratory Waterbird Agreement (AEWA), in particular the Principal Range States crucial to the recovery or management of a species are encouraged to adopt NAPs, based on the respective agreed international framework and to establish National Working Groups to coordinate the implementation of activities nationally. AEWA Guidelines on the preparation of National Single Species Action Plans for migratory waterbirds are available to support this work (AEWA 2005). National Species Working Groups should, in turn, be established to coordinate the development and implementation of National Action/Management Plans and be used to engage all relevant national stakeholders in the process. As such, these groups should be inter-governmental and inclusive.

The International Single Species Action Plan for the Conservation of the Lesser White-fronted Goose *Anser erythropus* (here-

after LWfG) covering the Western Palearctic population, encourages the drafting and adoption of NAPs for all Principal Range States for the LWfG (Jones et al. 2008). Additional NAP formulation and adoption is usually foreseen for the European Union Member States at least, by national biodiversity legislation. NAPs for the conservation of the LWfG so far already exist for Norway, Finland, Estonia and Sweden, and are available on the website of the AEWA LWfG International Working Group page: **https://goo.gl/BEZnvT** and **http://piskulka.net**.

As a result, the Hellenic Ornithological Society (HOS), the Bulgarian Society for the Protection of Birds (BSPB) and the Hortobágy National Park Directorate (HNPD) formulated NAPs for the LWfG in Greece, Bulgaria and Hungary respectively, following the relevant AEWA guidelines as well as national legislation. In Greece, a NAP for the LWfG was drafted in 1999 (Kazantzidis & Naziridis 1999), but this was never fully implemented or endorsed due to lack of a legal framework for NAP endorsement. Action Plans are foreseen in Greece with Law 3937/2011 on "Biodiversity conservation and other provisions" (A' 60), for species whose conservation is obligatory from international conventions and EU legislation; species that are included in national and international red data books, endemic species and species with a fragmented distribution range. In Bulgaria NAPs are foreseen for all globally threatened species by Ordinance No5/1.8.2003, which is included in the Biodiversity Act of Bulgaria. NAPs are drafted to be implemented for ten years and can be developed, following delegation from the Bulgarian Ministry of Environment and Waters, by a number of organizations including science institutes and NGOs. Twelve NAPs have been adopted in Bulgaria so far, most of which regarding bird species, including the Dalmatian Pelican *Pelecanus crispus*, Ferruginous Duck *Aythya nyroca*, Eurasian Bittern *Botaurus stellaris*, Pygmy Cormorant *Microcarbo pygmaeus* and the White-headed Duck *Oxyura leucocephala*. In Hungary, NAP formulation and adoption is coordinated by the Department for Nature Conservation at the Ministry of Agriculture, and according to Act no. 1996/LIII., upon acceptance, responsible National Park Directorates are obliged to follow the recommendations listed in the NAP for the relevant species. The LWfG NAP was the first to be developed for a non-breeding bird species in Hungary.

2. The National Action Plan process

Overall, the NAP process as outlined by the AEWA guidelines includes: 1) the formation of a National LWfG Working Group, 2) the production of a status report as a background document for each NAP, 3) the production of the NAP using a standardized format, 4) the NAP implementation and 5) the monitoring of the NAP implementation and impact. The abovementioned procedure was followed by the development of all three NAPs (Greek, Bulgarian and Hungarian) and adjusted according to the needs of each country. The production of a status report for the LWfG gathered all the existing information on the LWfG, and indentified threats for the species. In Hungary, the status report also included the development of a National Database for the LWfG. Based on the status reports; appropriate measures were described in each NAP document in order to tackle individual threats, as per country. All three NAP processes included at least one consultation meeting in which stakeholders related to LWfG issues, were invited. These included the relevant ministries (Environment, Water, Rural Development, Agriculture etc.), research and academic institutions, forest services and management authorities from all LWfG sites, local and regional hunting organizations, national and international expert individuals and NGOs. In Greece, in order for the NAP to become a legal document it needed to be adapted to the format of a Ministerial Decision, and to follow the relevant procedures foreseen. As a result, the Decision draft was made available online for a public consultation. Although all NAPs were prepared and submitted to the respective Ministries in due time, only the Hungarian NAP has so far been endorsed, published (Bogyó et al. 2014) and implemented.

3. Results

3.1 National Action Plan contents

All three NAPs included a Status Report for the LWfG in the respective countries, either as an integral part of the NAP, or as a separate document. Based on the LWfG Status Report, the NAPs list the species threats and necessary measures. The increased mortality by illegal shooting was identified as a very high threat in Greece and Bulgaria, whereas habitat loss was identified as a high threat in all three countries (**Table 1**). Additional threats identified in Bulgaria included in the NAP are the conversion of farm crops from cereals to technical crops, wind farm development via its direct and indirect impact on the species, disturbance at the roosting sites by fishermen and by farmers at the foraging sites. There are 17 threats in total that were identified in Bulgaria as the main drivers for LWfG unfavorable population status in the country.
In Hungary, climate change is identified as one of the most important threat for the species, due to its potential impact on the roosting and feeding sites for the LWfG; and its effect on habitat change (wetland drainage and extreme weather events).

In Greece the Status Report forms a separate document (Vasiliadis et al. 2015), and it contains a detailed review of all available knowledge on the LWfG that is relevant for its conservation in Greece. It includes historical observations of the LWfG in Greece, with the first dating back to 1954, and the highest being the observation of 480 LWfG in Evros Delta in 1973 (Handrinos & Goutner 1990). The Report also reviews the LWfG habitat and distribution data, lists the protective measures that exist, and provides a species threat analysis. Based on the Status Report, the NAP for the LWfG in Greece aims to contribute to the restoration of the LWfG Fennoscandian population to favorable conservation status. The objectives of the NAP are further identified under population and habitat conservation, policy and legislation, monitoring and research, and communication and education. Measures of high priority include the safeguarding/patrolling of the LWfG flyway in Greece, the cooperation of patrolling authorities, appropriate habitat management at the LWfG sites, maintenance of the GWfG hunting ban at all LWfG sites, evaluation of the safety of "Kalavos" area in Evros Delta in regards to the LWfG, systematic LWfG monitoring, and organization of training seminars for wardens and hunters.

LWfG threats		GR	BG	HU
Increased mortality	Illegal shooting/killing	VH	VH	M
	Disturbance	M	VH	M
	Lead poisoning	L	H	N/I
	Poisoning by pesticides	N/I	VH	L
	Collision with power lines/wind turbines	U	U	N/I
	Avian influenza	N/I	U	N/I
	Predation at roosting sites	N/I	U	N/I
	Species competition (geese)	N/I	U	N/I
Habitat loss and degradation	Agricultural Intensification	H	VH	N/I
	Dams, Wetland drainage, canalisation	H	U	VH
	Habitat change/reduction	M	VH	H
	Climate Change	U	U	VH
	Land abandonment	M	N/I	N/I
	Overgazing	L	N/I	N/I
	Pollution of wetland/waters	U	U	N/I
Alien gene introgression	Geese of hybrid origin	N/I	U	L
	Captive collections	L	U	N/I
Lack of knowledge	Unknown wintering/staging sites	H	VH	N/I
	Hunting pressure	M	VH	N/I
Very high (VH), High (H), Medium (M), Low (L), Unknown (U), not included (N/I)				

Table 1.
LWfG threats as identified in the National Action Plans for the LWfG in Greece (GR), Bulgaria (BG) and Hungary (HU).

The Bulgarian NAP (Iankov & Dobrev 2015) consists of eleven sections that are developed according to the National Biodiversity Act. The NAP includes the biological information for the species, its ecological requirements and the national status and distribution of the species followed by a threat analysis and the planned conservation actions. Also, the text describes the species distribution and historical presence in the country dating back to 1894 with a detailed review on LWfG phenology and wintering sites in the country. Moreover, an indicative model for the habitat suitability for the species in the country has been developed especially for the needs of the Bulgarian NAP. Most of the actions include direct conservation measures and some legislation changes needed in order to ensure the effective species conservation. The main conservation actions include the establishment of non-hunting zones along the key wintering sites for the LWfG in the Shabla and Durankulak lakes, joint anti-poaching patrol schemes between institutions and NGOs, expansion of the protected sites borders along the Black Sea coast (i.e. Burgas lakes), prohibition of boat fishing in the key roosting sites for the species, ban of lead shot, strict control on the hunting bag and limit of the hunters numbers, as well as some monitoring of the main species roosting, staging and wintering areas in Bulgaria. Finally, the NAP includes a budget and time frame.

The Hungarian LWfG NAP stakeholder meeting. © HNPD

The Bulgarian LWfG NAP stakeholder meeting in March 2013 in Sofia. Subsequently a public discussion was organized in November 2014 where the draft of the LWfG NAP was discussed. © BSPB

The Hungarian NAP is divided in three main sections that are: 1) the species status report, 2) the species threats and general recommendations for action and 3) the Hungarian National Action Plan. The most important part of the NAP document is the Action Plan which describes the relevant conservation actions to tackle the main threats for the species in Hungary. The Action Plan describes conservation actions both for the Fennoscandian and Western main population, focusing more on the Fennoscandian. The most important actions cover habitat restoration actions through changes in water and grazing management in the Hortobágy region and other staging sites, as well as the reduction of disturbance, and hunting pressure all over the country. As a priority, continuous monitoring, international cooperation and cooperation with hunting organisations were described (Bogyó et al. 2014).

3.2 NAP implementation

The NAPs identify coordinators for each proposed action, the necessary budget and an overall overseeing authority. In Greece the NAP oversight is the responsibility of the Department of Wildlife and Protected Areas from the Ministry of Environment and Energy, while each action in the plan is assigned to a pertinent authority or organisation (Ministry of Environment and Energy, Ministry of Agriculture, Prefecture Forest Directorates, Ministry of Education, Research and Religious Affairs, Management Authorities, research and academic institutions and the HOS), while relevant authorities/organizations that contribute to the respective actions are also listed. For actions that their implementation requires funding, a budget is allocated and included in the NAP. The total cost of the NAP sums up to 497,000 € for its five year duration. The NAP also defines the members of the working group that will review the NAP after the foreseen 5-year implementation.

Presentation on the LWfG in the Hortobágy National Park during the LWfG NAP stakeholder consultation meeting on the 3rd of April, 2013, in Balmazújváros, Hungary. © HNPD

The implementation of the actions described in the Bulgarian LWfG NAP is assigned to pertinent state authorities, public bodies, science institutions and NGOs like the Ministry of Environment and Waters, Ministry of Agriculture, Ministry of Regional Development, Executive Forestry Agency, Executive Fishery and Aquaculture Agency, Bulgarian Academy of Sciences, Municipalities and NGOs. However, in practice NAPs for protected species are usually implemented only by NGOs. The LWfG NAP has a ten year duration and its review is foreseen after five years of implementation. Each action is budgeted. However, its implementation depends on funding being available for the NGOs that will take on the action implementation. The NAP itself, once adopted, is a legal document published in the National Gazette, and as a result is a powerful tool that can support funding applications. The foreseen budget for the implementation of the working plan equals to 595,925 € for its 10 year period.

In Hungary, the Local National Park Directorates are responsible for the implementation of the NAP. Each action is assigned to a regional National Park Directorate (mainly the Hortobágy National Park Directorate) and its relevant departments where necessary. Responsible organizations were also assigned to more general actions like the cooperation with the hunting organizations and international cooperation. The Hungarian NAP is overseen by the Hortobágy National Park Directorate in cooperation with the Ministry of Agriculture and the Hungarian LWfG working group that consists of experts from the National Park Directorates, Ministry, scientific community, hunting authorities and NGO's (Bogyó et al. 2014). The working group members and responsible experts at the Ministry of Agriculture agreed to review the document every 3-5 years (if there is no urgent need for earlier review) and to organize a working group meeting in this timeframe. The NAP contains no recommendations on the budget.

4. Discussion

National Single Species Action Plans are effective and often legally binding tools for national efforts in the conservation of endangered species. It is often the case that for the implementation of a NAP for a single species, others will also benefit. For example, all three NAPs (Greek, Bulgarian and Hungarian) developed in the framework of this project highlight the necessity of eliminating mortality as a threat and propose hunting patrolling and training amongst other measures. The elimination of such threats in LWfG staging and wintering areas, in Greece, Bulgaria and Hungary, most if not all of which are Natura 2000 sites, will favor a number of priority species and habitats for which the Natura 2000 sites have been designated.

In Greece the development of the LWfG NAP has been the first NAP to be developed for adoption for any wildlife species, and as a result it paves the way for a number of NAPs to follow. Although the NAP reached its last stages of being adopted as Ministerial Decision, very lengthy administrational procedures within the Ministry for Environment and Energy did not allow its timely adoption as of yet. Additionally and since the beginning of the NAP process in 2012, Greece has had four national elections and the Ministry of Environment and Energy has had major structural changes that halted NAP progress for significant amounts of time. As a result the NAP process has faced major administrational obstacles. Nevertheless, and due to positive political will, we are confident that the Greek LWfG NAP will be endorsed and implemented as foreseen.

In contrast to some European countries where species action plans are financially and practically supported by the relevant ministry and its structures, in Bulgaria the implementation and execution of any species action plan is mainly being done by NGOs. The NAP itself is a very important document that can ensure legal and institutional support for the conservation of a protected species. As a result, funding of the proposed actions and their implementation should be of high priority for the relevant state authorities. Endorsement of the LWfG NAP in Bulgaria will be a step forward towards the protection and conservation of the species in the country, it will engage the national authorities, adhere to the National Biodiversity Act as well as to international agreements (AEWA).

Regarding the Hungarian LWfG NAP, even though only two years have passed since the adoption of the NAP, the HNPD and the Ministry of Agriculture have presented it at almost all available scientific forums within the country, while the National Park Directorates (responsible bodies for local/regional nature conservation) and the expert audience also accepted the document. As a result, the implementation of the actions and the development of additional ones are considered to have a good chance of success. The NAP as a document is also a very good tool to be used when negotiating favorable / unfavorable pro-

posals for the LWfG and other waterfowl species (for example hunting regulations and agricultural developments). The HNPD and the Ministry of Agriculture is planning to hold the first NAP evaluation workshop in 2017. One of the major tasks will be to adapt the NAP to the increasing number of Western Main LWfG individuals within Hungary.

In conclusion, the formation of National Working Groups and running of the NAP processes contributed to raising the profile of the species and its conservation needs amongst relevant government institutions and stakeholders in all three countries. The delays in getting the NAPs in Bulgaria and Greece adopted within the time frame of the LIFE project, demonstrate how difficult the transition of international as well as NGO-driven nature conservation activities into the national biodiversity agenda, even if the reasons behind the delayed adoptions in both countries are linked to bureaucratic rather than political issues. The actual adoption of the drafted NAPs will be a crucial step in ensuring the institutionalization of conservation measures for the species, regardless of whether the actual coordination and implementation of the foreseen activities is taken over by government authorities or remains in the hands of stakeholder groups. The wider international Lesser White-fronted Goose conservation community under AEWA will thus continue to encourage both Bulgaria and Greece to adopt the developed NAPs as soon as possible.

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Possible negative implications of goose re-introduction initiatives on the Fennoscandian Lesser White-fronted Goose population

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1. Introduction

A brief history of Lesser White-fronted Goose re-introduction initiatives

Three wild populations of Lesser White-fronted Geese (*Anser erythropus*, hereafter LWfG) currently exist that are internationally recognized (Jones et al. 2008). These are the Western Main population that breeds in Northern Russia, west of the Taymyr Peninsula, the Eastern Main population breeds east of the Taymyr Peninsula, and the Fennoscandian population that breeds in Norway, Finland and the Kola Peninsula in Western Russia. While all populations have experienced considerable declines in numbers in the previous century, the Fennoscandian population has suffered severely and currently numbers 30-40 breeding pairs. There has been a positive trend in the development of the Fennoscandian population of LWfG since 2010, yet the population is still in a very critical and vulnerable position, and it would take little to tip the balance.

In addition to the three wild populations, a fourth one exists (Swedish population), that originates from LWfG that were released in Sweden, in the framework of the Project *Projekt Fjällgås*. This is currently wintering mainly in the Netherlands. The *Project Fjällgås* was implemented by the Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet) and they carried out releases of captive-bred LWfG in a traditional breeding area in Norrbotten, Sweden between 1981 and 1999, resulting in the establishment of a small LWfG population. The geese that were released originated from various waterfowl collections and zoos, and the goslings produced were released together with Barnacle Geese *Branta leucopsis* as foster parents (von Essen 1982). The Barnacle Geese flew to the Netherlands in autumn together with the fostered LWfG and the following spring the LWfG returned to the release site (von Essen 1999). A new migration route was established between the Swedish mountains and the wintering areas in the Netherlands that *Projekt Fjällgås* considered safer than the original migration route followed by the wild Fennoscandian LWfG. This re-introduced population grew slowly up until 2002, after which, numbers in the wintering grounds in the Netherlands varied between 110 and 130 individuals during the period 2003-2011 (Koffijberg & van Winden 2013). From the very start of the releases undertaken by the Project *Fjällgås*, some critics questioned whether the captive stock that was used was appropriate for the purpose.

A family of Lesser White-fronted Goose reared in Sweden, in an enclosure pen at Valdak Marshes, Finnmark in Norway in 2010. An experiment to reinforce the Fennoscandian population in Norway ceased after two seasons (2010 and 2011), after it was found that young Lesser White-fronted Geese without their parents did not join the flock of wild birds as hoped, but rather followed other goose species on the southward migration to areas outside their normal winter distribution. © Tomas Aarvak

As genetic analysis methods improved in the 1990's, a study on the genetics of the captive LWfG stocks that were used for release projects both in Finland and in Sweden was carried out at the University of Oulu, Finland. Due to the discovery of genetic material from another goose species in this study, Greater White-fronted Goose *Anser albifrons* (Ruokonen 2001), releases of captive-bred birds in Sweden stopped after 1999.

In 2010, *Projekt Fjällgås* launched a new round of releases, this time using descendants of LWfG captured in the wild from the Western Main population. Between 2010 and 2016, a total of 299 LWfG were released, mostly in the mountains of Arjeplog in Norbotten, Sweden, and in 2013 also in a town park at Hudiksvall on the east coast of Sweden (Liljebäck et al. 2013). The latter is known as a moulting site for some of the Swedish LWfG that were released before 1999. Most of the released birds were goslings, although some yearlings were also included. As opposed to the previous releases by *Projekt Fjällgås*, during 2010-2016 birds were released without any foster parents and were thus less able to learn the migration route or important behavioural traits like e.g. shyness from potential predators, from parents / foster parents. For birds in general, an intraspecific comparison between the wild-caught and first generation captive-bred birds pointed to a rapid loss of natural anti-predator behaviour in captivity (individual lifetime) rather than to differences among species (evolutionary exposure (Carrete & Tella 2015).

Parallel to the conservation work in countries hosting the Fennoscandian LWfG population an ongoing debate remains, surrounding the possible negative ecological impacts of the re-introduced Swedish population on the wild Fennoscandian LWfG population and its effect on the international LWfG conservation efforts. The aim of the release projects was to establish a LWfG population that was not migrating through areas with a high hunting pressure such as Russia and Kazakhstan. However, as the methods and results of the *Projekt Fjällgås* releases did not follow internationally agreed priorities for the conservation of the species, the Scientific Council of the Convention on Migratory Species (CMS) were asked for an advice in 2005 for the preparation of the Single Species Action Plan for LWfG (Jones et al. 2008). Their main conclusion was as follows: "Given the possibility that the above-mentioned free-flying birds, or their descendants, may pose a risk to the genetic make-up of the wild Fennoscandian population, the Scientific Council is of the opinion that these birds should be caught or otherwise removed from the wild".

2. Methods

We have reviewed literature on the LWfG release projects in Europe since the early 1980's as well as general literature on the relevant subjects concerning the Swedish population, Fennoscandian population and the genetic and ecological factors handled in the report. We scrutinized altogether 300 references that are all listed in the report "A critical review of Lesser White-fronted Goose release projects" (Aarvak et al. 2016). Furthermore, we assessed data from national observation databases in the countries were LWfG of captive origin has occurred and we have investigated LWfG museum materials in the Netherlands, Sweden, United Kingdom, Germany and Norway.

On some occasions, observations have been received directly from the observers. For the calculations of the viability of the Swedish LWfG population as compared to the wild Fennoscandian population, we have used observation data during winter from the Netherlands and Greece respectively as well as own production data from the LWfG monitoring project as measured post-breeding at the Valdak Marshes as well as reproduction data from the annual reports of Project *Fjällgås*. All datasets are provided in the report of Aarvak et al. 2016.

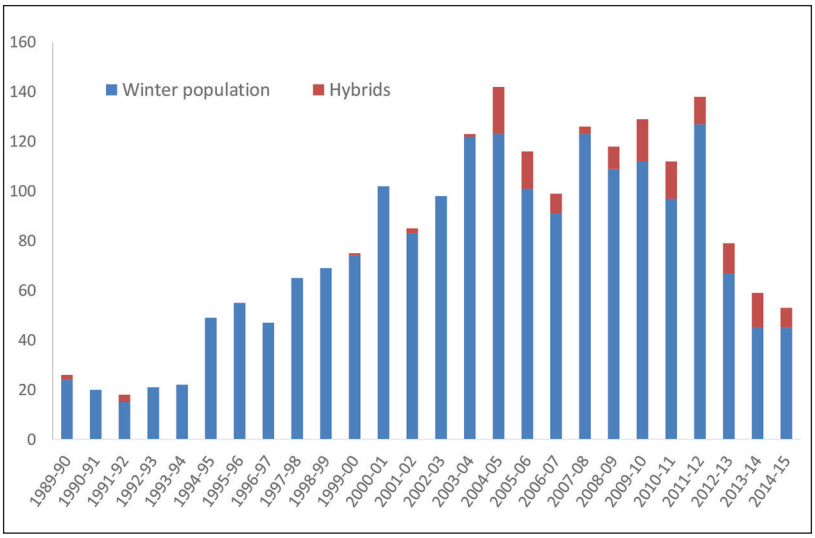

Figure 1.
Population trend for the Swedish re-introduced free-flying population.
Winter population is estimated as peak number during winter in the Netherlands and total number of hybrids the preceding summer and autumn in Sweden (data from the Swedish Reporting System, Koffijberg & van Winden 2013, as well as annual reports in the magazine Fågelåret).
hybrids = Lesser White-fronted Goose x Barnacle Goose.

3. Results

Genetic studies have shown that the captive LWfG used in the first release project (1991-1999) carried genetic material from Greater White-fronted Geese (Ruokonen 2001, Ruokonen et al. 2007). Although hybrids between these two species in the wild are theoretically possible, there is no confirmed evidence for this having occurred and one can suggest that genetic contamination has occurred in captivity. Additionally, among the re-introduced population, a number of hybrids (LWfG x Barnacle Goose) have been produced as a result of interbreeding between these two species (Aarvak et al. 2016). Between 2004 and 2014, around 14.6% of the entire re-introduced population comprised of such hybrids (**Figure 1**, Aarvak et al. 2016). In addition, there are confirmed observations of second generation hybrids (i.e. crosses between hybrid geese or between hybrid geese and either LWfG or Barnacle Geese).

LWfG released during the period 1981-1999 followed the man-induced migration route to the Netherlands using foster

parents. As the geese released from 2010 onwards have been without parents/foster parents, the chances of these reaching the wintering sites of the initial re-introduced birds in the Netherlands, or to the moulting area in Hudiksvall is considered to be moderate or small. Indeed, many of the birds released since 2010 have spread in all directions from the release site, with observations in several European countries that are not within the species' usual distribution range (Aarvak et al. 2016). An increasing number of LWfG have spent the winter in southern Sweden rather than migrating from the country, with up to 21 individuals recorded in winter 2014-2015 (**Figure 2**). There is an increased possibility that LWfG of re-introduced origin will, by joining the Fennoscandian population, initiate an alteration of the Fennoscandian LWfG population migration route. Indeed, re-introduced LWfG have been recorded at several key sites for the Fennoscandian population, including Valdak Marshes (Norway), Nemunas Delta (Lithuania), Hortobágy National Park (Hungary), and sites in Poland (see observations at **www.piskulka.net**).

common among captive animals, and these features are exhibited by the Swedish released LWfG. The LWfG in the town park in Hudiksvall allow humans to approach to only a few meters, and exhibit little fear of potential predators such as dogs and cats. Birds held in captivity are prone to a number of diseases, some of them fatal, and it would be unfortunate if these were to spread to wild populations. Individuals from the Swedish captive stock used for the releases after 2010 has proved to suffer from fatal diseases (Aarvak et al. 2016).

It is overall likely that the Swedish released LWfG have a lower survival rate compared to the wild Fennoscandian birds (Aarvak et al. 2016). This is perhaps due to the combination of the mentioned changes in migration route, habitat choice and anti-predatory behaviour, as well as increased susceptibility to disease. As expected, there was a positive relationship between the number of geese released between 1989 and 1999 and population development. However, counts in the wintering grounds in the Netherlands after the new batch of releases from

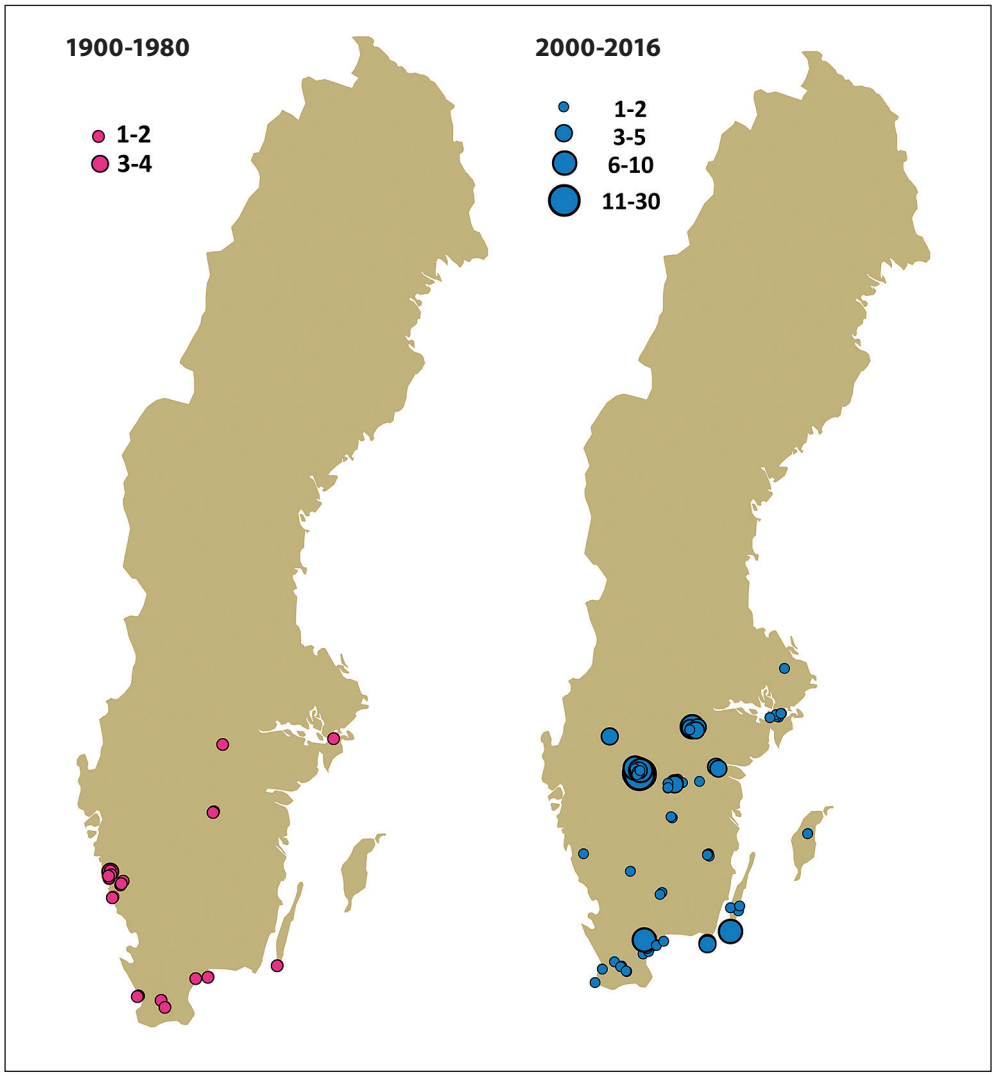

Figure 2.
All open access records of wintering (November to February) Lesser White-fronted Geese in Sweden in the years 2000-2016 (n=189) and years 1900-1980 (n=50, pre reintroduction projects) registered in the Swedish Species Reporting System (data downloaded 24/10/2016).

Wild LWfG are habitat specialists, and utilise almost exclusively natural steppes and coastal meadows where these habitats still exist. The loss of such natural habitats over large parts of the species' traditional range is perhaps one of the factors contributing to their drastic decline. However, the Swedish released LWfG have different habitat requirements including arable grasslands in winter, and park lawns during summer and autumn (Aarvak et al. 2016). Reduced fear of humans and towards predators is

2010 onwards show that numbers have declined in the period 2010-2015 despite the large releases in the same period (**Figure 3**). A possible explanation for this is that mortality rate is higher for the birds released from 2010 onwards, and that this has had a negative effect upon those birds remaining in the release area, by attracting predators to the area.

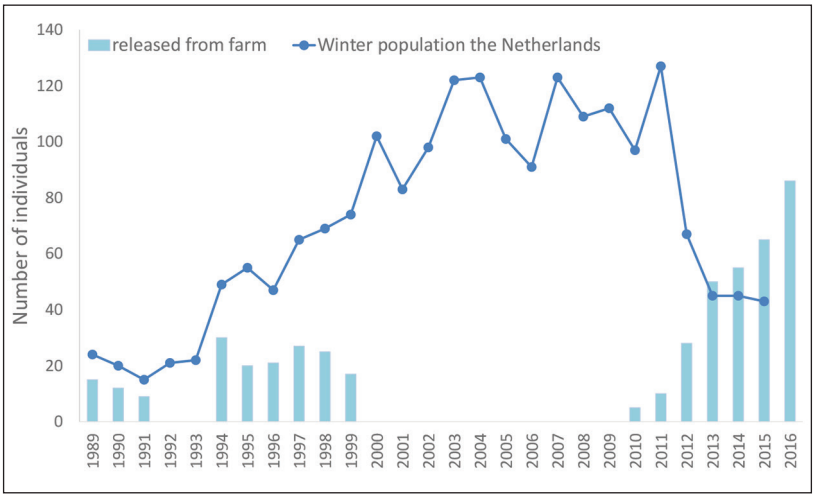

Figure 3.
Population trend and annual number of releases for the Swedish reintroduced Lesser White-fronted Goose population. Trend data are based upon counts during winter in the Netherlands. Data from Koffijberg & van Winden (2013), updated with data from Waarneming.nl (2016) and Kees Koffijberg (pers. comm.).

Also, the return rate to the breeding/release area is much lower for the Swedish LWfG compared to the Fennoscandian LWfG. From the accessible data on number of broods produced in the Swedish re-introduced population in the period 1994-2015 (99 broods) compared to the number of broods produced in the wild Fennoscandian population in the same period (181 broods), it is evident that the proportion of pairs that successfully produce young is considerably lower in the Swedish reintroduced population, as the size of that population was higher than the wild Fennoscandian population during much of this period (**Figure 4**).

Since the size of the Swedish re-introduced population is not estimated during spring migration as is the case with the wild Fennoscandian population, we have used the wintering population size numbers in the Netherlands and Greece respectively (**Figure 4**). Numbers from Greece are estimated since count coverage has been of high quality only since 2005. Estimates are based on spring total numbers, juvenile production and

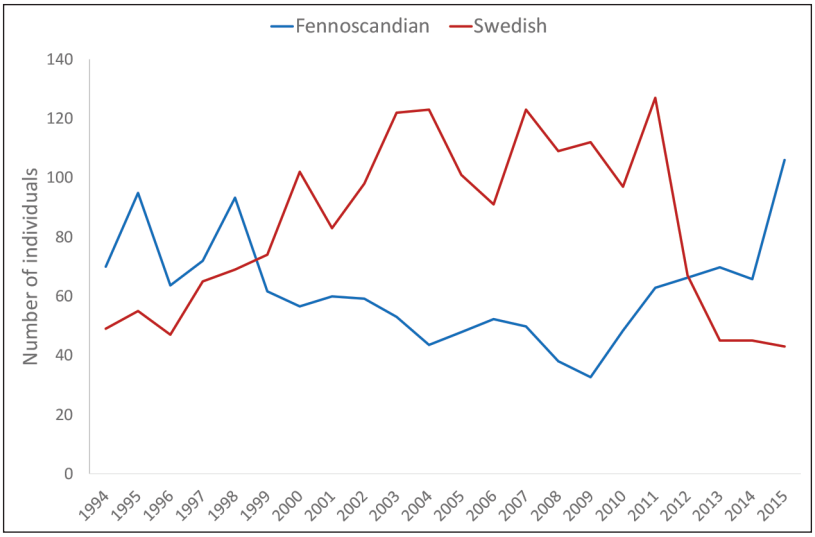

Figure 4.
Annual winter population size for the Swedish re-introduced population in the Netherlands (sums) and for the Fennoscandian population in Greece (expected) for the years 1994-2015.

expected mortality for adults and juveniles until mid-winter. For Greece, actual (average 65 ind.) and estimated numbers (average 62 ind.) are closely correlated (χ^2=0.916, p<0.000, n=12) with an average of 104% individuals observed in comparison with numbers estimated. Comparing the winter population size for the Netherlands (average number of ind.=84.0) and Greece (average number of ind. =62.1) shows that the size of the Fennoscandian population has been on average 74% of the Swedish re-introduced population in the years 1994-2015 (**Figure 5**). Dividing the annual number of goslings counted in autumn with corresponding total estimate of winter population size the preceding winter gives an estimate of effective production in these populations. The Swedish reintroduced population produced on average 0.14 juveniles per adult, while the corresponding figure for the Fennoscandian population is 0.47 (n=21, SE=0.025), a threefold significant difference (t=4.338, df=40, p<0.000, SE=0.074) (**Figure 5**).

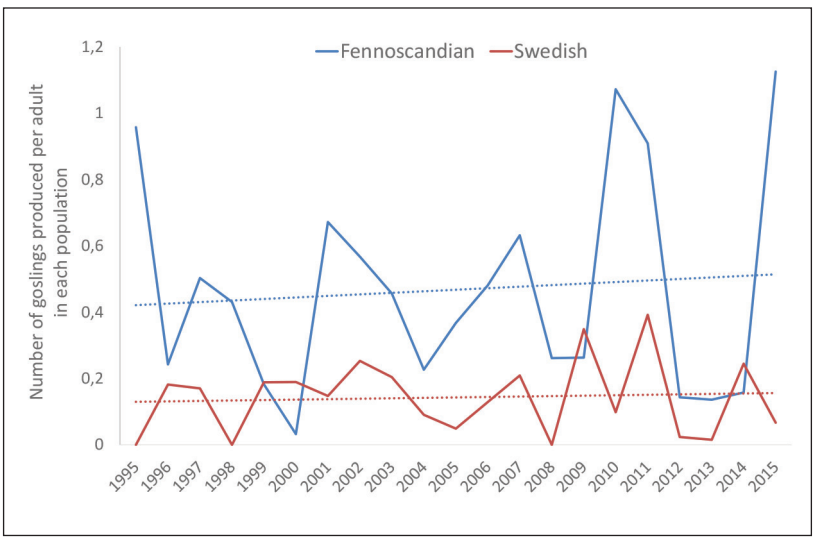

Figure 5.
Annual estimate of juveniles produced per adult in the winter population the preceding winter for the Swedish re-introduced population and the wild Fennoscandian population for the years 1994-2015.

4. Discussion

The Swedish LWfG population has declined since releases re-commenced in 2010, without the reasons being apparent. Predation of eggs from Red Foxes *Vulpes vulpes*, and of breeding adults by White-tailed Eagles *Haliaetus albicilla*, are cited as possible factors. However, these factors alone cannot explain the drastic decline in the re-introduced Swedish population in the years 2010-2015 (Liljebäck et al. 2013).

The genetic deviations in the Swedish LWfG population is well known and in addition to the possibilities of the loss of the spectacular migratory system of the wild Fennoscandian LWfG population (Aarvak & Øien 2004, Øien et al. 2009) if the two populations should become mixed. In our recent work, we have however uncovered additional behavioural deviations and ecological maladaptations in the Swedish LWfG population. We suggest that the effect of the sum of these factors is the lower viability of the Swedish LWfG population as compared to the wild Fennoscandian one that we have revealed. The reduced adult survival and the severely reduced reproductive success in the Swedish LWfG population is probably a result of a combination of the genetic, ecological and behavioural deviations described above in the results chapter. The Fennoscandian LWfG population is very vulnerable, and it is important that it is protected from the probability of mixing with conspecifics that show reduced adaptation to the natural environment as the Swedish LWfG population does, as a such situation could seriously jeopardize the future of the Fennoscandian LWfG population.

The current ongoing debate has attempted to address the above discussed issues in addition to the true status of the Swedish population (as a re-introduction or as a reinforcement), whether the current migration route existed in former times, and to the international status and acceptance of the Swedish re-introduced population. The current debate has hampered much of the conservation efforts towards the wild Fennoscandian population due to the conflict taking focus away from the important conservation work. These disagreements have also led to a delay in updating the International Single Species Action Plan.

This article is based on a comprehensive and detailed report on LWfG re-introduction projects and the potential effects of releasing LWfG upon the Fennoscandian population that was published in 2016 (Aarvak et al. 2016). The full report can be accessed at: **https://goo.gl/STGaxW**

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Putting an end to illegal killing in Northern Greece: design and implementation of an ambitious campaign aimed at reducing mortality risk for the Lesser White-fronted Goose

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1. Introduction

According to the International Single Species Action Plan for the Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) (Jones et. al 2008), illegal killing is the most important threat for the species globally, as well as a major widespread conservation problem for many species listed in Annex I of the EU Birds Directive. The resemblance to the Greater White-fronted Goose *Anser albifrons* (hereafter GWfG) is unfortunate, as the more common and widespread goose species is also a common quarry across most of the Western Palearctic. The LWfG is therefore prone to be mistaken for GWfG during hunting. Waterfowl hunting takes place mostly during autumn and in the winter months, mainly during dawn and dusk when waterfowl move between their roosting and feeding grounds. Low visibility as well as the tendency of the LWfG to mix with usually larger GWfG flocks, creates an increased risk of LWfG being shot.

In Greece, waterfowl hunting takes place in parts of at least two of the three main LWfG sites, namely the Ismarida Lake and the Evros Delta. However, illegal shooting has been recorded in all LWfG wintering sites, including Kerkini Lake in 2007. There a male LWfG was found shot dead inside the strictly protected National Park of Lake Kerkini, and proved that much more conservation work was needed (Tsougrakis 2009). Evros Delta hosts the largest numbers of wintering geese (mainly GWfG) in Greece (Handrinos et al. 2015), and as a result, it is the most popular goose hunting site in Greece. Numerous illegalities concerning hunting are regularly observed and recorded in the area and are considered a direct threat to the remaining LWfG population. Although no LWfG fatalities have been recorded in the Evros Delta area so far, the extremely small size of the LWfG flock that winters in Evros (max. number of 85 individuals during the years 2011 – 2016), the proximity of the LWfG distribution area to the goose hunting zone in the Evros Delta, and the practical impossibility to distinguish the LWfG amongst other geese during flight, hunting therefore constitute a significant threat to the LWfG.

Apart from having serious conservation implications, illegal shooting is a multi-faceted issue that takes place for a variety of reasons (e.g. limited controls by pertinent authorities, ignorance regarding the impact, ethical issues etc). Although publicly discouraged by almost all sectors of society, illegal killing and

One Lesser White-fronted Goose (in the middle of the photograph) within a Greater White-fronted Goose flock at the Dimitriadis grassland in the Evros Delta, Greece. The great resemblance between both species is evident. © Dimitris Kokkinidis

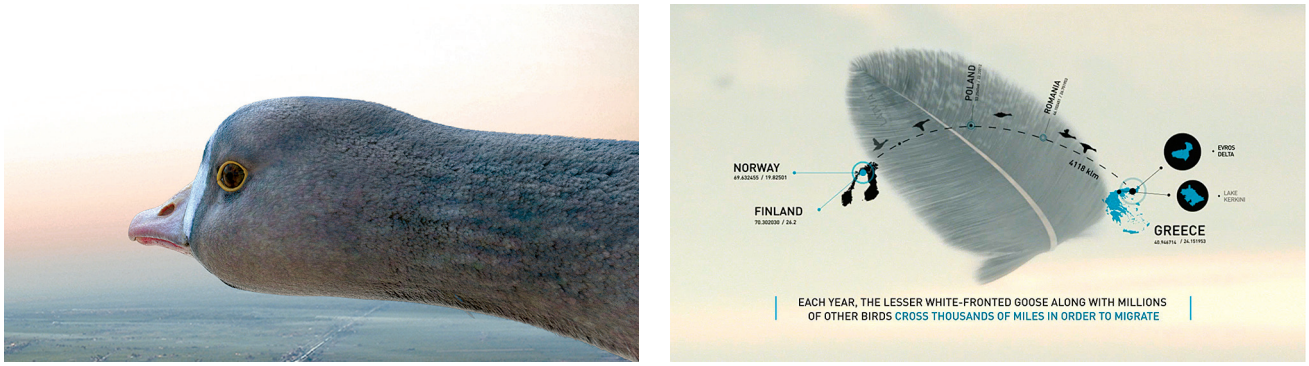

Figure 1. *Stills from the TV Spot.*

shooting can be directly linked to hunting as it is most common during the hunting season (Stephen 2003).

As a result, a comprehensive campaign against illegal shooting and killing in the Northern Greek wetlands was designed and implemented by the Hellenic Ornithological Society (HOS) and the Ministry of Environment and Energy, in the framework of the LIFE+ Project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway". The campaign focused mainly on the LWfG and waterfowl hunters, patrolling authorities as well as the general public. The Ministry of Environment and Energy is the competent authority regarding the hunting regulations in Greece, and works in close collaboration with the Hunter's Associations, while HOS has a long experience in communication campaign implementation. The campaign employed a number of tools in order to reach at the same time, a wide as well as a specific audience.

The campaign included communication tools such as a TV and Radio spot and a full-length documentary, policy reform, press releases, the publication of a hunting manual on good practice while hunting in wetlands as well as a LWfG Identification Guide. Parallel to the campaign, training seminars for wardens and hunters took place in all three areas.

2. Campaign tools and methods

2.1 TV and Radio Spot: "A species can become extinct in a blink"

A short video (TV spot) was created in which the difficulties of bird migration (adverse weather, wetland loss, intensive agricultural practices and illegal shooting & killing) where highlighted as issues affecting all migratory birds. Special emphasis was given to the LWfG and other protected species that can be found under the same circumstances (Red-breasted Goose *Branta ruficollis*, Corncrake *Crex crex* and the Ferruginous Duck *Aythya nyroca*). Viewers are urged to *"not fire the ultimate shot, as a species can become extinct in a blink"*. Similarly, an audio spot (radio) was created where, in a conversation taking place in a local café, two men argue on the importance of not shooting protected species. Both spots urge the public as well the hunters to become active participants in the efforts to stop illegal shooting, and promote the use of the public hot line (1591), where illegal incidents or suspicions for such can be reported to the pertinent authorities. The TV and Radio spots were approved by the Greek National Council for Radio and Television (NCRTV) as social-message-containing spots. Thus, they were promoted through many television channels free of charge from January 2014 and thereafter, and during the winter months in order to coincide with both the LWfG presence in Greece as well as the waterfowl hunting season. Both spots were broadcasted in Greek national and local television channels, and are also available on the HOS YouTube channel (**www.youtube.com/user/eoehos/videos**), where a version of the TV Spot is also available in English.

2.2 Full length documentary: "Feathering Heights: a travelogue of co-existence in the Greek wetlands"

Using the LWfG as the emblem for the illegal shooting and killing campaign, a full length 42 minutes documentary was produced. Using striking high definition imagery from Kerkini Lake, Evros Delta as well as the LWfG staging areas in Norway, the viewer appreciates the unique beauty of the landscape in the protected areas. Imagery is interwoven together with a commentary of relevant parties on illegal shooting and its connection with the LWfG as well as the quality of the protected areas in general. The interviewees include representatives from the HOS, the Forest Service of Alexandropoulos, the Ministry of Environment and Energy, the Forest Research Institute, the Evros Delta and Kerkini Lake Management Authorities, the Hellenic Hunters Confederation, the Norwegian Ornithological Society, birdwatchers, local residents and members of the hunting community.

As a result, the viewer is informed about the LWfG and the paradox of its coexistence with the remaining users of the protected areas. These include birdwatchers, fishermen, hunters and scientists amongst others. The documentary premiered at the 18th International Documentary Festival in Thessaloniki in March 2016, and has since been screened in numerous venues, events, as well as on the television. It is also available with English subtitles and at the HOS YouTube channel (**www.youtube.com/user/eoehos/videos**).

Figure 2.
Stills from the "Feathering Heights" documentary showing (from top left) (1.) the complete darkness in which illegal shooting takes place, (2.) birdwatchers from the UK in Evros Delta, (3.) Dalmatian Pelicans in Lake Kerkini, (4.) an illegally shot Ruddy Shelduck found injured in Evros Delta, (5.) LWfG site in arctic Norway, (6.) a patrol check in Evros Delta, (7.) cartridge collection in Evros Delta for lead analysis, (8.) a LWfG pair in Norway, (9.) HOS representative interview.

2.3 Media releases

A total of 13 media releases have been published in the framework of the campaign, until December 2016. The releases corresponded mainly to campaign milestones like the Local Action Plan meetings and final endorsement, as well as, the TV & Radio Spot and Documentary releases. Press releases were also issued in response to major illegal killing incidents that took place during the campaign in the project areas, and for which the foreseen legal steps were taken. These included: 1) poaching taking place inside the non-hunting zone of Lake Kerkini in January 2014, 2) a shot Common Shelduck *Tadorna tadorna* (protected species) found inside the non-hunting zone of Evros Delta in February 2015, 3) a shot dead Dalmatian Pelican *Pelecanus crispus* (protected species) also found inside the non-hunting zone of Evros Delta in January 2016, and 4) social media display of protected species (Ruddy Shelduck *Tadorna ferruginea* and Shelduck) poached in Evros Delta in May 2016 (**Figure 3**). Media releases were sent to and re-distributed by local and national press, as well as through internet and social media, reaching a very wide audience.

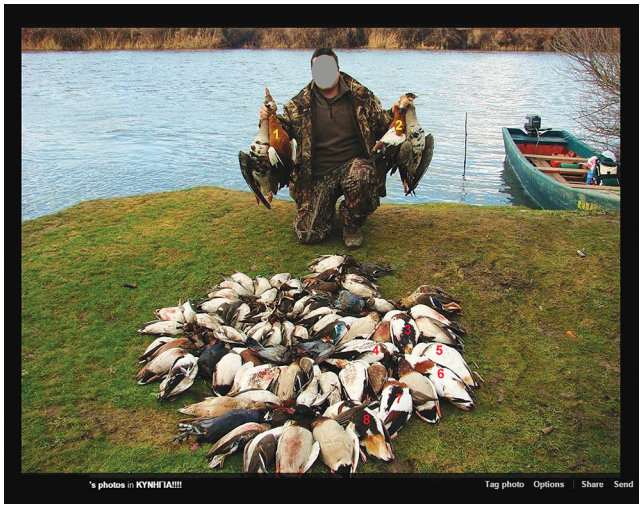

Figure 3.
A print screen of a social media post showing illegal killing, at the Evros Delta. The post was uploaded on 14/11/2014, and has since been removed.

2.4 A "Good Practice Guide for Hunting in Wetlands"

A "Good Practice Guide for Hunting in Wetlands" was published in 2,000 copies, aiming to provide a useful pocket field guide for anyone interested in hunting in the Greek wetlands (**Figure 4**). Waterfowl hunting requires advanced bird identification skills and also has certain limitations. For example, the use of lead shot is not permitted for waterfowl hunting in the Greek wetlands, and hunting of the Greater White-fronted Goose is not allowed within the boundaries of five Special Protected Areas (SPAs) that are significant for the LWfG. Additionally, hunters are required to have advanced waterfowl identification skills in order to be able to correctly identify and abstain from shooting protected species. Apart from extensive waterfowl identification drawings and explanations, the Guide also outlines relevant hunting legislation, guidelines for hunting inside the Natura 2000 network, safety instructions, an overview of illegal shooting in wetlands, the issue of lead poisoning and bird flu, and instructions upon finding ringed and/or injured or dead birds.

Figure 4.
The front cover of the "Good Practice Guide for Hunting in Wetlands".

Stakeholder consultation meeting for the Local Action Plan of Kerkini Lake National Park in 2013. Participants included the Ministry of Environment and Energy, the HOS, the Regional Hunting Federation of Macedonia - Thrace, Forest Services and the Management Authority of Kerkini Lake. © Roula Trigou/HOS

2.5 Local Action Plans

Following stakeholder consultation meetings in 2012 and 2013 in all three areas relevant to the LWfG and the LIFE+ Project sites, on 29/06/2015 Local Action Plans (LAP) were published in the governmental gazette (Ministerial Decision number 124378/1687/20-5-2015) entitled "Local Action Plan for the protection of the protected species of fauna" for the three project sites (Lake Kerkini, Lake Ismarida and Evros Delta). The LAPs are focused on tackling illegal killing by foreseeing effective coordination of all relevant local authorities and services (Forest Service, local government, hunting organizations, Management Authorities, environmental NGOs, police/coastguard/fisheries as required). They are overseen by the Ministry of Environment and Energy and are coordinated by the Forest Directorates of each project site prefecture (Kerkini Lake/ Serres prefecture, Ismarida Lake/ Kavala prefecture, Evros Delta/ Evros prefecture). Following the endorsement of the LAPs a number of coordination meetings have been organized by the relevant Directorates. Regarding the Evros Delta, six meetings have taken place in 2015 and 2016. For Ismarida Lake, two meetings have taken place in 2015 and 2016.

2.6 Training seminars for wardens and hunters

During the 2012-2013 and 2014-2015 winter seasons, one training seminar per season took place in each project area (Kerkini Lake, Ismarida Lake and Evros Delta), organized by the Ministry of Environment and Energy and the Hellenic Ornithological Society. In total six training seminars took place aimed towards hunters and wardens of the protected areas. Presentations included waterfowl identification, with a special emphasis given to the LWfG and other grey geese (GWfG, Greylag Goose *Anser anser*, Bean Goose *Anser fabalis*, Pink-footed Goose *Anser brachyrynchos* and Red-breasted Goose *Branta ruficollis*). Emphasis was also given to each protected area characteristics and legislation. Presentations included hunting legislation and illegal shooting and killing as a phenomenon in the particular areas. A session was particularly designed for wardens, where training was given regarding the behaviour of wardens during a patrol and particularly during spot checks, suspects' questioning and riffle check, as well as proper complain filling and appearance in court. In the framework of the Local Action Plan (LAP) implementation in Evros Delta, and following the LAP endorsement in June 2015, training seminars were independently organized by the Directorate of Evros Prefecture during the 2015-2016 and 2016-2017 hunting seasons.

Waterfowl identification presentation by the HOS, at a training seminar in the Visitor Centre of the Evros Delta National Park in 2015. © Roula Trigou/HOS

2.7 LWfG Identification Guide

In order to increase the LWfG knowledge skills and awareness of hunters, volunteers, project sites' visitor birdwatchers, etc., the UNEP/AEWA Field Guide for the identification of the LWfG was adapted in Greek by the HOS and printed in 2,000 copies (in waterproof version). The guide has been distributed during 2014-2016 by the HOS wardens during patrolling of the project sites, as well as during training seminars, meetings etc.

Figure 4.
The front page of the LWfG Identification Guide in Greek.

3. Results

The effectiveness of the campaign is reflected on the audience reach, the type of audience targeted as well as its availability of the campaign outputs locally, nationally and/or internationally. The TV and Radio Spots had an attractive and modern layout and as a result were reproduced by the media beyond their standard obligation to broadcast them as a social message. In total, and not taking into account the YouTube reproductions (over 5,100), the TV and Radio Spots where broadcasted more than 6,560 times by more than 40 media, reaching a much larger audience than expected. The "Feathering Heights" documentary was screened in a number of film festivals and events, as well as the television, reaching an audience of over 900,000 persons in Greece, as well as, abroad. Media releases published caused media attention and over 250 articles were published in press and digital media. During the Local Action Plan stakeholder consultation phase, 62 persons participated at the meetings. However, following the adoption of the Plans, several implementation coordination meetings were organized independently by the local Forest Directorates.

Campaign output	Timeframe	Target Audience	Level	Reach*
TV Spot	Jan 2014 – ongoing**	public	local/national/international	6,329 broadcasts
Radio Spot	Jan 2014 – ongoing**	public	local/national	5,369 broadcasts
Documentary	March 2016 - ongoing**	public	local/national/international	18 screenings, 1,100 participants
Media Releases / articles	July 2012 - ongoing**	public	local/national	15 releases, over 250 articles
Good Practice Guide	February 2017 - ongoing**	hunters	local	2,000 copies
Local Action Plans	June 2015	local authorities	local (policy)	62 meeting participants
Training Seminars	December 2012 - ongoing**	wardens & hunters	local	275 seminar participants
LWfG Id Guide	March 2014 - ongoing**	wardens & hunters, public	local/national	2,000 copies

** Until 31/12/2016 - ** Outputs are still in use*

Table 1.
Types of campaign actions against illegal killing and the results of each one of them, in Greece during the years 2014-2016.

Practice in bird identification, during training seminar in Kerkini Lake, November 2014. © HOS

4. Discussion

The large variety of communication tools used in the campaign resulted in reaching a wide audience through the media, and also a more specific one through the publication of the Good Practice Guide for Hunting in Wetlands and the training seminars. Additionally, the endorsement of the Local Action Plans has ensured the continuation of the coordinated efforts after the end of the LIFE project. This has been evident in the case of Evros Delta, where the Forest Directorate of Evros Prefecture, organizes patrolling coordination meetings throughout the duration of the hunting season, as well as training seminars. The implementation of the Local Action Plans is a permanent legal obligation of the regional Forest Directorates, and is expected to provide a cost effective way of coordinating efforts to stop illegal shooting and killing in the main LWfG sites.

During the course of the campaign, the project sought collaboration with the hunting community through the Hellenic Hunting Confederation of Greece, the top administration body for all hunters who are members of hunting clubs under its jurisdiction. As well as representing the majority of hunters in Greece, the Confederation operates a patrolling body financed by the hunting license fees that members pay to their respective local Hunting Club. Collaboration between the project and the Confederation had a number of challenges mainly regarding the illegal killing threat towards the LWfG in Greece. Nevertheless, the Confederation, as well the regional Federations and local hunting clubs were invited to all training seminars and meetings during the campaign. Following the approval of the Local Action Plans and their subsequent implementation especially in the Evros Delta, patrolling coordination takes place under the coordination of the regional Forest Directorate, and all regional authorities related to patrolling (including the regional hunting Federation and Hunting Club) take part.

Not part of the campaign as such, a powerful tool for reducing the extent of illegal killing and shooting indirectly, has been the implementation of the Environmental Education Program that was developed in the framework of the LWfG LIFE project. Using the LWfG as the program's flagship, environmental education activities were and are implemented in schools across Northern Greece. Through teacher trainings and the pupils' environmental education, active citizenship with strong environmental awareness is promoted that extends to the teachers' and pupils' immediate family environment. As a result, the necessity for the conservation of LWfG and other protected wildfowl is indirectly spread to relevant stakeholders (hunters, fishermen, tourist operators, Forestry Service employees etc.)

Although extensive, the campaign tools and implementation needs to be utilized further. Illegal shooting and killing continues to exist, and subsequently pose a threat to LWfG and other protected waterfowl. Campaign materials are publicly available; the HOS will continue to disseminate them as part of the overall work carried out against illegal killing and shooting. The organization of public events, as well as training seminars are recommended to be implemented on a local level, and directly with local organizations and/or individuals in order to avoid unnecessary conflict. Wildlife and habitat conservation of wetlands of international importance and Natura 2000 sites, like the LWfG areas, are considered a priority on a local level, and appreciation of such encourages the feeling of local pride. Although the campaigns also need to be extended nationally to influence policy, local collaboration and actions have proven to be able to provide tangible results and effective conservation.

Presentation during training seminar in Lake Kerkini, November 2014. © Roula Trigou/HOS

SPA signboard in Evros Delta. © Roula Trigou/HOS

5. Acknowledgements

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An environmental education programme for the protection of an endangered species: the case of the Lesser White-fronted Goose

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1. Introduction

The decline of species populations like the Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG) in Europe, highlights one of the most important current environmental issues, that of the biodiversity loss (Flogaiti 2011). Alongside all conservation actions for the protection of rare species, environmental education plays a crucial role in fostering organizational citizenship behaviour for the environment (Skanavi & Petreniti 2005). One of the main goals of environmental education, as they have been endorsed by the Tbilisi Declaration (1977), is "[…] *to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment*" (UNESCO 1978). Through environmental education, individuals can explore the issue of biodiversity loss (or the implications related to biodiversity loss), engage in problem solving and take action for the conservation of endangered species. In any case, the change of attitudes, emotions and beliefs requires a long-term and continuous educational process as well as the development of awareness of the importance of the environmental problem its self (Kamarinou 2005). As a result, the implementation of short-term educational activities does not suffice if an environmental educator aims to achieve actual change of children's attitude towards an environmental challenge. There is a need for an environmental program that will aim: a) to solve the targeted environmental issue and b) to ensure its lasting implementation. Finally, one of the dimensions of the environmental education refers to the environment as a sphere for interdisciplinary learning and research (Williams 1996). A natural landscape can become a beneficial natural setting for outdoor educational activities where teachers and students can use natural surroundings to pursue knowledge on the protected areas and the wildlife they host (Bentsen et al. 2008).

Taking into account all of the above, the primary aim of the environmental education actions of the LIFE+10 NAT/GR/000638 Project was to create an annual Environmental Education Programme (EEP) that would be incorporated into the curriculum of the schools in the targeted project areas. The main actions towards the achievement of that were: a) creation of a well targeted educational material for three age groups, b) material evaluation from teachers, c) teacher training in material use and d) field trips with the pupils.

The LWfG became the main tool in order to pedagogically approach the value of biodiversity conservation, highlighting the global perspective of losing a threatened species that is wintering in only two sites in Greece, Kerkini Lake and Evros Delta. In order to implement the educational material during the school year, emphasis was given to the above two key areas, at Serres (Kerkini Lake) and Evros (Evros Delta) prefectures respectively. All actions were carried out in the framework of the LWFG LIFE+ Project from 2012 until 2017.

2. Methodology

The design of the Environmental Education Programme was developed in six stages: 1) evaluation of the environmental problem, 2) defining the main project aims, 3) defining the target group and the educational objectives, 4) composing the educational activities and selecting the appropriate pedagogical methods, 5) evaluation of the educational material from the teacher and finally 6) implementation by the teacher.

LWfG on a tour around schools: indoor and outdoor EEP activities at Ano Poroia Primary School. © Roula Trigou/HOS

Stages 1 to 4 mainly refer to the design of the educational material while stages 5 and 6 refer to the incorporation of the final material to the school curriculum. The editorial team of the educational material consisted of both educators and conservationists as to better define the environmental problem but also to select the appropriate educational tools.

2.1 Designing the educational material

The main threats of the LWfG are high mortality as a result of illegal shooting and the habitat degradation and loss, with both threats being directly and indirectly related to human activities (Jones et al. 2008). As a result, the issue of LWfG population decline could be tackled by the design of a LWfG-focused EEP. In its pedagogical dimension, the aim of the materials developed in the EEP is to support the educators in creating the appropriate circumstances for the engagement and sensitization of their pupils in the protection of a threatened species, of species in general and of the environment as a whole.

An action-oriented research approach to the environment, needs to be centered on humans in their local environment (UNESCO 1985). Since the LWfG wintering sites in Europe are nowadays limited to a few areas in Northern Greece, the material was mainly tailored for schools in Serres (Kerkini Lake), Evros (Evros Delta), Ksanthi and Rodopi (Ismarida Lake) Prefectures. By targeting the local educational community, students can be encouraged to play a crucial role and work positively to problem solving on a local level (Georgopoulos & Tsaliki 2006). Additionally, the educational material was structured taking into account the different perceptions and knowledge levels of each age group. It is tailored for children of pre-school age as to ensure that if the problem is to be solved it will not appear again in the future, to primary school students since they can in the long-term work positively towards the solution of the problem and finally to high-school students as they can have a critical role in the present but as well as in the near future.

The main topics of the educational material were divided in three categories: 1) biodiversity, 2) the world of birds and 3) the Lesser White-fronted Goose. Each theme addressed concepts directly connected to the LWfG conservation, while a shift from general concepts (i.e. biodiversity) to specific concepts (i.e. LWfG) was also made. This enables children to engage and become aware of wildlife in general as well as other environmental issues, besides the LWfG. The educational objectives were approached as to develop cognitive, emotional and psychomotor skills. Some of the objectives were aimed for children to: understand the concept and importance of biodiversity, become aware of the LWfG and its conservation issues, develop critical thought in order to address LWfG threats, be encouraged in common and everyday conservation action. The educational material was based on the principle of humans being an inseparable part of nature and as a whole towards the environment (Stapp et al. 1969). The methods used are those usually applied in the environmental education such as role play, storytelling, drama, use of different art forms, outdoor activities and games, problem solving, debate, etc. Most of the activities were based on cooperative, collaborative as well as creative learning.

2.2 Engaging the local educational community

Environmental education was institutionalized in Greece in 1990 (Law1892/31-7-90, ar.11, par.13), while informal environmental education activities were already implemented by Greek schools or NGO's (Kosmidis 1999). Because of the already existing national legislation that foresees environmental education as part of the school curriculum, the inclusion of the LWfG environmental education material in the curriculum of the schools in the target areas was aimed. The official approval of the educational material from the Greek Ministry of Education, Research and Religious Affairs, was a prerequisite for the inclusion of the material in the framework of a school Environmental Education Program (EEP) and was granted accordingly.

The school teachers' point of view on the material was considered necessary and as a result the educational activities of the material were piloted and evaluated by teachers from primary and secondary education at the Serres Prefecture, using worksheets. The evaluation worksheets used referred to the educational material as a whole and the activities each schoolteacher selected to pilot. In relation to the overall evaluation of the material, schoolteachers' answers were grouped to a) setting the strong point of the material, b) setting its weak point and c) suggestions for improvements.

In relation to the activities' evaluation we examined a) the achievement of the activity's educational objectives, b) students feedback on the activity, c) suggestions for improvement. The evaluation worksheets were filled in by the schoolteachers after the pilot implementation of the educational activities during a six months period. The final material was presented at the project's area educational community where teachers were also invited to actively participate in the implementation of an EEP for the protection of the LWfG.

In the framework of the LWfG EEP, school groups would attend at least one field trip during which students would be familiarized with the LWfG and its wintering habitats. Focus was mainly given to neighboring schools of the protected areas where the species is still present during the winter in Greece.

Narration of the Children Story during Environmental Education event in Athens. © Katerina Giosma/HOS

Figure 1. *Activity sheets of the material. © HOS*

Figure 2.
"Fasten your seat belts. Take off!" – pages of the Children Story. © HOS

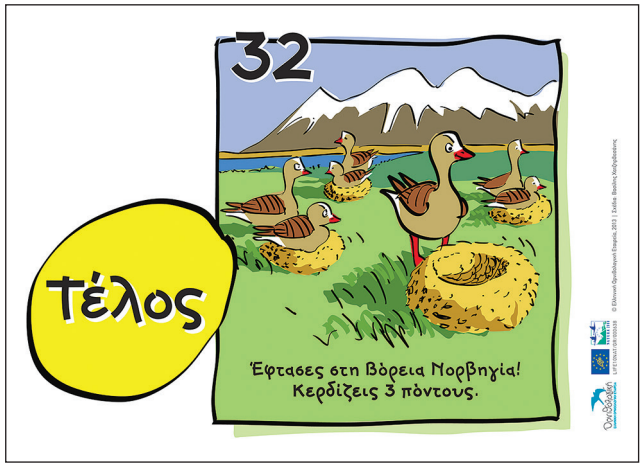

Figure 3.
Floor game image
(You have finally reached Norway!
You gain 3 points). © HOS

3. Results

3.1 The educational material «Travelling with the LWfG»

In total, forty eight (48) activities were designed for the primary and secondary education (**Figure 1**). The number and structure of the activities allow their implementation during an annual EEP aiming to have an affect not only on the children's level of knowledge but also on their attitude and perception on the environment. Additionally, complementary educational material was designed to be used by the teachers as a creative incentive for children's acquaintance with the LWfG. More precisely, an educational children's story was created (*A goose no less… a Lesser White-fronted Goose*) highlighting the challenges of bird migration (**Figure 2**), giving the teachers the opportunity to develop drama in education, storytelling and creative learning. Additionally, a memory game, a poster, a color book and a floor game (**Figure 3**) with the different stages of the LWfG lifecycle were also produced. All material is digitally available on the HOS website: **www.ornithologiki.gr/nanoxina**.

3.2 Evaluation of the project material

The target group for the pilot implementation of the material consisted of eighteen of pupils groups while at the evaluation meeting, nine primary and secondary teachers participated. The comments were mainly focused on additional pedagogical suggestions, as well as proposals for minor alterations in some activities. In some cases, teachers along with their students, inspired by the material, designed their own activities. Overall the material received positive comments and was characterized as "organized, interdisciplinary, comprehensive, explanatory, well structured, a useful educational tool" while "promoting experiential learning" and was "enthusiastically accepted by the children". The weak points mentioned were a) the limited suggested duration of the activities and b) the limited scientific information given concerning the LWfG and other terms related to the environment. In all activities, teachers commented that the educational objectives were met. According to teachers' answers, 30% of the students liked the material a lot, 65% liked it and 5% quite liked it (**Figure 4**).

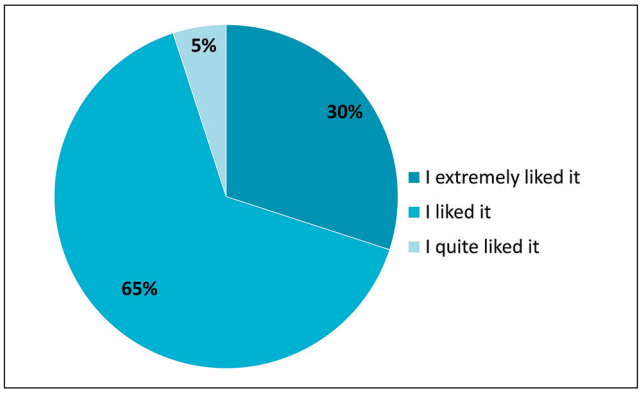

Figure 4. *Students reaction to the activities according to teachers.*

3.3 The project material in action

The project material was ready to be implemented following three workshops organized for the Serres, Evros and Rodopi educational community. The material was finally used by schools in the framework of the curriculum as well as the Management Authorities and the EE Centers in a number of events and educational programs.

3.3.1 The LWfG School Network

The educational community was very responsive to the EEP and took the initiative to develop an official school network and include the produced material into the school curriculum. In collaboration with the Hellenic Ornithological Society (HOS), and the Schools' Activities Officers of the Serres Directorate of Education along with the collaboration with the Kerkini Lake National Park Management Authority and the Environmental Education Centre of Poroia a 2-year Local Environmental School Network entitled "The LWfG at Lake Kerkini" (school years 2013-14, 2014-2015 and 2016-2017, 2017-2018) was developed. The creation of the Network included the participation of 775 students from 27 schools and proved to be a great motivation for the teachers. During its duration, schools used the project material and implemented its activities, visited the Environmental Education Centre of Poroia and Lake Kerkini and finally presented their outcomes. The secondary education students presented their LWfG projects to the local community at two public events where more than 1,700 people attended, spreading the message for the need of LWfG conservation.

Out in the Kerkini Lake:
Pupils of the LWfG Network participating
in outdoor EEP activities,
March 2014. © Roula Trigou/HOS

In the LWfG flyway:
Implementing educational activities (LWfG floor game) during EEP event
in Evros Delta, March 2014 and Educational Seminar in Lake Kerkini,
November 2016. © Roula Trigou/HOS

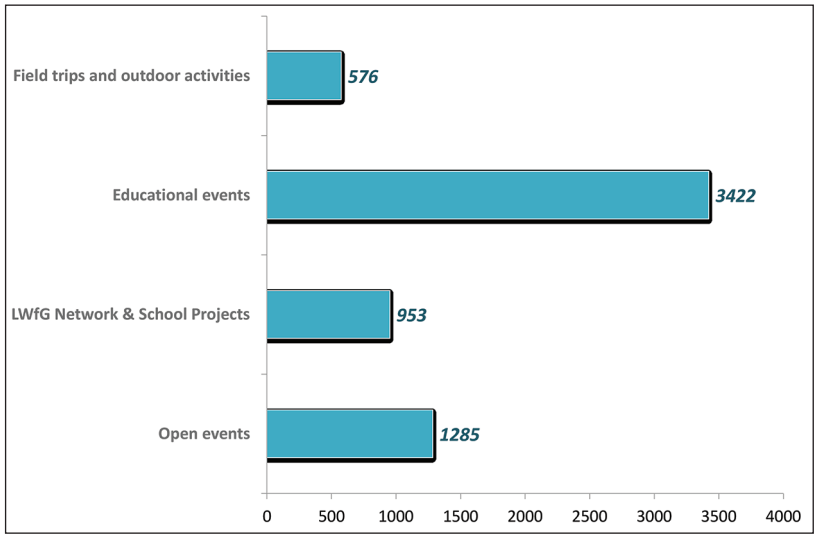

Figure 5.
Number of students that participated in the Environmental Education Programme and through which means.

3.3.2 Supplementary use of the project material

The educational material was used by all three Management Authorities of the National Parks of the main LWfG areas in Greece (Kerkini Lake, Ismarida Lake and Evros Delta) whose staff implemented EEP activities with more than 1,000 students. The project material was also used in numerous other educational or open events that took place at the project areas and beyond, scoring a total participation of 5,939 children. Field school visits were also organized by the HOS and the Greek Ministry of Environment and Energy, where 576 pupils from 23 schools, along with their teachers participated in birdwatching activities, outdoor games, and presentations of the LWfG children story.

The total participation in LWfG activities is shown in **Figure 5**. It includes students' participation in 1) the LWfG Network, 2) field trips and outdoor activities, 3) educational events and 4) open events.

4. Discussion

The evaluation of the material proved to be very useful for its improvement and tailoring to the students' neEds. Activities were adjusted according to teachers' comments while a teachers' guide and power point presentations were produced to cover their needs in a scientific level. The LWfG School Network contributed to the acquisition of knowledge and skills with which pupils and students can accept, support and actively participate in the solution of the environmental problem (Blionis 2009). The creation of the School Network and the continual utilization of the project material gave to children the opportunity to become familiarized with the environmental problem of species extinction. Role games, composing and performing a LWfG song, theatrical performances, posters, informative panels were some of the projects presented by the pupils, most of them underlining the threats of the LWfG during its migration journey, such as illegal killing and habitat loss. The variety of means students used to express a common issue highlighted the innovative learning methods and the successful dissemination at a local level. Nevertheless, the incorporation of any EEP into the curriculum cannot be considered as a simple task. On the contrary, a strategic plan must be set while personal initiatives from the local community can play a crucial role.

The use of the material outside the school curriculum contributed to a great number of participants in Environmental Education Project activities. The local Management Authorities and the HOS implemented the material in several occasions (school projects or visits, awareness events) transmitting to children of the community the importance of LWfG conservation. At the same time, through a large number of field visits, children came to direct contact with the threatened species' habitats in Greece.

A long term implementation of an EEP requires capacity, time and resources but is found absolutely vital if we truly wish to transmit to the citizens of tomorrow the value of biodiversity conservation.

Art from local pupils, exhibited in the Evros Delta Management Authority Visitor Centre. © Roula Trigou/HOS

Pupils of Secondary Schools of the lake Kerkini area, members of the LWfG School Network, during EEP event in Lake Kerkini, November 2014.
© Roula Trigou/HOS

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Twenty years of Norwegian-Russian cooperation on the Lesser White-fronted Goose

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Juha Markkola and Aki Arkiomaa from Finland, Ingar Jostein Øien from Norway (back row, left to right) and Aleksander Ivanovitch Artyohov and Aleksander Vladimirovich Astapenko (in front, left to right) from Russia on Taimyr Peninsula in 1997. © Ingar J. Øien

Biodiversity has been a central cooperative field of the Joint Norwegian-Russian Commission on Environmental Protection since the agreement was signed in 1988 (between Norway and at that time, the Soviet Union). The Lesser White-fronted Goose (LWfG) was early identified as a key species for collaboration and in 1997 and 1998 comprehensive field surveys were carried out on the Taimyr Peninsula in Northern Siberia. Important breeding areas for the Western Main Lesser White-fronted Goose (LWfG) population and important moulting areas for both the Fennoscandian and the Western Main LWfG population were discovered during these surveys. Catching of breeding LWfG was carried out during these expeditions and satellite telemetry tracking of breeding LWfG in this region revealed important stopover sites for the species in the Kurgaldzhino–Tengiz area in Kazakhstan (Tolvanen et al. 1998, Øien et al. 1999). These areas were later surveyed thoroughly through collaboration by Finnish, Norwegian, Russian and Kazakh colleagues (Tolvanen et al. 1999).

In the last decade, the main cooperative partners, the Norwegian Environment Agency, the Norwegian Ornithological Society (NOF-Birdlife Norway) and VNII Priroda (Vladimir Morozov) have focused on the Western Main population - and the western parts of the breeding range in "Polar Ural" and Bolshezemelskaya Tundra. Since 2004, during nine field seasons, V. V. Morozov and his field teams have surveyed and documented important breeding areas in these vast tundra areas, and caught and tagged birds in order to track individual movements and migration. Based on the tracking results from this long and persistent effort, several surveys have been conducted in the areas where new stopover sites on migration and wintering areas have been revealed from the tracking results (Morozov et al. 2014, 2015, 2016, Øien et al. 2005), and today we have a considerably better understanding of the LWfG migration through Kazakhstan and further to the wintering quarters in Azerbaijan, Turkey, Iran and Iraq.

On both, south-and northward migration, the Ob River Valley in Russia has proved to be of vital importance for the western main population. A survey of LWfG was carried out in the Lower Ob River in autumn 2010 and ca. 4000 LWfG were found along the surveyed route. The area was also found to have a very high level of hunting and poaching and a substantial need for effective management and conservation (Rozenfeld & Strelnikov 2011).

In November 2012, a survey was undertaken of the important LWfG staging areas in the Volgograd area in southern Russia. These were revealed by satellite tracking of Fennoscandian LWfG in 2006 and of birds from the Polar Urals in 2012 (Øien et al. 2009, Morozov et al. 2013). In another staging area at the Chograyskoye Reservoir in the Kalmykia region and Stavropol Krai, which was revealed by satellite tracking of LWfG from breeding areas at the Yamal Peninsula, Russia, a minimum of 80 individual LWfG were observed roosting (Karvonen et al. 2012).
In 2015, a survey was carried out in Nakhchivan in Azerbaijan, where many of the satellite transmitter tagged LWfG from the Polar Urals have wintered in later years (Morozov et al. 2016).

Two additional surveys in February and December 2015 on the Iranian side of the Aras reservoir on the border between Nakhchivan (Azerbaijan) and Iran, revealed that this area is probably the most important known wintering site for the western main population of the species. Up to 4,600 individuals in an almost pure LWfG flock were found wintering in this area (Lampila & Eskelin 2016).

All these results have been of significant value for the international LWfG conservation work, not only to improve the knowledge of the Western Main population but also in order to refine essential knowledge of the migration of the Fennoscandian population and to stimulate and establish new competence networks in the staging areas along the LWfG migration routes. For the small and vulnerable Fennoscandian population this work is of vital importance, as subadults and pairs that fail during the early face of reproduction are known to undertake a moult migration eastwards (Aarvak & Øien 2003) and an autumn migration that partly overlap with the Western Main population – along the Ob river valley to Kazakhstan (Øien et al. 2009). Better knowledge and active conservation along this eastern migration route is essential for a holistic conservation effort in Europe, and should be prioritized in upcoming work plans and projects.

The Ob-valley was first time surveyed with a small fixed winged aircraft in 2010. © Sonia Rozenfeld

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Lesser White-fronted Goose survey notes at Saros Bay and Meriç Delta in Turkey

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1. Introduction

Despite being listed as a principal range state for the Lesser White-fronted Goose (LWfG), still very little –if any– is known about the movement of the species in Turkey. Rather scarce observations since 1980 suggest that this rare winter visitor can use deltas at the Mediterranean, Aegean and Black Sea coasts of Turkey, together with the lakes in Eastern and Inner Anatolia generally occurring in very small numbers (**Table 1**, Jones et al. 2008 and LWfG website: **www.piskulka.net**). As of today, much of the interest that Turkey receives is probably due to its proximity to the wintering grounds of the Fennoscandian main LWfG flock in Greece. Particularly, when the flock temporarily disappears from Evros Delta (Panagiotopoulou et al. 2009), Turkey comes into mind for possibly hosting them.

The LWfG LIFE10 NAT/GR/000638 project team contacted us to find out potential areas where this flock may visit and a survey was planned for areas around the Meriç Delta (i.e. the Turkish side of Evros) and the Saros Bay.

2. Study area and Methods

The survey was scheduled between 23rd and 25th of February 2016 and the team was formed by Mehmet Oğuz Mül-ayim and Cemil Gezgin. We aimed to scan the entire Kavak Delta; Erikli, Vakıf and Karagöl lagoons; the entire Meriç Delta and former floodplain of Meriç River; Sığırcı and Hamzadere Reservoirs; and finally, Suvla lagoon (**Figure 1**). We expanded our conventional mid-winter waterfowl census spots at these sites to check potential areas nearby. We were able to access every planned observation point thanks to land and weather conditions. We used all available daylight. Highest temperatures for survey days were 2 to 10°C warmer than the average value for February (9.2°C). Despite a couple of showers we always had clear visibility (2 to 4 km). The hunting season had ended two days earlier and we did not hear any shots. All of the survey sites are listed as Important Bird and Plant Areas (for further information see Magnin & Yarar 1997, Kılıç & Eken 2004, Özhatay et al. 2005).

3. Results

We could not see any geese during the trip. Below we give our analysis of the sites as a future reference for a better understanding of possible LWfG sites on the Turkish Thrace. These notes also reflect our more than 10 years of mid-winter waterfowl census experience at the region.

3.1 Kavak Delta

A vast coastal wetland (1,580 ha) at the eastern tip of Saros Bay. The delta comprises Kavak creek, large coastal meadows, seasonal small brackish lagoons, sand dunes and several crop fields (mainly wheat). Seasonal wet meadows are dominated by *Salicornia* spp., *Juncus* spp. and grasses. Cattle grazing at some parts keep the vegetation low. Hundreds of ducks roost at the shallow shoreline and hence, geese might occasionally use this

Date	Location	Region	Total	Adults	2cy	Comment	Source
19/02/2016	Akyatan Lake	Mediterranean region	5	3	2		Sercan Bilgin
12/02/2015	Delta of Kizilirmak River, Sam-sun	Black Sea	2	2	0	LWfG was recorded/photographed by Emin Yogurtcuoglu	**http://www.trakus.org** conveyed by Ahmet Karatash
04/02/2015	Delta of Kizilirmak River, Sam-sun	Black Sea	2	0	0	Flying LWfG with Bean Goose in WfG flocks, photograph by Mustafa Sözen	**http://www.trakus.org** conveyed by Ahmet Karatash
02/12/2014	Edremit coast of Van Lake	Van	1	0	0	Dead bird, confiscated from hunters	Mustafa Erturhan
29/01/2006	Ormanli, Catalca	Istanbul	1	0	0	Observed by Ömer Necipoglu near Ormanli Village of Çatalca District (Is-tanbul)	**http://www.trakus.org**
29/12/2001	Göksu Delta	Mediterranean region	2	0	0		Kirwan et al. 2003
06/04/1990	Seyfe Gölü	Central Plateau	12	0	0		Kirwan et al. 2003
31/12/1987	Bafa Gölü	Western Anatolia	3	0	0		Kirwan et al. 2003

Table 1. *Lesser White-fronted Goose observations in Turkey.*

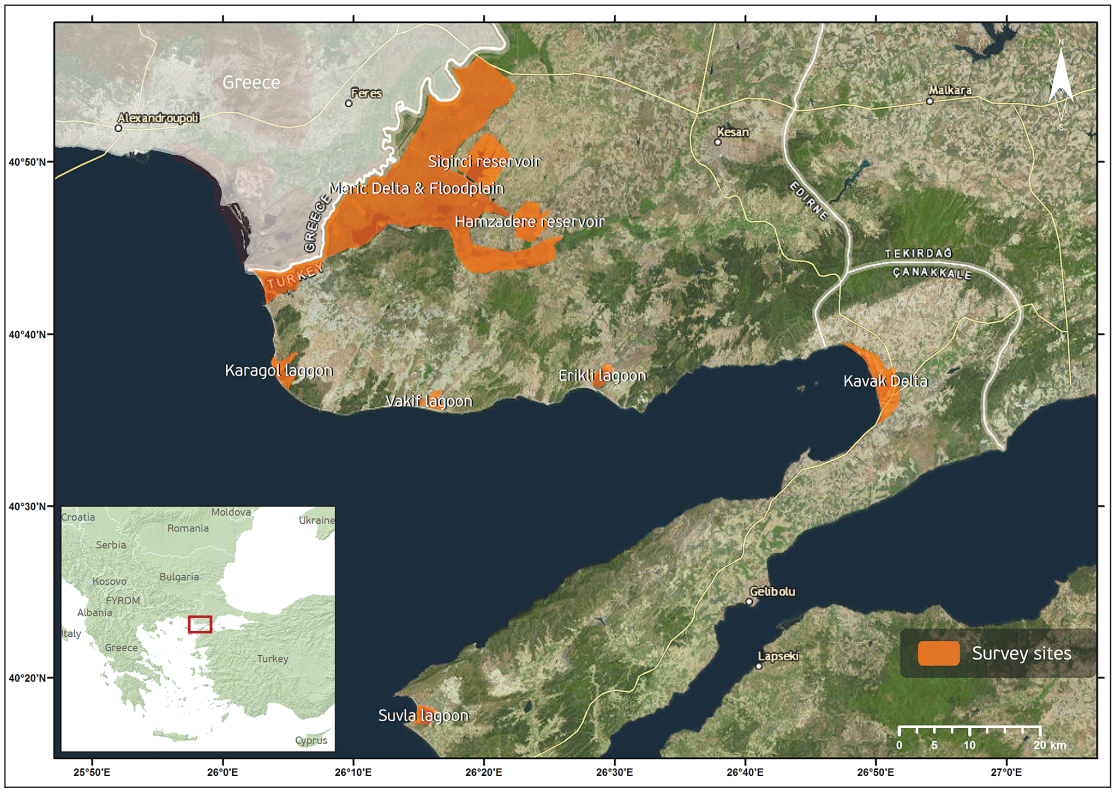

Figure 1.
Map of survey sites.

line for the same purpose, as well. In rainy winters, the delta is largely inundated and some parts become inaccessible. But still, hunting is practiced though it is not even as half intense as it is at Meriç. There is no close settlement and human activity in winter is limited to herdsmen and hunters. Three hillocks on the delta which look like tumuli are excellent lookouts, especially for scanning inaccessible parts of the delta.

3.2 Northern Saros Bay Lagoons

Erikli Lagoon (max. water surface 350 ha) is next to a settlement, so it is unlikely to be a feeding area for geese. But it may still be a potential roost site for passing geese due to its large water surface. A small low-growth grassland lies on its north. Vakif Lagoon (max. 190 ha) is a potential feeding and roosting site with an adjacent seasonal wet meadow (145 ha) on the east where flocks of Common Shelducks *Tadorna tadorna* and Ruddy Shelducks *T. ferruginea* feed and roost in their moderate numbers. *Salicornia* spp. and grass species form the dominant vegetation on the meadow. There are two nearby villages. Karagöl Lagoon is a smaller lagoon (max. 46 ha) which is 2 km to Enez's villa district. There is an adjacent coastal saline meadow of 60 ha to its northwest. We believe it might only be used as a stopover site on harsh weather conditions. These lagoons are subject to hunting mostly by local people.

Kavak Delta, Turkey, February 2016. © Cemil Gezgin

3.3 Meriç Delta and former floodplain of Meriç River

This huge area (24,000 ha in total) is considered by many to hold arguably the best alternative feeding and roost areas for the LWfG wintering at Evros Delta since it is located just on the other side of the river. The delta contains Büyük Gala, Küçük Gala and Pamuklu freshwater lakes which altogether are declared as the Gala Lake National Park; Dalyan, Taşaltı and Bücürmene lagoons which are declared as a Nature Reserve; vast areas of flooded and semi-dry rice fields along Enez-İpsala road and on former floodplain of Meriç River; and a few large meadows near Orhaniye and Yapıldak villages. There is constant human presence (fishermen, farmers, hunters, etc.) around almost the whole area and throughout the year. The military zone inside the delta which is a very narrow area following the river requires special permission to access and sometimes it hosts waterfowl flocks of significant numbers as a refuge. Siğirci and Hamzadere Reservoirs are two large bodies of freshwater (590 ha and 1,488 ha respectively) near Meriç delta which might be used as a temporary roost site. Meriç delta has always been a paradise for hunters and unfortunately, the already intense hunting pressure seems to increase each year (both in legal and illegal terms). Although Gala and Pamuklu lakes are protected as a National Park; there is no buffer zone and only an embankment road separates the park from the hunting-allowed area. Illegal hunting is not uncommon at legally protected lagoons either.

3.4 Suvla Lagoon at Southern Saros Bay

The only lagoon (max. 260 ha) on the Gallipoli Peninsula is scarcely visited by birdwatchers. Yet it might serve as a staging site for south flying flocks thanks to minimal human presence. Ruddy Shelducks graze on the seasonal wet meadow adjacent to the lagoon. There are two farms nearby and sheep graze on *Salicornia* spp., *Juncus* spp. and grass-covered area. This site resides in the Gallipoli Peninsula National Park and it is relatively far from any village and tourist attraction point and hunting doesn't seem to be practiced here regularly.

4. Discussion

Although there are potential feeding and roosting grounds for the LWfG at our survey sites, we believe that these areas could only serve as a short stopover/staging sites due to heavy disturbance by humans, one way or another, of which the heavy hunting pressure has the most negative effect. This confirms the fact that we rarely observe geese during midwinter counts at the region, and the very few ones that we see are often found in the military zone with limited access in Meriç Delta. That said, we still believe that these sites should be on top of the checklist in search of the LWfG, especially when they disappear from Greece during winter. In such a case, Meriç could be the first site to check, but Kavak Delta is also a good candidate thanks to its suitable habitat which becomes partially inaccessible on rainy winters. Suvla Lagoon should be considered especially when the LWfG are forced to leave Evros because of frost, since this site is usually warmer (average lowest temperature ~3°C higher than Meriç's) and it also provides suitable habitat and less human activity. Finally, we believe other large deltas at westernmost of Turkey, namely Gediz, Menderes and Güllük should also be surveyed in next years in search of the mystery wintering sites for the Fennoscandian main flock.

Suvla Lagoon and adjacent meadow, Turkey, February 2016. © Mehmet Oğuz Mülayim

5. Acknowledgements

We thank Petteri Tolvanen from WWF Finland and Eleni Makrigianni from Evros Delta Management Authority for contacting us. Expenses of this survey were covered by WWF Finland as a part of the Lesser White-fronted Goose LIFE+ Project (LIFE10 NAT/GR/000638), which is co-financed by the European Commission and the Norwegian Environment Agency.

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Monitoring of the Lesser White-fronted Goose in Romania in 2012-2016

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Two adult and one immature Lesser White-fronted Goose.
© Emil Todorov/SOR Birdlife Romania

1. Introduction

The Lesser White-fronted Goose (*Anser erythropus,* hereafter LWfG) is one of the most endangered goose species in the world. It is considered globally threatened and recognised as vulnerable by the International Union for the Conservation of Nature (IUCN). Lesser White-fronted Geese are long-distance Palearctic migrants, currently breeding discontinuously in the sub-arctic zone from Northern Fennoscandia to eastern Siberia, whose staging and wintering areas and migration routes are only partially known. The global population of Lesser White-fronted Goose has declined rapidly since the middle of the 20th century. The decrease in numbers has been accompanied by fragmentation of the breeding range and is continuing to affect all populations, giving rise to fears that the species may go extinct. Overhunting and habitat loss are considered to be the main threats (Jones et al. 2008).

In Romania, the Lesser White-fronted Goose is protected by national legalisation (OUG 57/2007) and considered "Critical Endangered" according to the Romanian Red Data Book (Botnariuc & Tatole 2005). The species is considered a rare but regular winter visitor and recent estimates of the wintering population in Romania are ranging from 20 to 30 individuals (European Environmental Agency 2014). At the end of 19th century and the beginning of 20th century the species was considered to have a regular presence in Romania among the Greater White-fronted Goose *Anser albifrons* flocks, representing 1-2 % of the goose species in these flocks (Linția 1955). The first documented presence of the LWfG in Romania is coming from Transylvanian region in 1901. A stuffed specimen (from the old private collection of Dr. P. Theil) is reported in the Brukenthal Natural History Museum, Sibiu (Florin T., pers. comm.). In the period 1935-1943 another four individuals were collected and stuffed, and these are reported in the Ornithological Catalogue of Banat Museum in Timisoara, (collection 1878-1970). All of them were collected in Timis County at Western Romania, close to the border with Hungary and Republic of Serbia. In the period 1989-2000 there are several observations of LWfG, ranging from few individuals to few dozens, but most experts have expressed serious doubt about the reliability of these figures (unpublished report of Romanian Ornithological Society). A survey on 1-2 December 1996 failed to locate any LWfG in the Romanian Coastal Dobrogea (Aarvak et al. 1997). Comprehensive field data collection of wintering geese in Costal Dobrogea was done in the period 1998-2001, but with no records of LWfG (Hulea 2002).

A better organized data collection of wintering geese in Romania was organised after 2002 as part of the work of the AEWA International Red-breasted Goose Working Group, covering mainly the Romanian Coastal Dobrogea. The wetlands along the Lower Danube section were rarely monitored. Although, the main wintering grounds are systematically monitored there are no other records until 2007, when the first sighting in many years was reported. More systematic data collection begun in 2012 when more experienced observers were organized within the national monitoring scheme of wintering geese in Romania and field observations intensified. The coverage of the monitoring scheme was extended, covering also wetlands along the Danube River and more inland lakes in Braila, Ialomita and Buzau counties. The aim of this paper is to present the monitoring data collected during 2012–2016 and to outline the current wintering distribution and numbers of the LWfG in Romania.

2. Study area and methods

The monitoring of the LWfG in Romania was implemented as part of the coordinated Red-breasted Goose counts in Bulgaria, Romania and Ukraine under the AEWA International Red-breasted Goose Working Group and in over 20 large brackish and freshwater wetlands located in Tulcea, Constanta, Braila, Ialomita, Calarasi and Buzau counties in south-east Romania. These were known to hold significant numbers of wintering geese and were monitored once or twice a month from the end of November to the beginning of March in the period 2012-2016. All goose species, the majority of which were Greater White-fronted Geese (hereafter GWfG) and Red-breasted Geese *Branta ruficollis* were counted from 7.00 to 10.00 am. at their roosts when departing to the foraging areas. Afterwards, the monitoring team followed the GWfG flocks to their foraging fields and when the geese settled, detailed screening for LWfG was performed using spotting scopes 20-60x and digital tele-zoom photo cameras. Due the fact that the GWfG were spreading widely around the foraging grounds and because of the large distance to some of them, not all flocks were sampled. Geographical coordinates of the foraging field, type of crops, numbers and aging of the LWfG were recorded. Another monitoring technique used to detect LWfG was sampling with telephoto zoom lens, when geese were in flight. This technique was used only in case the geese were scared at their foraging grounds before the observer could perform the screening. Apart from the goose monitoring scheme, non-systematic data collected by birdwatchers were reported and submitted online to the national bird observation database at ***www.rombird.ro***. All duplicate counts of LWfG during the survey period were excluded from further analyses.

3. Results

During the study period, we registered 29 LWfG observations with a total of 59 individuals. The numbers of the LWfG observations have shown a rapid increase from 2012 onwards (**Figure 1**).

More than 95% of the LWfG were found in SE Romania, mainly along the Coastal Dobrogea and Lower Danube wetlands. Two individuals were registered at the border with Hungary and one in Transylvania. The most important regions are the Coastal lagoons along the Black Sea coast and the brackish and freshwater lakes along the Danube River sections between Calarasi and Braila (**Figure 2**).

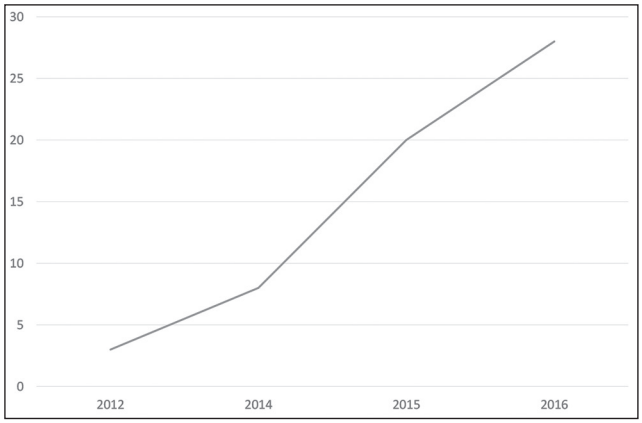

Figure 1. *Trend of the Lesser White-fronted Goose observations in Romania in 2012–2016.*

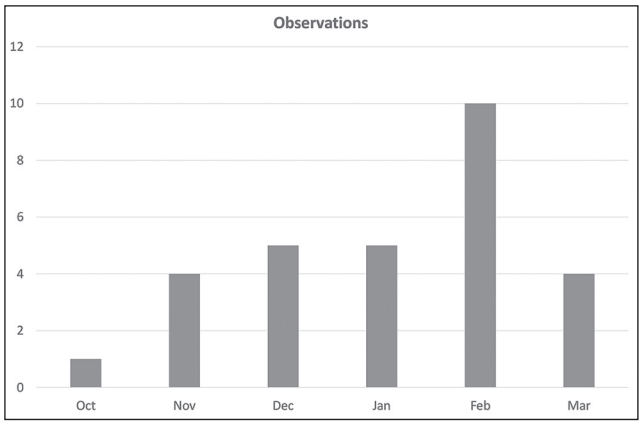

Figure 3. *Monthly records of the Lesser White-fronted Goose in Romania in the period 2012-2016.*

The LWfG is a winter visitor in Romania, with the first arrivals in mid-October. The latest observation was in mid-March. The peak of LWfG records was in February, while the observations in the other months are stable, suggesting no further arrival or departures (**Figure 3**).

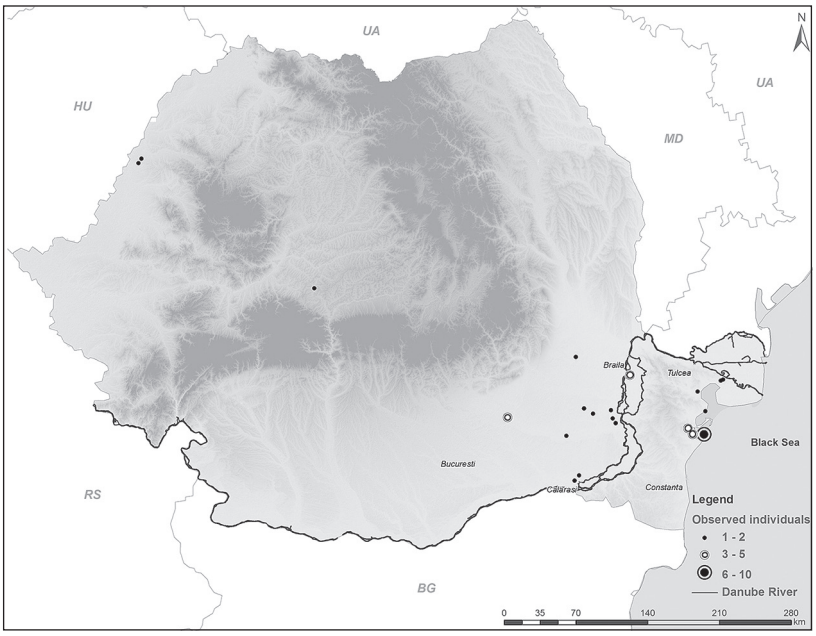

Figure 2. *Distribution and numbers of the LWfG in Romania in 2012–2016.*

*Adult Lesser White-fronted Geese feeding in natural dry steppe habitats. © Szabó József / **www.rombird.ro***

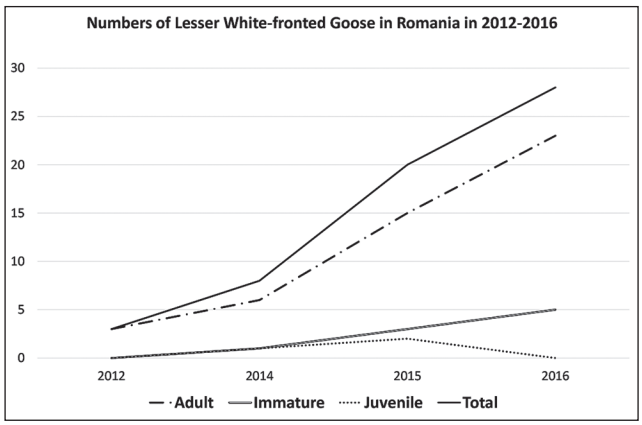

***Figure 4.** Age structure of the registered individuals of the Lesser White-fronted Goose in Romania in the period 2012-2016.*

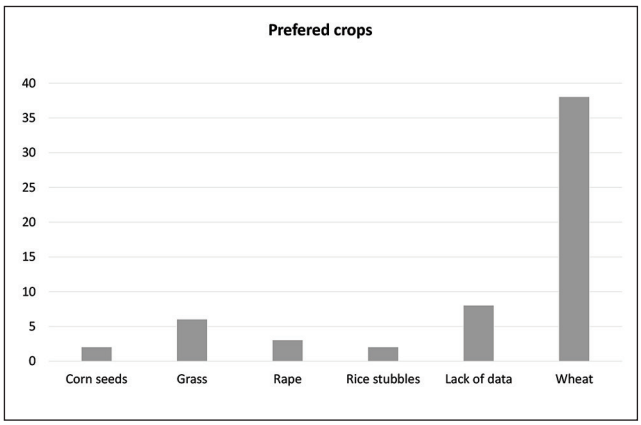

***Figure 5.** Preferred crops by the Lesser White-fronted Goose in Romania in the period 2012-2016.*

The majority of the observed individuals were adults (80.6%), followed by immatures (2nd calendar year, 13.9%). Juveniles were very rarely registered, with only 3 individuals during the whole study period (**Figure 4**).

Arable land and permanent pastures were identified as the main LWfG foraging habitats. The main preferred crops were winter wheat, most likely due to the fact that the LWfG were observed within large flocks of Greater White-fronted Geese, which favour wheat fields. At the end of the wintering season and before the start of the prenuptial migration, the LWfG mainly grazed on grass in flooded permanent pastures (**Figure 5**). There were no observations of color ringed or neck banded individuals during the study period. There are no known recent records of LWfG being shot accidentally.

4. Discussion

The LWfG winters in Romania within the larger flocks of the much more abundant GWfG (up to 280,000 individuals, European Environmental Agency 2014) and is thought to belong to the Western Main population, the latter estimated at about 8,000 to 13,000 individuals (Jones et al. 2008). In the period 1990-2000 the Romanian wintering LWfG population was estimated at 31-

Foraging Greater White-fronted Geese at flooded pastures near Danube River February 2016. © Emil Todorov/ SOR-Birdlife Romania

50 individuals (Birdlife International 2004), although this estimate is based on observations during the annual International Winter Counts (IWC), which lately are not considered reliable. The current estimate of the wintering LWfG population is ranging from 20-30 individuals (European Environmental Agency 2014), based on observations documented with photographs, but the real figures might be much higher since LWfG screening was not applied to all flocks of GWfG wintering in Romania. The large gap of data between 1950 and 2012 it might be due to the fact that the LWfG wintering population in Romania is quite small and remains "hidden" among the numerous GWfG. Usually, 1-2 individuals are seen within a flock of tens of thousands of GWfG. Almost all registered individuals are found while grazing. It is very likely for inexperienced observers to overlook the species due to its similarities with the GWfG. For instance, the highest number recorded in 2016 was in a flock of 2,000 individuals of GWfG and 10 LWfG were relatively easy to spot. Most of the registered individuals were re-observed within several days to few weeks after their first detection, which supports the hypothesis that all individuals are not leaving the areas chosen as wintering quarters.

Another obstacle for better screening of LWfG among the numerous GWfG is hunting. Goose hunting in Romania is permitted for two species, Greylag Goose from 15 August and GWfG from 15 October, and until 15 February for both species. Usually, the geese are disturbed all day long by hunters and become too agitated to be approached from a close distance by the monitoring team. Moreover, the disturbance produced by hunters forces the geese to fly far away from their preferred foraging grounds in the vicinity of the roosts, which makes it difficult for the monitoring team to follow their movement. Although, there are no reports of accidently shot LWfG, goose hunting remains a critical threat for the geese in Romania. In the winter period, key sites for the LWfG are used for hunting GWfG. Hunting usually takes place between the roosting and feeding sites, and usually in bad weather conditions with poor visibility. A common hunting strategy is to attract geese at foraging sites by using decoys and electronic devices replicating goose calls, even if the use of the electronic devices is illegal. The hunters shoot from hides and do not have time to identify the geese due to very short reaction time. In 2015 there were several reports of accidently killed Red-breasted Geese. In many discussions with hunters, the monitoring teams often remain surprised to hear that the hunters' knowledge about the protected waterfowl species is very poor.

An additional problematic issue is that of lack of control of the hunting bag and hunting bag reports. The reason is that nobody would report accidental killing of protected species because this would mean that the hunter would be fined. Accidental shooting, disturbance from noise and proximity of the hunting parties pose a serious threat for the wintering LWfG. Due to disturbance LWfG can feed less, travel longer from the roosting places to the feeding grounds and maintain a poor fitness status affecting the success of the migration and subsequent breeding. SOR/Birdlife Romania is maintaining permanent dialog with the local hunting associations operating in most of the key LWfG areas. For instance, goose hunting was banned temporarily at Balta Alba Lake in 2015, where large numbers of geese roost in the beginning of the winter, before the lake freezes. Sometimes the weather is also an obstacle when searching for LWfG, since during November and December there are days with almost permanent fog. Usually, the movements of the wintering geese

Two Red-breasted Geese killed by a Romanian hunter in October 2015. © social media

in Romania are influenced by the variation of the weather. Significant movements of the all goose species wintering in Romania occurs in mid-January, after all wetlands are frozen and the foraging areas are completely snow-covered. The only available wetlands not severely affected by the cold weather are the coastal lagoons along Black Sea. The cold wave usually has duration of several weeks, but as soon as the temperature rises, large numbers of GWfG and RbG reappear in February, preparing for the prenuptial migration. Most likely, the LWfG follow the same pattern of movements during the winter.

In conclusion, accurate estimates of the LWfG population in Romania looks challenging due to all difficulties mentioned above. Several key Natura 2000 areas were identified as regular wintering areas of the species. The largest Natura 2000 site in Romania, the Danube Delta and Razim-Sinoe Complex located at the western bank of Black Sea, holds regular observations of LWfG. The Danube Delta was also declared a biosphere reserve in 1990, where hunting is forbidden. Other important LWfG Natura 2000 sites are: Balta Alba-Amara-Jirlau, Balta Mica a Brailei, Bertesti de Sus-Gura Ialomita, Balta Tataru, Lacul Beibugeac, Campia Gherghtei and Iezerul Calarasi. More than 75 % of the observed individuals were registered within the limits of protected areas, where hunting is allowed. The rest of the observed individuals were found in the vicinity, in foraging grounds, which are well known as traditional goose areas, but not legally protected, which raises the needs of legal extension of some protected areas to secure the proper protection of the species. Strict control of the hunting at key Natura 2000 sites for wintering geese and declaring of hunting free zones are urgently needed. Elaboration of site management plans and National Species Action Plan are also critical conservation measures necessary to ensure the survival of the LWfG in Romania.

5. Acknowledgements

Many people were involved in the LWfG monitoring scheme in Romania in 2012–2016. My special thanks are due to all observers that carried out the field work and reported their observations during these years: Andreea Dehelean, Ciprian Fântână, Dorin Damoc, Dani Dragan, Florin Chirila, Horváth Gábor, Luca Dehelean, Mihai Baciu, Mircea Radu Achim, Marian Huc, Pál Lajos, Sebastian Bugariu, Szabó József, Simó Imre. The monitoring was made possible with financial support of the SOR/Birdlife Romania and participants` own contribution.

SOR/Birdlife Romania monitoring team searching for Lesser White-fronted Geese. © Emil Todorov /SOR/Birdlife Romania

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Lesser White-fronted Geese. © Seppo Ekelund

Occurrence and threats for Lesser White-fronted Goose in the Islamic Republic of Iran

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1. Historical occurrence of the Lesser White-fronted Goose in Iran

Based on earlier reports, there are many indications that the Islamic Republic of Iran has importance as a wintering area for the Lesser White-fronted Goose (*Anser erythropus*, hereafter LWfG). Perhaps the earliest estimates are given by Peter Scott, who observed at least 30,000 individuals in the Gorgan Bay area (in the south-east corner of the Caspian Sea) in the 1930's, a figure which is higher than the current estimate of global population (Mansoori & Amini 2011)! Still in the early 1970's the number of LWfG in the mid-winter waterfowl censuses (conducted in January) varied between 1,867 and 5,249 individuals and in addition a single flock of 6,650 was observed in the marshes at the west end of Gorgan Bay on 21 December 1972 (Scott 2010, Mansoori & Hamini 2011).

In the period from 1992 to 2008, the total number of the LWfG in Iran has varied from zero to 264 individuals during mid-winter counts (Mansoori & Amini 2011) and the species was not observed at all in 2009 (Amini & van Roomen 2009), although latter report only covers 8 out of 31 provinces of Iran.

However, in 2004, one LWfG fitted with a 30g satellite transmitter in the Polar Urals, Russia, visited the Aras Reservoir on the border between Nakhchivan, Azerbaijan and Iran (Morozov & Aarvak 2004). In 2013 two birds from the More-Yu River, Bolshezemelskaya Tundra in Russia arrived at the Aras reservoir on 16th and 30th of October. One of the birds was apparently shot in mid-November, but the second bird stayed in the area until March 2014 (Morozov et al. 2014). In 2014 five birds were fitted with satellite transmitters in the Polar Urals, Russia. Of these, three birds visited the Aras Reservoir during the following winter highlighting the importance of the area (Morozov et al. 2015).

2. International expeditions in 2015

Based on these records, two expeditions (February and December 2015) were organized to the Aras reservoir and other potential LWfG areas in the northern parts of the Islamic Republic of Iran. These expeditions, organized in co-operation with AEWA and the Department of Environment (DoE) of Iran, proved to be very successful (**Table 1**). On the first expedition, a minimum of 1,970 individuals / maximum of 2,750 LWfG were recorded in Aras, and in December, as many as 4,610 LWfG were recorded. Details of these expeditions will be published at a later stage in an AEWA report series (Lampila & Eskelin unpubl.). The number in December constitutes the biggest congregation in the wintering area of the western main population for decades. It is also >15% of the current world population estimates (BirdLife International 2016).

In the expeditions, LWfG were not recorded outside the Aras water reservoir area. However, LWfG have been recorded in several sites after the expedition (**Table 2**). This can partly be attributed to an increasing awareness among local ornithologists,

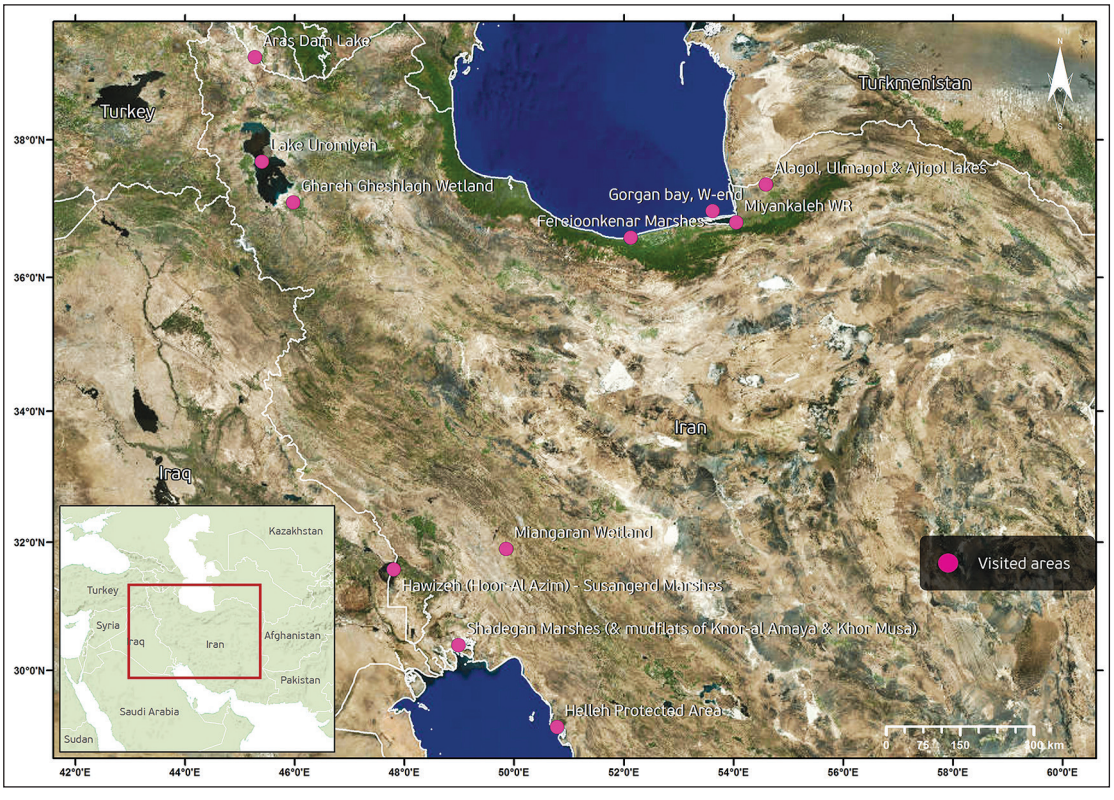

Figure 1. *Map of the visited areas during the expedition in 2015.*

	Winter 2014–2015	Winter 2015–2016
Survey period	31 Jan. – 16 Feb.	5 Dec. – 21 Dec.
LWfG observations	2 - 4 Feb. 2015 Aras reservoir: min 1970 - max 2450 LWfG observed	5-7 Dec. 2015 Aras reservoir: 4610 LWfG observed
Main sites covered by the surveys	Urmia lake & adjacent wetlands, Aras reservoir, Khoda Afarin & Aslandooz Dams, Anzali wetland, Bujagh, Fereydoon Kenar, Miankaleh, Gorgan bay & Gomishan wetlands	Aras reservoir, Gharesh Gheslagh, Fereydoon Kenar, Miankaleh, Gomishan wetlands, Helleh, Miangaran, Hoor Al Azim

Table 1. *Results of the Lesser White-fronted Goose monitoring (international expeditions) in Iran in the winters 2014-2015 and 2015–2016.*

Location (IBA code)	Maximum number of LWfG recorded	Date
Fereydoon Kenar (IR019)	2	02/11/2014
Gandoman marsh (IR067)	1	02/03/2015
Aslandooz Dam (-)	57	11/12/2015
Ghareh Gheslagh (-)	9	05/03/2015
Mighan Wetland (-)	20	15/12/2015
Bandar Kiashar lagoon (Boujagh National Park) (IR017)	11	27/11/2016

Table 2. *Observations of Lesser White-fronted Geese in Iran outside the Aras reservoir since winters 2014/2015 (source:* **www.piskulka.net**, *Abbas Ashoori).*

also outside the winter bird census season (in January). It seems probable that relatively large numbers use the Southern Caspian Sea coast on migration, but Aras seems to be the only known regular wintering site in Iran at the moment. In some years the Aras reservoir can freeze over, forcing the geese to migrate further. The Mesopotamian Marshes in Southern Iraq (and to some extent, in South-Western Iran), as well as some wetlands at the Persian Gulf may be particularly important on those years, but much more information is needed.

Part of the staggering flock of 4610 LWfGs at the Aras reservoir in December 2015!
This is the largest number recorded in the wintering grounds of the Western main population for decades. © Petri Lampila

3. Threats to the Lesser White-fronted Goose in Iran

3.1 Poaching

According to the local specialists (Hamid Amini & Alireza Hashemi pers. comm.), poaching may exist to a varying degree in all protected areas, even despite the presence of local guards. Both Greater White-fronted Goose and LWfG are legally protected, which means that LWfG should not be shot by mistake. In Aras Reservoir poachers were met on both mornings during the first expedition: on the 3rd February the poachers escaped to the Azerbaijan side of the border and on the following day the local hunting guards caught one poacher, who was delivered to the police officials. Despite these events, Aras Reservoir is potentially a safer area for LWfG than many others in Iran, because hunting is banned also due to the proximity to the Azerbaijan border, which is also controlled by the frontier guards. In addition, DoE workers have done important education work among hunters especially in Aras. In December 2015 (after the awareness campaign by the DoE) no poachers were seen in Aras, but it is of course difficult to know if this was a permanent situation. Furthermore, poachers were discovered also in Miangaran wetland and in Helleh Wildlife Sanctuary during the international expeditions.

3.2 Trapping and mist-netting in Fereydoonkenar

Fereydoon Kenar is a complex of shallow freshwater impoundments developed for irrigation purposes and as a duck-hunting area and it is surrounded by rice paddies (Scott 1995). It is best known for its wintering Siberian Crane *Grus leucogeranus* population, which has decreased down to just one individual. A serious threat to all bird populations wintering in the area is the wide-scale trapping and mist-netting. Within a range from 500,000 to 1,000,000 birds may be killed annually (Hamid Amini & Alireza Hashemi pers. comm.). This activity is at least partly legal and the DoE provides trappers with licenses. The DoE is, however, limited in its capability to limit the trapping. Protected bird species are widely caught too, and are in fact specially targeted as they are being sold to private wildfowl collections or to taxidermists, whereas more common species are being sold for meat. Information campaigns about the LWfG are thus not recommended for this site: information about the rare bird possibly occurring in the area might induce trappers to increase their efforts to catch LWfG. Already now, LWfG are regularly caught, even though this species is apparently fairly rare in the area. Koros Rabiee (DoE) has been able to release at least six LWfG originally caught from the nets (in both 2014 & 2015). Some of these individuals have spent up to two years in captivity before the release, because hunters cut the primaries from the individuals that are meant to be sold for collections.

3.3 Habitat degradation in wetlands

In addition to poaching, water balance in many wetlands is also of major conservation importance for a wide range of species, including LWfG. According to the locals, in many of the visited areas the water level was particularly low in 2015, but for example in Miangaran Wetland there apparently has been a declining trend in water level for years already. This is also the case with the Urmia lake (e.g. Lofti 2012) and its adjacent satellite wetlands, like Ghareh Gheshlagh Wetland. It is unclear whether this is more a consequence of the global climate change, dam constructions or the result from the use of water for e.g. agriculture. Probably they all are involved and their relative importance depends on the area. Also, different construction activities (bridges, roads) can alter the water balance. In Khuzestan province, oil-drilling particularly near the Hoor Al-Azim complex is also a major concern.

In Aras reservoir, however, drought may actually have created new habitat for the LWfG, since the water level was much higher in the past decades. It remains to be seen, what will happen to areas currently favored by the LWfG. It may be possible to find new feeding habitats in the neighboring areas, but these might be more vulnerable to hunting. Currently, the majority of the LWfG feed and roost practically in the same area, thus lacking the usual roost flight behavior.

Koros Rabiee is ready to release a LWfG, which was originally saved from the hunters' nets in Fereydoon Kenar. Because some rarer birds are sold for private collections, their primaries are cut by the hunters. Thus, these individual have to spent at least a year in captivity before the release. © Petri Lampila

The story of the most famous species of the Fereydoon Kenar, Siberian White Crane (Grus leucogeranus) is coming to an end. The last remaining individual called Omid (= "Hope") has returned alone to the area for the last seven years, after its spouse apparently died. © Petri Lampila

4. Conclusions

Iran is shown to be an important country for the LWfG, but much of the occurrence is still unknown, particularly during the migration season and in the years when the Aras reservoir freezes over. Hunting and poaching remain the biggest threats to the species, but there is some positive progress related to this issue. Habitat changes, particularly drought in some wetlands, are another potential threat to the species. Furthermore, Aras reservoir lacks any formal status as a protected area, but apparently, this does not form an imminent threat to the area. Very preliminary discussions to form a transboundary protected area, including adjacent areas in Azerbaijan, have also been started.

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Natura 2000 Award for the Lesser White-fronted Goose network

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Natura 2000 Award Ceremony, May 2016. Manolia Vougioukalou and Roula Trigou from Hellenic Ornithological Society and Karmenu Vella and Roby Diwer from the European Commission. © EU Environment

Every year, in recognition and celebration of the Natura 2000 network, the largest network of protected areas worldwide, the European Commission recognizes excellence in the management of Natura 2000 sites and conservation achievements through launching the Natura 2000 Awards. Each year, anyone directly involved with the Natura 2000 Network (NGOs, national and private organizations, land owners and even individuals) can apply for one of the categories of the award which are: (1) Conservation, (2) Socio-Economic Benefits, (3) Communication, (4) Reconciling Interests / Perceptions, (5) Cross-Border Cooperation and Networking, and the (6) European Natura 2000 Citizens Award.

The LIFE + project for the Lesser White-fronted Goose (LWfG) – *Anser erythropus* "Safeguarding the Fennoscandian Lesser White-fronted Goose population in key wintering and staging sites within the European flyway" conservation has been a major catalyst for the network that has been developed for the conservation of the LWfG. In 2016 the project received the Natura 2000 Award in the "Cross-Border Cooperation and Networking" category, by Mr. Karmenu Vella, the European Commissioner for the Environment and Mr. Roby Biwer, rapporteur of the Committee of the Regions' (CoR) opinion on the fitness-check of the Nature Directives.

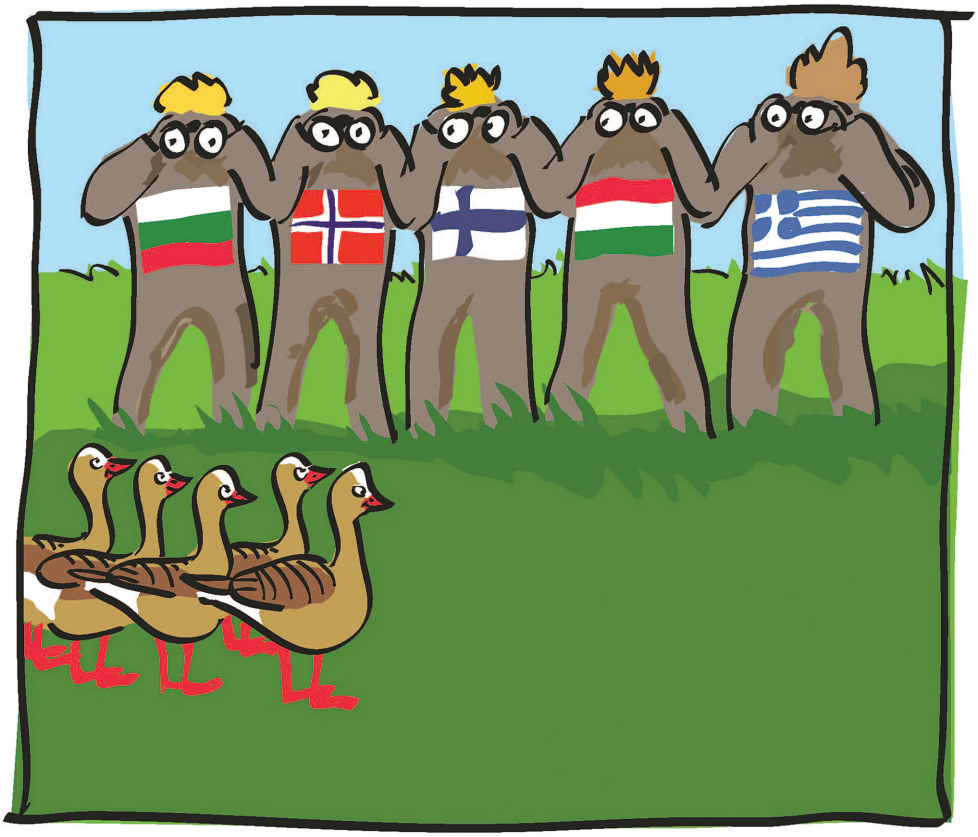
Previous work on the Fennoscandian LWfG population and the significant efforts put in during the LIFE + project implementation has led to the development of an extensive and multi-dimensional network. The geographical extent of the network was dictated by the distribution range of the LWfG mainly in Europe, but it has been expanded to cover almost the entire LWfG global range. With the involvement of eight partners from four European countries, including two national public authorities (Ministry of Environment and Energy/Greece, Metsähallitus/Finland), three NGOs (Hellenic Ornithological Society/Greece, Bulgarian Society for the Protection of Birds/Bulgaria and World Wildlife Fund for Nature/Finland), one research institute (Forest Research Institute/Greece), one National Park Authority (Hortobágy National Park Directorate/Hungary) and the UNEP/AEWA Secretariat, the network for the LWfG expanded not only geographically but also in different levels within the society. In addition, the project received the support of six ministries (Greece, Bulgaria, Hungary, Finland and Norway), and worked together with three National Park Management Authorities (Evros Delta, Kerkini Lake and Ismarida Lake in Greece) and three pertinent Forest Services (Alexandroupolis, Sidirokastro and Rhodopi in Greece). The network implemented concrete actions in seven NATURA 2000 sites across Europe. During the operation of the current LWFG LIFE+ Project the network extended to 16

additional countries also beyond the European borders. This multi-national and multi-institutional partnership has played a key role to the implementation of the networking, training, management and patrolling actions that were implemented in the framework of the LIFE + project. The cross-border cooperation and networking activities proved to be highly effective as the LWfG Fennoscandian population numbered a maximum of 69 individuals in 2011 when the project began and by 2016 reached a maximum number of 144 individuals.

Almost daily LWfG observations were recorded online in the LWfG international portal (**www.piskulka.net**), as a result of the international LWfG network that includes more than 100 members. Since the beginning of the LIFE + project, during three workshops at least 36 persons from 15 different countries have been trained in LWfG identification and monitoring. As a result, the LWfG observations have increased significantly; have spanned 18 countries from Hungary to Iran, and have discovered new LWfG sites. Increased mortality from hunting and illegal killing is, according to the International Single Species Action Plan for the LWfG, the main threat for the species. In the framework of the project, more than 50 state game guards have been trained in effective wildlife patrolling and new techniques, as well as LWfG ecology and conservation in the Greek and Bulgarian project sites, forming the on-the-ground patrolling network. Additionally, the project has created a school network in the Northern Greece, in which more than 30 schools participated, including more than 1,000 children. Educational activities especially designed by the project for the LWfG were implemented by the teachers themselves as part of the school curriculum. Altogether, the network operated and still operates on many levels and can be estimated to count more than 1,200 persons.

Through this network, the LWfG Fennoscandian population is possibly the most well monitored waterbird population in Europe, and a conservation success story.

Winning this award meant that the contributions of all network members, from high level government officials to local hunters and school children, received significant high-level recognition. Through this acknowledgement, the network can expand even further and become an example for persons and organisations interested in investing in the conservation of migratory birds as well as NATURA 2000 sites.



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Project publications

Available in:
https://wwf.fi/en/lwfg/lwfg7 & **http://piskulka.net**

THE LESSER WHITE-FRONTED GREECE WEDDING!