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Population Estimates and Survey Methods for Migratory Goose Species in Northern Kazakhstan (2016)

by Richard Cuthbert (lead compiler) & Tomas Aarvak

NORWEGIAN ENVIRONMENT AGENCY

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Photo on cover: Mixed species of geese feeding within stubble fields in Akmola. © A. Szilágyi

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Executive Summary

Northern Kazakhstan and adjoining areas of Russia are of key importance for Arctic breeding geese due to their use as staging grounds for birds as they move south to their wintering sites. The critical role of these areas for geese has long been recognized for the globally threatened Lesser White-fronted Goose *Anser erythropus* (LWfG) and Red-breasted Goose *Branta ruficollis* (RbG), as part of the Fennoscandian and the whole Russian Western Main subpopulations of LWfG and the entire global population of RbGs are believed to stage in these areas. As a consequence, international surveys of migratory geese have been undertaken in Northern Kazakhstan since 1996.

In 2016 a team of Kazakh and international ornithologists visited Northern Kazakhstan for three weeks to undertake surveys across the region. Four survey teams departed from the city of Kostanay on 26th September to visit lakes in Akmola, Kostanay West, Kostanay North and North Kazakhstan count areas. The four teams surveyed a total of 80 lakes and recorded more than one million geese in the region. Geese were most abundant in the Akmola and Kostanay West count regions, with around 740,000 and 420,000 birds, respectively. Fewer geese were staging in North Kazakhstan and Kostanay North (~32,000 and ~18,000 birds), and observations of large numbers of migrating birds in these two areas suggest that most geese were moving straight to the Akmola and Kostanay West survey areas in 2016. As was apparent in previous years, the Taldykol/Kulikol lake system in the Kostanay West survey area was of high importance as a staging site, with mixed flocks of geese totalling 348,150 birds present on 6th October. These two lakes held key numbers of LWfG and RbG and numbers at these lakes contributed 73% and 47%, respectively, of all records for these species.

Greater White-fronted Geese *Anser albifrons* (GWfG) were the most abundant species, with a total of ~890,000 birds recorded on the survey. Observations on brood size and age ratios of GWfG indicated an average brood of 2.86 ± 1.57 juveniles per pair (± 1standard deviation) and with the population consisting of 72% adult birds and 28% juveniles. Observations of LWfG recorded an estimated 32,000 birds during the surveys, with a mean brood of 2.52 ± 1.43 juveniles per pair, and with the population consisting of 69% adults and 31% juvenile birds. Along with these observations the expedition also recorded ~250,000 Greylag Geese *Anser anser*, ~53,000 Ruddy Shelduck *Tadorna ferruginea* and ~37,000 RbG.

Utilizing data on the presence or absence of all geese species at surveyed lakes indicated that geese were more likely to be using larger and more vegetated lakes, and those that were more distant from villages. When this analysis was restricted to LWfG, this species showed a stronger tendency to prefer more vegetated and larger lakes. Spatial data on the extent of occurrence of croplands and the distribution of LWfG and RbG in 2016 and previous years, indicates that they were utilizing areas where croplands were 10-25% and 25-50% of the land area and avoiding regions with higher cropping densities (mainly in the north and eastern areas) and lower crop densities (steppe grassland in the south). The distribution of these two geese species (and other migratory geese) in these areas is assumed to broadly correspond with the mix of wheat crops, abandoned agricultural land and grassland areas where birds were observed feeding in 2016 and previous years. Based on the distribution of previous records of LWfG and RbG and their use of these cropland

areas, we mapped the core staging areas of both species in order to demarcate the areas where most birds are likely to occur.

Prior to the 2016 fieldwork we made an *a priori* classification of lakes in Kazakhstan for both LWfG and RbG in order to prioritise the lakes to survey and also to enable total population estimates to be produced that could extrapolate across the whole survey region, recognizing the fact that the teams could only visit a proportion of all lakes. Lake categories were based on records of the species in the region and utilized cut-off points of 1% and 10% of the estimated minimum population size of each species (LWfG = 8,000 birds; RbG = 56,000 birds) to define Category 1 lakes (>10% of the population), Category 2 lakes (1-10%), Category 3 lakes (<1%), and unknown Category 4 lakes where no previous knowledge was available. Surveys of all four lake categories were made for both species, although coverage was better for LWfG (50 lakes in categories 1-3) than RbG (17 category 1-3 lakes). After removing lakes that were smaller than the observed minimum lake size used by each species, we calculated the total number of potential lakes available within the core staging areas of each species (330 lakes of >320 hectares for LWfG; 361 lakes of >100 hectares for RbG). Boot-strapping procedures, with replacement, were then utilized to estimate the total populations likely to be present in the region. These calculations produced total estimates of 34,250 birds (95% confidence intervals 28,500 – 40,100 birds) for the Western population of LWfG, and an estimated population of 50,100 RbG (95% CI 28,100 – 72,600 birds).

Comparison of these figures with previous records suggests that the previous population estimate of 8,000 – 13,000 birds for the Western LWfG population is too low and that considerably more birds are present. Counts of more than 21,500 LWfG at 15 sites in 2014 also support this conclusion. Large-scale fluctuations in numbers of LWfG are apparent from previous surveys and it is difficult to distinguish whether these more recent figures represent an increase in the actual population of the species, or – and perhaps more likely – represent better coverage of sites and inter-annual variation in the distribution of birds across the landscape. Further knowledge on the population or ecological processes that influence the distribution of LWfG from year to year will increase our understanding for interpreting previous surveys. Similar comparisons for the RbG support the estimate of ~50,100 birds in 2016, with this figure broadly matching recent population estimates of 55-57,000 birds.

As well as surveying geese, the 2016 expedition was also used to assess the likely effectiveness of the surveys and to make recommendations on the methodology. This review is set out separately in an Annex to the main report and includes observations in relation to (a) estimating total bird numbers at lakes; (b) estimating species composition including direct counts versus sampling, random sampling procedures and the timing of observations; (c) standardizing count locations; and (d) the overall survey design.

Key points from this review include the following:

- The accuracy of flock counts depends critically on the use of experienced ornithologists and good communication between observers, and the precision of resulting flock size estimates appears to typically be around 10-11%.

- Direct counts and identification of all birds present are suitable for observing species composition of smaller flocks of geese (~<5,000 birds), but assessing species composition through sampling of geese is strongly recommended for all larger flocks.
- The precision of random sampling of flocks is improved through counting every fifth or tenth bird, rather than counting groups of 20-30 birds, and ideally around 20% of the total flock should be sampled to produce reliable estimates. Sampling is highly intensive and is best done in 10-15 minute blocks with breaks between sampling.
- There are species-specific differences in the timing of movements to and from lakes, which may cause highly variable and unreliable estimates of species composition. As a consequence, observations and sampling of species composition across longer time periods (4 – 5 hours) are likely to provide more reliable estimates of the overall and true species composition versus sampling in short (1-2 hours) time periods.
- Sampling of species composition in the afternoon when birds are returning to lakes to roost in conjunction with total counts at dusk on the same day or at dawn the following morning are less likely to be influenced by changing species composition due to the arrival or departure of geese during the day.
- Utilizing fixed observation points at lakes is recommended to reduce this potential source of sampling error, although teams will need to use their experience depending on the location of birds.
- The overall sampling design should prioritize field teams in the Akmola and Kostanay areas where large numbers of birds are often recorded, along with a team that surveys a wider region of Northern Kazakhstan to ensure that these areas are covered in years when birds may be more widely distributed across the region.

Acknowledgements

The expedition and the results presented in this report could not have been undertaken without the support of a large number of individuals and organizations who provided their assistance in the preparation and write up of the results. In particular we would like to thank Nina Mikander from the UNEP/AEWA Secretariat for her wholesale support and in arranging international logistics; Dr Sergey Sklyarenko, Alexey Timoshenko and Saltanat Sapanova at ACBK for support with visa applications and in-country travel plans and logistics; Dr Geoff Hilton and Dr Baz Hughes from WWT for guidance on the survey design and write up; and our three local drivers/mechanics/field team supporters, Petr Zaew, Sergey Pasechniy and Valeriy Odincev; whose help in the field made the surveys possible. Funding for the expedition was generously provided by the Norwegian Environment Agency, the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and WWT.

1. Introduction

Lakes and other wetlands within northern Kazakhstan and bordering areas of Russia are among the most extensive and important sites for Anatidae (ducks, geese and swans) and other waterbirds in Central Asia (Cresswell *et al.* 1999; Yerokhov 2006). These wetlands are significant for populations of resident species of Anatidae, including globally threatened and Near Threatened species such as the White-headed Duck *Oxyura leucocephala* and Ferruginous Duck *Aythya nyroca*, as well as being critically important for Arctic breeding migratory geese species that utilize north-western regions of Kazakhstan and bordering areas of Russia as staging areas on route to their more southerly wintering grounds. Millions of Arctic breeding geese pass through these areas each autumn, making use of the large numbers of lakes for roosting sites and feeding within the extensive wheat stubble fields and steppe habitats that are characteristic of this region (Kamp *et al.* 2015).

Among the Arctic geese that utilize these areas are the globally Endangered Lesser White-fronted Goose *Anser erythropus* (hereafter referred to as LWfG), the closely related Greater White-fronted Goose *Anser albifrons* (GWfG) which is classified as Least Concern by the IUCN, and the Vulnerable Red-breasted Goose *Branta ruficollis* (hereafter referred to as RbG). While these areas of Kazakhstan and Russia are important for all three species, they are of key significance for the LWfG and RbG as it is believed that the part (annual average of 50%, Aarvak & Øien in prep) of the Critically Endangered Fennoscandian population (~100-150 birds; Fox *et al.* 2010) and the entire Russian Western Main subpopulations of LWfG (~10,000 to 21,000 birds; Fox *et al.* 2010), as well as the entire global population of RbG (~56,000 birds; Wetlands International 2015) passes through this area in a narrow 3-5 week period each year (Jones *et al.* 2008; Cranswick *et al.* 2012).

Greater White-fronted Geese of the subspecies *A. a. albifrons* that breed in the Arctic tundra of Russia, from Kanin Peninsula to the Taimyr Peninsula, have traditionally been divided into several geographically distinct populations (Mooji 1996). Recent winter estimates of these populations following Nagy *et al.* (2014) and Koffijberg & van Winden (2015) are:

(i) **Baltic-North Sea** wintering population - 1,000,000 individuals in 2012
(ii) **Pannonic group**, wintering mainly in Hungary (+adjacent countries) - about 163,000 in 2013
(iii) **Pontic/Anatolian** wintering in Greece, Turkey and the Black Sea - at 240,000-250,000 during 2010-2013
(iv) **Caspian Sea/central Asia** wintering - estimates of 15,000 individuals remain based on counts from the mid-1970s

Of these, the majority of the birds from the Pannonic to the Caspian groups pass through Kazakhstan during spring and autumn migrations, along with a likely large portion of non-breeding birds (originating from the Baltic-North Sea population) moulting in high numbers at sites like the Pyasina Delta and Taimyr Peninsula. Unpublished, tracking data of satellite and GPS transmitters used on GWfG caught during winter in the Netherlands (Baltic-North Sea group) in 2015-2016 (available at www.blessgans.de), shows that 89% (25 of 28 tracked birds) of the individuals

travelled the short western route through the Baltic during autumn. Two individuals followed a more inland route, while only one individual came through the Northwestern parts of Kazakhstan. Similar data, from five birds caught while wintering in Hungary, revealed that all birds migrated through Kazakhstan in autumn (www.blessgans.de).

The presence of so many geese in a relatively small area in Kazakhstan presents several threats for the species – such as disturbance, habitat loss and especially hunting – as well as opportunities, including the potential to determine the population size, monitor population trends and evaluate breeding success.

Surveys of migratory geese have previously been undertaken in these regions and include expeditions by visiting teams of international experts during both spring and autumn (e.g. Aarvak *et al.* 2004, Gurtovaya *et al.* 1999, Tolvanen & Pynnönen 1997, Markkola *et al.*1997, Tolvanen *et al.* 1999a, 2000, 2001), as well as more recent counts and assessment undertaken by staff from the Association for the Conservation of Biodiversity of Kazakhstan (ACBK) and other Kazakh and Russian ornithologists (Rozenfeld *et al.* 2009 2010, 2012, Rozenfeld & Timoshenko 2009, Yerokhov *et al.* 2000, 2004). While these surveys have provided a great deal of information (including estimates of migrating numbers, knowledge of key lakes and an assessment of threats: Yerokov 2013) they have also produced further uncertainty due to the highly variable results that have been observed, with there being high levels of inter-annual variability both within and among sites. These highly variable results may be a consequence of process variation – reflecting genuine changes in the abundance and distribution of geese at lakes from year to year – or be caused by sampling variation and error and the inherent difficulty in obtaining accurate counts of migratory geese that are departing from lakes at dawn in flocks of tens to hundreds of thousand birds and subsequently moving between lakes and feeding grounds throughout the day. The latter issue is of particular significance for monitoring LWfG due to its very similar appearance with the closely related GWfG (Øien *et al.* 1999) and its occurrence within large mixed species flocks where it typically comprises a small proportion of the total number of birds[1]. Due to the problematic identification of these two species, three specialized identification training workshops were arranged through an EU LIFE+ Nature project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway" (2011-2016). In these workshops, 36 participants from 14 countries (Estonia, Lithuania, Poland, Hungary, Romania, Bulgaria, Greece, Turkey, Russia, Ukraine, Kazakhstan, Azerbaijan, Iran and Iraq) brought with them experience and pictures (of varying quality) of these two species, to help train participants in identification, of which special emphasis was given to flight identification.

These highly challenging situations in the field are the setting for interpreting previous counts and estimates from northern Kazakhstan and Russia, and also for determining if further counts of migratory geese in this region are the best approach for assessing overall population sizes and evaluating trends.

[1] Autumn counts (n=12 years) carried out in Kazakhstan since 1996 indicated that LWfG on average comprised 3% of the birds among mixed species flocks.

In 2016, and with support from the UNEP/AEWA Secretariat, a team of Kazakh and international goose experts visited Kazakhstan from 24 September to 16 October in order to undertake counts in northern regions of the country and at adjoining areas of Russia. The purpose of the expedition was twofold:

1. To undertake surveys of migrating geese at key lakes and sites in the region in order to produce estimates of geese numbers;

2. To evaluate the methods used for undertaking counts and make recommendations for the monitoring and interpretation of results.

This report is organized in two sections that follow the above two objectives, with the first and main section covering the fieldwork methods, analyses and presentation of the main results from the 2016 autumn expedition including total population estimates for LWfG and the RbG. Evaluation of the methods used in the surveys, including discussions and examples of key issues, are presented separately as an annex to the report. Recommendations from this annex are included within the executive summary.

Image 1 ACBK ornithologists and drivers and international ornithologists in Kostanay at the start of the 2016 expedition. Photo: A. Szilágyi.

2. Methods

2.1 *Study area*

Due to the migratory behaviour of LWfG and RbG, these species have been recorded at a large number of locations and across a broad area of northern Kazakhstan and Russia as birds migrate southwards en route to their wintering grounds. Many of these sites are likely to be short stopovers as opposed to the longer 3-4 week staging areas in northern Kazakhstan and neighbouring regions of Russia. In order to define the staging sites and overall study area, a database compiled by BirdLife Norway comprising 93 lakes with coordinates and results from previous surveys of LWfG, was utilized. These sites include both autumn and spring counts. The long list of sites was used to select the outermost coordinates in order to define the overall study area. These outer coordinates were 48.83° to 55.78° N and 59.60° to 74.15° E, encompassing an area of 923,350 km^2. While it is possible that some migrating geese will occur outside this range, it is likely that the majority of the staging population would occur within this area. The boundary of this study area in relation to national and provincial boundaries is indicated below.

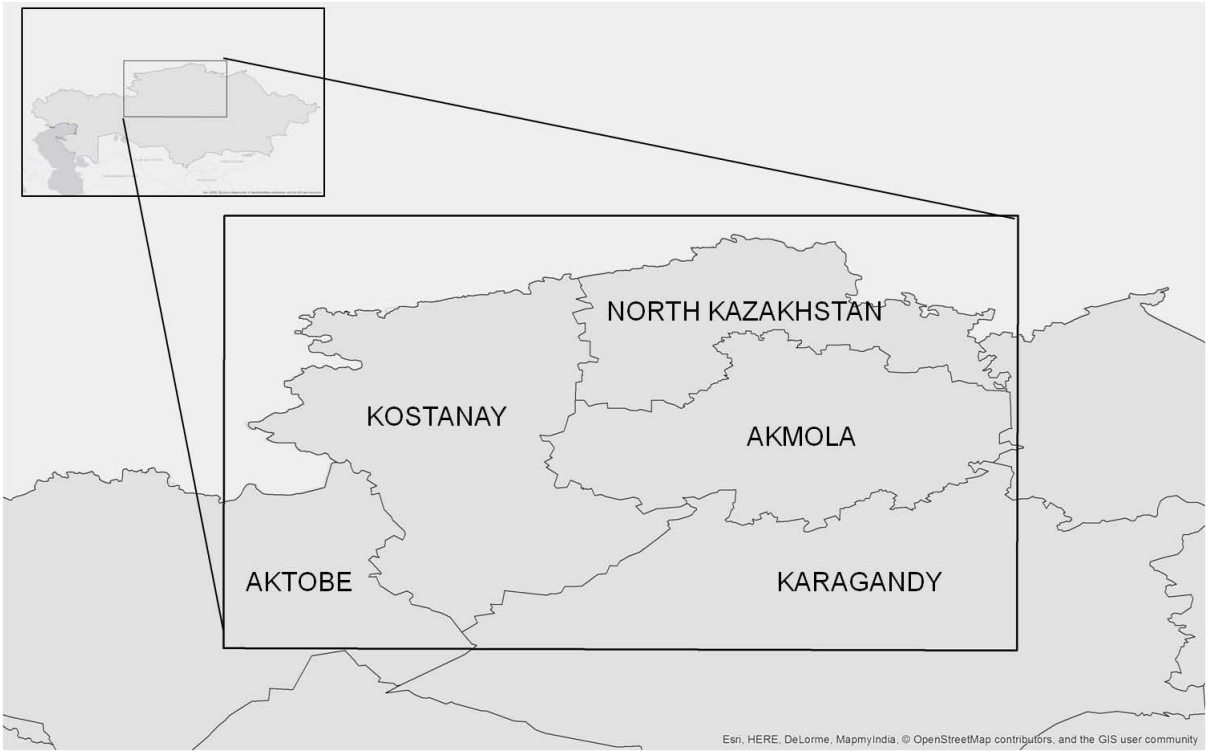


Figure 1 Map of the defined study area in northern Kazakhstan and southern Russia.

2.1 *Categorizing sites*

The database of lakes was used as the starting point for providing a list of potential survey sites. We also undertook searches of Important Bird Areas (IBAs) on the BirdLife website for Kazakhstan and Russia, including Central Asian and European regions of Russia as defined on the BirdLife website, using the following search terms:

- "*Anser erythropus*"
- "*Anser albifrons*"
- "*Branta ruficollis*"
- "*Anser*" species
- "A4iii" sites known or thought to hold, on a regular basis, > 20,000 waterbirds

Because LWfG and RbG occur in mixed species flocks the widening of search terms was used in order to select sites where they potentially could be present, even if they had not actually been recorded from these sites previously. These search terms for Kazakhstan and Russia were then filtered to only include locations within the study area as defined above, giving a list of 116 sites from the BirdLife database. This list of sites was then combined with the previous information (database, AEWA and Yerokhov 2013), and following the exclusion of duplications provided a final combined list of 121 sites.

In order to prioritize lakes, each IBA site (where applicable) was searched on the BirdLife website to capture information on counts of LWfG, GWfG and RbG, along with count information provided in the database from previous surveys. These data were used to provide a maximum count figure (where available) for each species and each site. The estimated population size in the current International Action of the combined Fennoscandian and Western Main populations of LWfG is 8,000 to 13,000 individuals (Jones *et al.* 2008). To be conservative, we utilized the lower estimate in order to categorize lakes which have had previous counts of >10% of the population (i.e. >800 birds), those with counts of between 1% and 10% of the population (80 – 800 birds), and those with counts of less than 1% of the population (<80 birds).

All lakes were then screened to exclude sites occurring outside the defined study area (**Figure 1**), leaving a total of 85 lakes, and were then categorized into the following three classes:

Category 1 Sites with maximum counts of >800 LWfG previously recorded present.

Category 2 Sites with previous counts of LWfG between 80-800 birds, where LWfG are predicted to hold >80 birds (based on 1% GWfG numbers), where LWfG have previously been recorded as "abundant" or "common" but without figures, and sites identified as "important" in Yerokhov (2013) not covered within the previous criteria.

Category 3 Sites with maximum counts of LWfG of <80 birds, or where LWfG were reported as "occasional", "rare" or "not recorded", or sites that have not previously been counted but which are known to hold other *Anser* species or large numbers of waterfowl.

As well as category 1-3 lakes, the study area contains more than 8,500 lakes and water bodies: based on satellite images and GIS layers for the region[2]. This large number of lakes were filtered by size to only include lakes of >100 hectares in extent (i.e. 1 x 1 kilometre square) which reduces the total number of water bodies to 2,634 sites. The potential for these lakes to hold LWfG, RbG

[2] Sources of information for the GIS layers used in this report are listed in Appendix 4

or other species is unknown and obtaining a better understanding of such sites is critical for determining the reliability of any population estimates and for guiding the design of future surveys. As a consequence, these sites are defined as below:

Category 4 Lakes and other water bodies with no information on bird numbers or suitability as a staging site, but which are within the study area and potential sites.

The same rationale as above was followed for RbG based on an estimated population size for the species of 56,000 birds (Wetlands International 2016) and again categorizing lakes by a 10% and 1% threshold of RbG numbers (5,600 and 560 respectively) and ordering lakes into Category 1 (>10% RbG), Category 2 (1-10% RbG), Category 3 (<1% RbG present) and Category 4 (unknown) lakes.

2.2 Sampling plan

Due to the distances involved in northern Kazakhstan, it was deemed necessary to have four teams covering four different regions, in order to allow for simultaneous counts to reduce the chance of double counting of birds moving between regions. Four field teams were available for the survey consisting of expert biologists from ACBK and nine international experts, many of whom had participated in previous surveys in Kazakhstan. Survey areas for each field team were determined on the basis of the time available in the field (two international experts could only remain in the country for two weeks), visas to enter Russia and nationality.

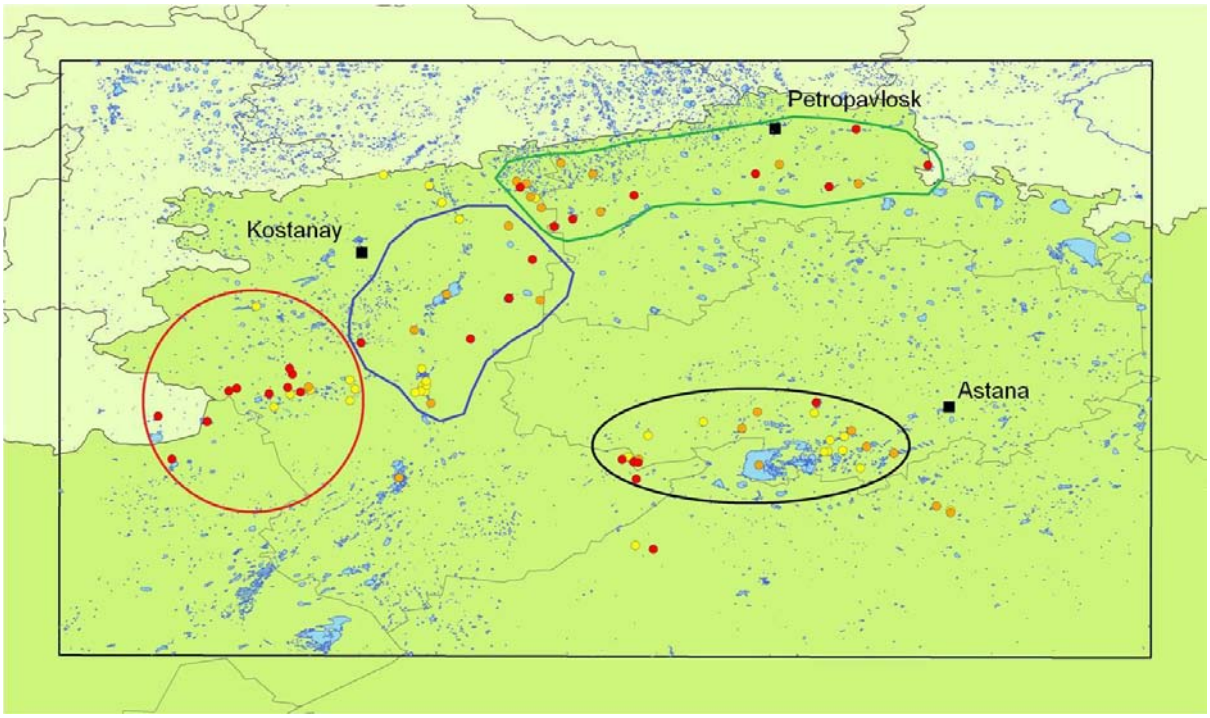


Figure 2 Map of the four survey areas and planned sites indicating the West Kostanay (red line), North Kostanay (blue), North Kazakhstan (green) and Akmola (black) survey areas and Category 1 (red filled circles), Category 2 (orange) and Category 3 (yellow) sites.

Each team had a minimum of one expert biologist from ACBK as well as a local driver. The areas covered were defined as West Kostanay, North Kostanay, North Kazakhstan and Akmola (**Figure 2**). Within these areas, a shortlist of lakes was produced for each team to sample, covering Category 1, 2 and 3 lakes. Sites that were very isolated or distant from the main areas were excluded, as well as sites in border regions with Russia, where surveys were not permitted. Unknown lakes (Category 4) were not specified as these were visited opportunistically during travel time between sites. A full list of lakes in all four survey areas, including the latitude and longitude of count locations, is presented in **Appendix 1** of the report.

2.3 Timing of surveys and reducing the likelihood of duplicate counts

The exact survey route and sequence of lakes to be visited was determined by each survey team and the practical constraints of the location of lakes in relation to the finishing point of each team: both the West and North Kostanay teams started and finished at Kostanay, whereas the North Kazakhstan and Akmola teams started at Kostanay but finished at Petropavlosk and Astana, respectively. Consequently, survey routes were planned to follow a logical sequence to limit driving distances and end up at the required final destinations.

Discussions in Kostanay at the start of the trip raised the issue of duplicate counts of the same birds – following large-scale movements between sites – and how the risk of this could be minimized amongst teams during the survey. In order to reduce the potential likelihood of any such duplication, local and international experts came up with a further short-list of the most important site (or sites) within each survey area. These sites and associated survey areas were:

- Kulykol 51.37523°N, 61.861555°E West Kostanay
- Taldykol 51.40982°N, 61.96793°E, West Kostanay
- Koybagar 52.61462°N, 65.59671°E North Kostanay
- Balikty 54.27314°N, 68.88539°E North Kazakhstan
- Kazkhsky Zharkol 50.42721°N, 67.26260°E Akmola
- Taldykol 50.46368°N, 67.10831°E Akmola.

These priority sites were counted as close together in time as possible to reduce the risk of duplicate counts taking place and were all counted within a seven-day period from 28 September to 4 October. Additional information was also supplied to the field teams during the survey on the migratory movements of four satellite-tagged LWfG coming from the Polar Ural Mountains and via the Ob-valley to Kazakhstan.

In addition, because of the previously identified importance of Kulykol, Taldykol and Koybagar as staging areas, these sites were subject to repeat visits, in order to increase the likelihood that peak number of birds would be observed and to provide more robust estimates on the prevalence of each species.

2.4 Field survey methods

Geese were surveyed following the guidelines set out in the "*Field monitoring instructions for Lesser White-fronted Goose*" (Tolvanen *et al.* 1999b), and a modified version of these guidelines are presented in **Appendix 6**. These guidelines have been used for surveys in Kazakhstan in previous years and, as far as possible, were followed during the course of the current survey. In brief, the survey methodology involved obtaining total counts of geese through observations of the number of birds departing from lakes in the early morning as geese moved from their roosting sites to feed on fields in neighbouring stubble fields. Due to the very large number of birds departing from some lakes and the poor light conditions at this time, it was generally not possible to identify species during the dawn counts and the emphasis was on obtaining an accurate total count for the overall number of birds present. Counts of departing birds followed standard procedures of counting subsets of birds leaving, such as up to a hundred birds, and then counting the rest of the flock in these count units. This process was repeated during the morning counts, in order to calibrate and recalibrate the counts. The species composition was later confirmed through identifying birds in flocks returning to the lakes after feeding to drink and rest during the middle of the day. Ruddy Shelduck *Tadorna ferruginea* were also included in the surveys of "geese" numbers at sites, as this species was frequently found within mixed species flocks and could not be separated during dawn counts.

Where possible and where geese numbers were not too high, it was recommended to identify all geese in returning flocks and this occurred for the majority of lakes in the current survey. However, where very large numbers of birds (i.e. tens of thousands) were returning, species composition was identified from sampling. In contrast to previous years, where sampling was undertaken through identifying all birds in samples of 20-30 birds in strict succession, the survey methodology for random sampling was altered so that observers identified every fifth bird across the whole flock. This approach was recommended because of the tendency among geese species to be more likely to group in flocks of their own kind and in tight family groups especially, which as a consequence invalidates the assumption of random sampling (each bird being independent of another) and leads to less precise estimates. Modelling of this grouping effect and sampling through either counting every fifth bird or counting flocks of 30, demonstrates that the former method is accurate and more precise than the latter (see **Annex 1** for details on this). The survey guidelines (**Appendix 6**) have included this modified methodology highlighted in red font.

As well as the above methods, observers also utilized photography to supplement the species identification and provide an additional way of sampling large flocks of birds. While photos were taken across all four survey regions, the use of this technique was primarily undertaken by the Akmola survey team at four lakes with very large numbers of birds (50,000 – 200,000 geese). In these instances, photos of flocks of geese were examined after the event in order to provide more accurate estimates of species composition.

In addition to counts of geese, observers also recorded numbers of adult and juvenile birds present. This was primarily done for LWfG and GWfG and was observed through recording the age structure of birds within flocks (based on the black patches on the belly of adult birds versus the plain grey belly of juveniles) and recording the numbers of adults and juveniles (juveniles also stand

out with black nail tips and ill-defined white sideline; Øien et al. 1999). Observers also recorded brood sizes of these two species, based on observations of family groups where an adult pair (or single adult) was accompanied by juvenile birds. Observations of migrating geese and other species, particularly Common Cranes *Grus grus*, were also made during the surveys, recording total numbers flying overhead and the direction of flight. These counts were only made during the course of lake surveys and while stopped at camp sites or on the road, and large numbers of birds were not recorded when the teams were driving or at night (when very large numbers of migrating birds were heard). As a consequence, such records are an index of the peaks of migration and main directions of movement, and are not a comprehensive record of the total number of birds that were migrating.

While the focus of the expedition was on geese species, observations were also made of other birds found within the survey areas. These observations were not undertaken in a formal or strictly quantitative way, but nonetheless include a large number of counts of a wide range of species, including some of conservation concern within the region. A full list of observations is not presented in this report; instead we report records and numbers of wetland associated birds that were collected for the following families: Anatidae (ducks, geese, swans); Gaviidae (divers/loons); Phalacrocoracidae (cormorants); Ardeidae (herons); Pelecanidae (pelicans); Podicipidae (grebes); Phoenicopteridae (flamingos); Accipitridae (hawks, eagles); Pandionidae (Osprey); Falconidae (falcons); Rallidae (rails, gallinules, coots); Gruidae (cranes); Otitidae (bustards); Recurvirostridae (avocets, stilts); Charadriidae (plovers); Scolopacidae (sandpipers, snipes, phalaropes); and Laridae (gulls, terns). These records are reported in **Appendix 3**.

Image 2 Fieldwork and geese observations in North Kazakhstan. Photo: R.J. Cuthbert

2.5 Analysis of count data

The majority of lakes were surveyed through direct observations, where all birds were identified and counted. Such lakes were typically surveyed on two occasions, with observations of returning birds made in the late afternoon/evening of the day that teams arrived at the site, followed up with observations of birds departing and returning to the lake the next morning. In these situations, the highest available count from the two periods was utilized as the total.

Sampling of birds was undertaken at Kubikol, Tengiz, Kumdykol and Shandykol lakes in the Akmola region, and at Taldykol and Kulikol lakes in West Kostanay, and the estimation of total numbers was calculated differently for these two regions. In addition, counts of birds at Zhetykol Lake in Russia were also calculated differently to other sites. Details on this are set out below, as well as the methods for calculating the likely species composition from unidentified species groups.

(a) Taldykol and Kulikol lakes

Taldykol and Kulikol lakes in West Kostanay have previously been identified as being of high importance for migratory geese. Because of their importance, these two sites were subject to multiple surveys, and counts were made on 17 occasions on 12 separate days from 26 September to 11 October 2016. Count "occasions" were surveys undertaken at either the lake or within different regions of a lake, or separate counts at the same site undertaken in the morning or afternoon when different flocks of birds were returning and/or departing. Geese were regularly seen moving between these two neighbouring lakes and due to their close proximity (the two lakes are 2.5 km apart at their closest points) a single count of 348,150 mixed geese (*Anser/Branta/Tadorna* species) observed at the lakes between 19:00-19:45 on 6 October 2016 was used as the maximum population at both sites. The observed proportions of different species varied greatly across the 17 count occasions and after careful consideration, we decided to estimate the number of each species based upon counts undertaken between 15:15-19:00 on the same day as the maximum count of 348,150 birds. This decision and the variability of species composition are explored in more detail in **Appendix 5**.

Species identification on 6 October was based on observations of a total of around 4,950 birds that were observed in flight moving from Lake Taldykol to stubble fields to the west/north-west of the lake. These observations included direct counts of 1,552 birds where species were identified, as well as four separate periods of sampling where, due to the large numbers of birds in flight, birds were systematically sampled through identifying every fifth bird among flying flocks. Sampling in this manner was undertaken in four ~10-minute time periods (undertaken between 16:00 and 17:10) with totals of 205, 204, 106 and 161 identified birds (total identified = 676) taken from a total of around 3,380 birds that were flying over (676 * 5 = 3,880).

To estimate the overall species composition from these samples and direct counts, we took the weighted average of these five sets of observations (the four periods of sampling and the direct counts of all birds). Calculating a weighted average from binomial sample data is commonly undertaken in meta-analyses, where the overall proportion and confidence limits from a number of proportions are frequently sought. A weighted proportion calculated in this manner was chosen

in preference to taking an average of all observed proportions (which treats all proportions as of the same value and does not consider the sample size involved) or an overall pooled mean (which disproportionally biases the results to counts with larger sample sizes). A weighted average for the proportions of each species was estimated after first calculating a Cohran's Q test and I^2 statistic in order to evaluate heterogeneity among counts. Weighted means from proportions with a large degree of heterogeneity (as was the case for geese numbers at Taldykol and Kulikol) were calculated based on a random effects model. These statistics and the weighted mean and 95% confidence limits were calculated following the methods of Neyeloff *et al.* (2012). A continuity correction of 0.5 (Cox 1970) was used for all instances where there was a zero count of a species at a lake in order to be able to calculate Q and I^2.

The total population (and upper and lower confidence limits) for each species was then calculated based on the following expression – with the assumption that species composition among identified birds reflected the overall composition of the total flock of 348,150 mixed geese – where the $Total\ N_{\text{mixed geese}}$ was the flock of 348,150 birds seen on the 6 October:

$$Total\ N_{\text{species A}} = Total\ N_{\text{mixed geese}} * \text{weighted average}_{\text{species A}}$$

(b) Zhetykol Lake

Due to difficulties in survey personnel crossing the Kazakhstan/Russian border, counts at Zhetykol Lake, which lies on the Russian side, it could only be undertaken by a single observer, and the relatively high numbers of birds present meant that counts of species composition were approximate[3]. As a consequence, we used the maximum observed count of 73,500 mixed geese seen on 9 October 2016 and calculated the weighted proportion of species composition (as above) from observations on the 8, 9, 10 and 11 October. We consider the weighted average and 95% confidence intervals of these four counts more likely to encompass the true population of each species present at the lake than using any single count.

(c) Kubikol, Tengiz, Kumdykol and Shandykol lakes

At Kubikol, Tengiz, Kumdykol and Shandykol lakes in the Akmola region, a total count of all geese present was first obtained by the team, which was an estimate of all "mixed geese" (*Anser/Branta/Tadorna* species) with no attempt at species identification. Further observations were then made counting and identifying birds to individual species. As many birds as possible were identified, and at the end of the survey (after birds had departed or light conditions became poor) the number of remaining "Un-Identified Species" was calculated as:

$$N_{\text{Un-Identified species}} = N_{\text{Total Mixed Geese}} - [N_{\text{species A}} + N_{\text{species B}} + \dots]$$

The species composition of the remaining Un-Identified Species was calculated based on photographs of flocks of birds at the count site. Photos were carefully examined by observers in the field team to identify and count individual species and to record the total number of birds

[3] Despite having Russian visas, the two Finnish ornithologists in this team were unable to cross into Russia as this border post was only open to Kazakh and Russian citizens.

examined in order to estimate the proportion of each species present. Because species identification from photographs was a sample of the total number, we calculated 95% binomial confidence intervals on the totals obtained with these estimates, in order to provide appropriate limits to the calculated numbers. Binomial confidence intervals were calculated using the inverse Fisher F probability function within Excel[4].

The total estimate for each species at the site was then based on the sum of the number identified through direct counts and the estimated number within the Un-Identified Species group, as follows:

$$Total\ N_{\text{species A}} = N_{\text{direct count species A}} + [N_{\text{Un-ID species}} * \text{proportion}_{\text{species A}}]$$

(d) Species totals from un-identified species groups

Direct observations or classification from sampling meant that most observations (93%) could be determined to the level of individual species; however there remained 91,455 where geese could only be identified to wider taxonomic groups. These groups included GWfG/LWfG where it was certain the birds were "White-fronted Geese" but where identification of these very similar species could not be definite; *Anser* species where it was clear that the birds were "grey geese" but where identification to GWfG/LWfG or Greylag Geese was not possible; *Anser/Branta* species where counts included unidentified grey geese and RbGs; and *Anser/Branta/Tadorna* species where mixed flocks of geese may have included grey geese, RbGs, and Ruddy Shelduck species. Such records were recorded from all four survey areas, although large numbers of migrating birds in the North Kostanay and North Kazakhstan regions resulted in a high number of observations of GWfG/LWfG in these two areas (8,085 and 11,156 birds, respectively), and restricted access at one site in Akmola (Lake Kozhakol) meant that 45,000 geese at this lake could only be identified as "*Anser* species".

Results of this kind are presented in their raw form for each species group within each of the four count regions (see **Appendix 2** for these tables). Estimates of the likely overall species composition and total numbers were undertaken for all areas combined, and were calculated through taking the weighted mean proportion of identified species across all sites where geese were recorded. As previously, a weighted average for the proportions of each species was estimated after first calculating a Cohran's Q test and I^2 statistic in order to evaluate heterogeneity among sites (Neyeloff *et al.* 2012) and weighted means from proportions with a large degree of heterogeneity (as was the case for all species) were calculated based on a random effects model. A continuity correction of 0.5) was again used for instances where there was a zero count of a species at a lake in order to be able to correctly calculate Q and I^2.

[4] Online tools and an Excel macro for calculating exact binomial confidence limits are available at http://statpages.info/confint.html

These calculations were undertaken separately for each species within the species grouping as set out below for estimating the likely total numbers of LWfG including numbers of this species within mixed flocks of GWfG/LWfG:

$$Total\ N_{LWfG} = N_{direct\ counts\ LWfG} + [N_{GWfG\ /\ LWfG} * Weighted\text{-}Mean_{LWfG}]$$

The estimated number of each species were summed across all species group where it occurred; for example, LWfG are predicted to be present (in decreasing proportions) within mixed flocks of "GWfG/LWfG", "*Anser*", "A*nser/Branta*" and "*Anser/Branta/Tadorna*" and the sum of these estimates was added to the number of LWfG observed through direct counts of this species. Similarly, RbG will only be expected to be present within the "A*nser/Branta*" and "*Anser/Branta/Tadorna*" species groupings.

2.6 Relationships among species and predictors of geese occurrence

Exploratory data analyses were undertaken to examine relationships between the abundance of different goose species and investigate potential explanatory variables for predicting the presence or absence of geese at a lake. Explanatory variables used in the analysis were lake area, percentage of open water and distance to the nearest village. These variables were measured in Google Earth Pro using the Polygon and Line measuring tools and measuring the outer area of each lake and linear distance to the nearest village. Areas of open water at lakes (based on the most up-to-date imagery within Google Earth Pro) were similarly measured in order to estimate the percentage of open water (versus reeds and other vegetation) at lakes. Lake size and the extent of open water are likely to vary from year to year due to varying water levels and these variables should be treated with some caution, although they are likely to broadly reflect typical lake extent and vegetation.

Prior to the analyses, visual inspection of all data was undertaken to check for assumptions of normality and outliers. To improve normality, lake area (in hectares) and distance to nearest village (kilometre) were log10 transformed, and the estimated percentage of open water were arcsine transformed. Inspection of count data indicated that the data were not normally distributed and that there was a high degree of over-dispersion and many more zero counts of geese than expected under a normal or Poisson distribution. Taking a natural logarithm[5] improved the fit of the data, although the data remained over-dispersed. As a consequence, analyses of count data were restricted to examining correlations between species and this was undertaken using all counts (i.e. including lakes with a zero count of a species) as well as restricting this to sites where only positive counts were made.

To investigate potential predictors of the presence of geese at lakes we constructed Generalized Linear Models (GLMs) with presence or absence of geese as a binary dependent variable and transformed data on lake area, percentage of open water and distance to the nearest village as factors (after first checking for collinearity among these factors through pairwise scatter-plots; which indicated no relationships). We developed eight potential candidate models which were: Lake Area, Village Distance, Open Water %, Lake Area + Village Distance, Lake Area + Open

[5] To avoid the mathematical issue of logs of zero numbers, count data (N) were transformed as $N' = LN(N + 1)$

Water %, Lake Area + Village Distance + Open Water %, and one null model with no explanatory variables to represent a baseline candidate model. We assessed the best-fitting model from the set of candidate models in an information-theoretic model-testing framework (Burnham & Anderson 2002) in program R v3.1.2 (R Core Team 2013), with the best model determined by the lowest Akaike's Information Criteria (AICc). When there was no clear top model (AICc <0.7) we explored the top models, depending on the degree of support from the weighted AICc values. This analysis was undertaken for the presence/absence of all geese species at a lake (76 observations, with geese present at 49 lakes and absent at 27), as well as separately for the presence/absence of LWfG alone (76 observations, LWfG present at 20 and absent from 56). The presence/absence of geese at a site was determined solely from observations of staging birds at lakes, and records of migrating birds were excluded from the analysis.

2.7 Estimating the total population of Lesser White-fronted Geese and Red-breasted Geese

The lakes monitored during the current survey are a sample of all available potential lakes within the study area, and geese will be occurring at sites that were not surveyed. These sites will include some Category 1-3 lakes (as defined above) where the constraints of time and distance precluded visits, as well as an unknown number of Category 4 lakes where we have no prior knowledge of their potential for supporting staging LWfG or RbG and where it was only possible to visit a sample of such lakes.

To produce a total population estimate for these two species in the region we assumed that:

- All birds passed through the survey area
- All birds were present during the survey period
- Sampling of lakes in Categories 1-4 are representative of all lakes in these categories.

A total population estimate was derived from the sum of the average number (μ) of geese recorded within a lake category multiplied by the number of sites in each of the four categories. Thus for LWfG this would be:

$$Total\ Population_{LWfG} = (\mu_{LWfG\ Cat\ 1} * N_{Cat\ 1}) + (\mu_{LWfG\ Cat\ 2} * N_{Cat\ 2}) + \ldots$$

Because counts of LWfG and RbG were not normally distributed and highly over-dispersed we utilized boot-strapping procedures (that make no assumption around the underlying distribution of data) with samples taken with replacement from all observed counts (including zero counts) within each lake category in order to extrapolate numbers to include unvisited sites. Due to the fact there was relatively low coverage of some site categories (see **Table 1**) and LWfG and RbG also only occurred at a sub-set of sites, we combined categories 2 and 3 sites for the LWfG and categories 1, 2 and 3 sites for RbG. In addition, the very high numbers of both species at Taldykol and Kulikol lakes in West Kostanay and at Zhetykol Lake in adjoining areas of Russia (see **3. Results**) meant that including these sites within the Category 1 classification would unduly bias all lakes in this category and would produce an unrealistically wide range of results. In the boot-strapping procedure we instead randomly selected values between the calculated 95% confidence limits for Taldykol and Kulikol (combined estimate) and Zhetykol, and undertook this for both

LWfG and RbG. These three sites were removed from the Category 1 list of sites in the boot-strapping procedure when calculating numbers at Category 1 lakes (for LWfG) and at Category 1-3 lakes (RbG).

A final population estimate and confidence intervals calculated in this manner also depends upon the number of unknown Category 4 lakes, and GIS information for the study area suggests that there could be a total of around 8,500 lakes and other water bodies in the region. In order to reduce this number of potential lakes we excluded lakes based on (a) the plausible minimum lake size where LWfG or RbG were observed to occur in 2016 (around 320 and 100 hectares, respectively) and (b) the observed distribution of the species in 2016 and previous years. The distribution of LWfG and RbG was further examined through looking at GIS data on cropland extent in order to look for broader patterns on the distribution of geese in the region[6]. Based on the mapped distribution of each species and distribution within cropland areas, we then mapped out core staging areas for each species (undertaken in Arc Map 10.2 software) and applied a buffer of 20 km to the resulting polygons, based on the reported foraging range of GWfG (Kear 2005), in order to ensure that the resulting areas captured lakes and wetland areas that were likely to be within the range of geese. The resulting buffered polygons were then used to determine the total number of lakes of >320 hectare and >100 hectares within the core area of each species in order to provide an estimate of the number of available Category 4 lakes (the total lakes minus the number Category 1-3 lakes).

A total of 10,000 boot-straps samples were derived in this manner in order to calculate a mean population estimate and 95% confidence intervals were calculated by selecting the lower 2.5% and upper 97.5% quantiles from the set of 10,000 estimates.

[6] See Appendix 6 for information on these data sources

Image 3 Large numbers of geese over Kubikol Lake in the Akmola region. Photo: A. Szilágyi

Image 4 Mixed species of geese feeding within stubble fields in Akmola. Photo: A. Szilágyi

3. Results

3.1 Lakes covered and numbers

A total of 80 lakes were surveyed during the expedition, which together recorded a total of more than 1.2 million geese, as well as many other waterbirds. Surveyed lakes were spread across all four count regions (**Figure 3**) and included sites previously identified as important for both LWfG and RbG (Categories 1, 2 and 3, as detailed in the methods), and an additional number of "unknown" (Category 4) sites where no previous information was available (**Table 1**).

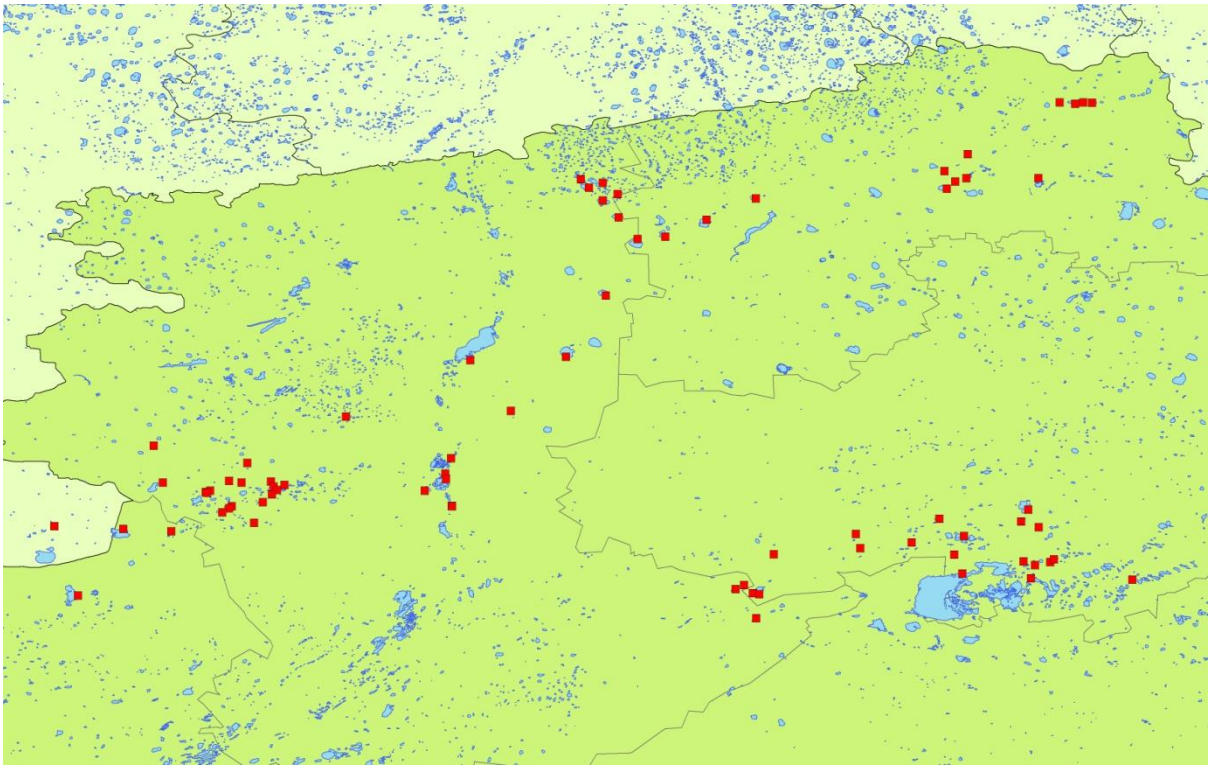


Figure 3 Location of all lakes and water bodies surveyed during the 2016 expedition in northern regions of Kazakhstan and at Zhetykol and Balakol lakes (one point on the map) in Russia.

Geese in highly varying numbers (1 to 348,150 birds) were present at 66 of these sites, with the remaining sites containing no birds. Sites where no birds were recorded included dry lakes, as well as apparently suitable lakes holding water where no geese were present. Totals for each species and the four count areas are presented in **Table 2**, as well as total estimates across the whole region. GWfG was the most common species, with over three quarters of a million birds, predominantly within the Akmola count region. Numbers of the two most threatened geese species, LWfG and RbG, counted on the expedition were 32,000 and 37,100 individuals respectively, although there are relatively wide confidence limits around these figures (**Table 2**). More information on these counts and the reliability of the results is presented in the following species accounts.

Table 1 Number of lakes identified prior to, and surveyed during the 2016 expedition, within Categories 1-4 for the Lesser White-fronted Goose and Red-breasted Goose.

	Identified *a priori*	Surveyed in 2016	% Coverage
Lesser White-fronted Geese			
Category 1	28	26	0.93
Category 2	26	15	0.58
Category 3	31	9	0.29
Category 4	unknown	30	-
Total	85*	80	
Red-breasted Geese			
Category 1	10	4	0.40
Category 2	11	10	0.91
Category 3	6	3	0.50
Category 4	unknown	63	-
Total	27*	80	

* Total for Category 1-3 sites only

Table 2 Total numbers of geese and Ruddy Shelduck counted across the four survey regions and combined. Numbers in square brackets are 95% confidence intervals, with lower and upper limits being rounded down and up to the nearest 100 birds (with the exception of the Bean Goose that were to the nearest 10), based upon sampling in Akmola and Kostanay West survey areas and the estimated number of each species within unidentified species groups.

Species/Group	Akmola	Kostanay West	Kostanay North	North Kazakhstan	All Areas **
GWfG	586,907 [585,200 - 588,400]	241,599 [150,500 - 332,600]	229	2,533	891,300 [789,900 - 992,600]
LWfG	1,673 [1,200 - 2,400]	29,299 [23,300 - 35,200]	12	10	32,000 [25,400 - 38,700]
Greylag	104,466 [103,100 - 106,000]	100,163 [31,800 - 168,600]	1,576	12,331	248,800 [177,700 - 320,000]
RBG	466	32,994 [10,900 - 55,100]	3,269	194	37,100 [15,000 - 59,100]
Ruddy Shelduck	14,950	38,260 [24,000 - 52,500]	0	2	53,200 [39,000 - 67,500]
Bean Goose	0	52 [50 - 55]	0	4	55 [50 - 60]
GWfG/LWfG	0	1,699	8,095	11,156	
Anser spp.	46,200	8,946	0	5,580	
Anser/Branta	0	3,320	4,519	200	
Ans/Bra/Tad	0	1,740	0	0	
All Species *	754,662	458,072	17,700	32,010	1,262,455
Geese Species	739,712	419,812	17,700	32,008	1,209,255
Staging Geese	739,712	415,965	13,175	16,121	
Migrating Geese	0	3,847	4,525	15,887	

* All species include Ruddy Shelduck

** Totals for all four areas are reported to the nearest 100 birds, apart from for the Bean Goose

3.2 Lesser White-fronted Geese

We counted an estimated total of 32,000 LWfG (95% CI = 25,400 – 38,700 birds) during the surveys. The majority (~95%) were observed within the Kostanay West survey region (**Table 2**), due to the very high numbers found at Taldykol and Kulikol lakes. Moderate numbers of birds were also recorded within the Akmola region, with ~1,700 birds in this area (**Table 2**). Very few birds were seen in Kostanay North and North Kazakhstan (**Figure 4**) although it is likely that migrating flocks of LWfG/GWfG in these areas (where we recorded minimum totals of 8,000-12,000 birds) contained further LWfG. The accuracy and reliability of these totals depends critically on the results from Taldykol and Kulikol Lakes, where estimated numbers were derived from a maximum mixed species flock of 348,150 birds seen on the evening of 6 October 2016 and where we estimate there were 23,205 LWfG (95% CI = 18,750 – 27,650) on this date. The reliability of the results from these two sites and the overall total estimate is explored in more detail in **Appendix 5**.

Brood size of LWfG was observed for 106 family groups, with a mean brood of 2.52 ± 1.43 juveniles per pair [range 1 – 7 juveniles, 95% CI = 2.24 – 2.79]. Counts of adult and juvenile birds were also made for all flocks where this could be observed. In total we made observations of 1649 adults and 754 juvenile LWfG, giving an adult to juvenile ratio of 1 : 0.452 birds. Based on these observations adult and juvenile birds comprised 68.9% (95% = CI 67.0 – 70.7%) and 31.1% (95% = CI 29.3 – 33.0%) of the population at this time.

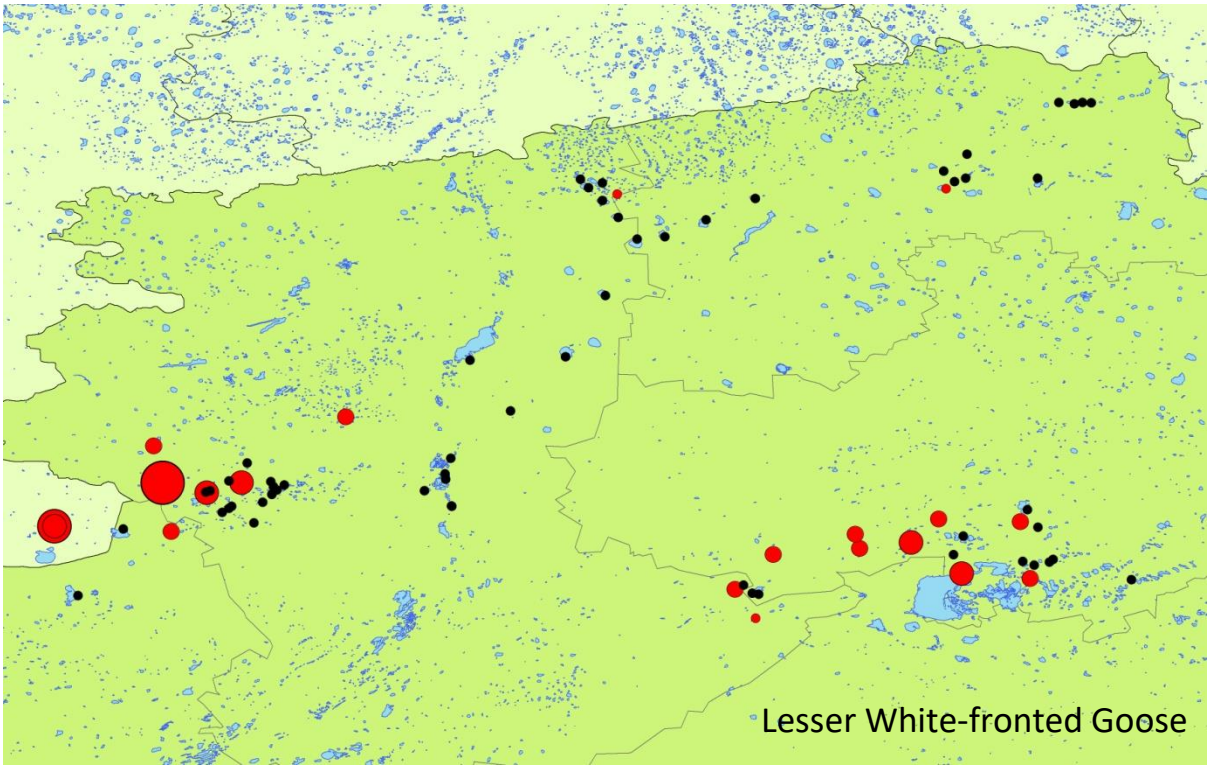


Figure 4 Observations of Lesser White-fronted Goose staging at lakes in northern regions of Kazakhstan and at Zhetykol and Balakol lakes in Russia. Numbers of birds are indicated with red circles of increasing size from 0-10, 11-100, 101-1000, 1001-10000, and 10001-100000 birds. Lakes with zero counts of birds are indicated by black circles.

3.3 Greater White-fronted Geese

GWfG were the most abundant species with 891,300 individuals recorded during the survey with very large numbers of birds recorded in the Akmola survey region (between 585,200 – 588,400 birds), as well as high counts of this species in Kostanay West (150,500 – 332,600 birds) (**Table 2**). GWfG were relatively broadly distributed across the Akmola and Kostanay West regions, with 10 lakes in these areas holding flocks of more than 10,000 birds (eight of which were in the Akmola area) and a further two lakes in Akmola recording 168,080 birds (Lake Tengiz) and 198,198 birds (Lake Kubikol) (**Figure 5**). Comparatively few birds were seen staging at lakes or in stubble fields in the Kostanay North or North Kazakhstan areas. However, both of these areas recorded large mixed species flocks of GWfG/LWfG migrating overhead (see separate section on migratory observations).

Brood size was also recorded for GWfG, with 87 observations of family groups and a mean brood size of 2.86 ± 1.57 juveniles per pair [range 1 – 7 juveniles, 95% CI = 2.52 – 3.20]. Observations of GWfG included 3736 adults and 1472 juvenile birds, giving an adult to juvenile ratio of 1 : 0.394 birds. Based on these observations adult and juvenile birds comprised 71.7% (95% CI = 70.5 – 73.0%) and 29.3% (95% CI = 27.0 – 29.5%) of the population at this stage of the annual cycle.

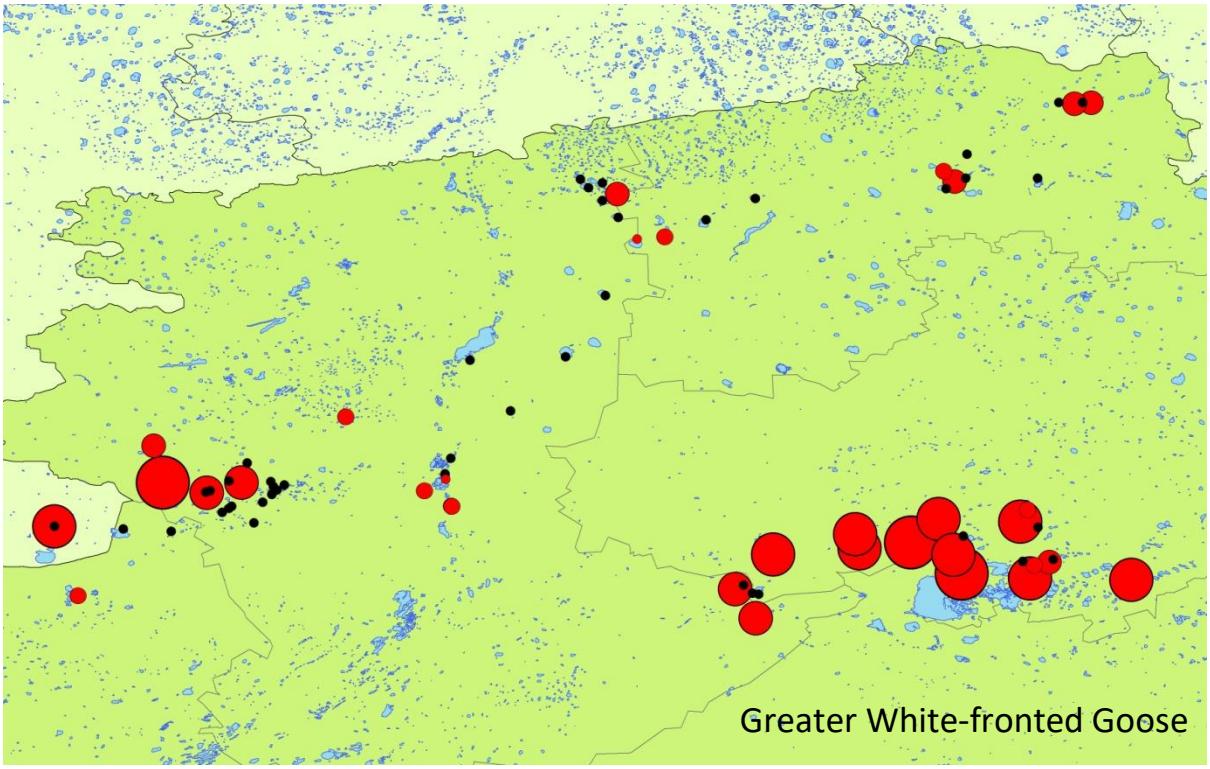


Figure 5 Observations of Greater White-fronted Geese staging at lakes in northern regions of Kazakhstan and at Zhetykol and Balakol lakes in Russia. Numbers of birds are indicated with circles of increasing size from 0-10, 11-100, 101-1000, 1001-10000, 10001-100000 birds and 100001-1000000 birds. Lakes with zero counts of birds are indicated by black circles.

3.4 Red-breasted Geese

Counts of RbG suggest that there were around 39,100 birds, but with wide 95% confidence intervals ranging from 15,000 – 59,100 birds (**Table 2**). The uncertainty around this estimate is due to highly variable sampling counts of this species recorded at Taldykol and Kulikol lakes where the majority of birds were observed. This is explored in more detail in **Appendix 5**. The majority of records were from the Kostanay West count area (89% of observations), with other larger counts from Kostanay North (**Figure 6**) including a count of 3,123 birds at Lake Koybagar. As mentioned previously, most observations of RbG were from Taldykol and Kulikol lakes where an estimated 17,550 RbG were recorded (95% CI = 1,550 – 33,550 birds). While the results from Taldykol/Kulikol have a strong influence on the final estimate, it is also important to note that observations at these lakes constituted around 47% of the total numbers, and the remaining 19,000 birds were from observations at other lakes where we have more confidence in the totals.

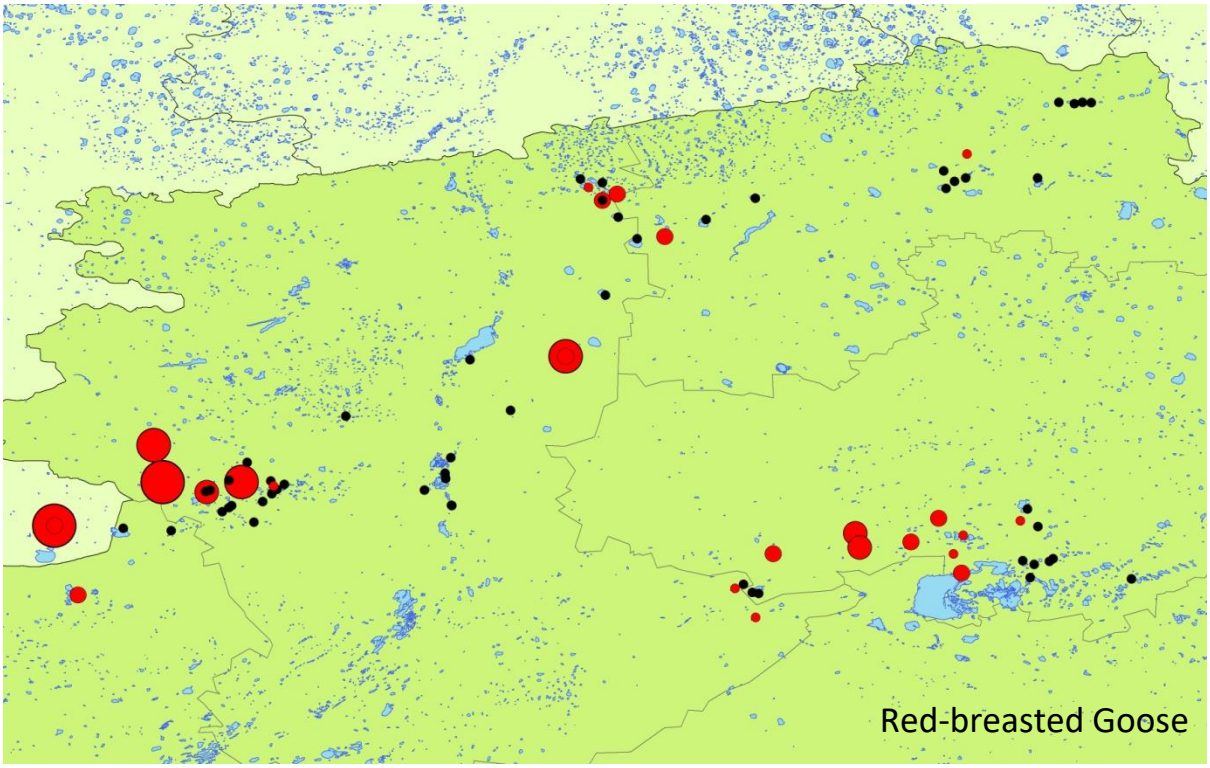


Figure 6 Observations of Red-breasted Geese staging at lakes in northern regions of Kazakhstan and at Zhetykol and Balakol lakes in Russia. Numbers of birds are indicated with circles of increasing size from 0-10, 11-100, 101-1000, 1001-10000, 10001-100000 birds and 100001-1000000 birds. Lakes with zero counts of birds are indicated by black circles.

3.5 Greylag Geese and Ruddy Shelduck

The distribution of Greylag Geese and Ruddy Shelduck are presented below, along with information on numbers for each species in **Table 2**. Greylags were widely distributed across all survey regions, whereas Ruddy Shelduck were almost totally restricted to southern lakes within the overall survey area (**Figure 7**). Total estimates for each species were 248,800 Greylag Geese (95% CI 177,700 – 320,000) and 53,200 Ruddy Shelduck (95% CI = 39,000 – 67,500).

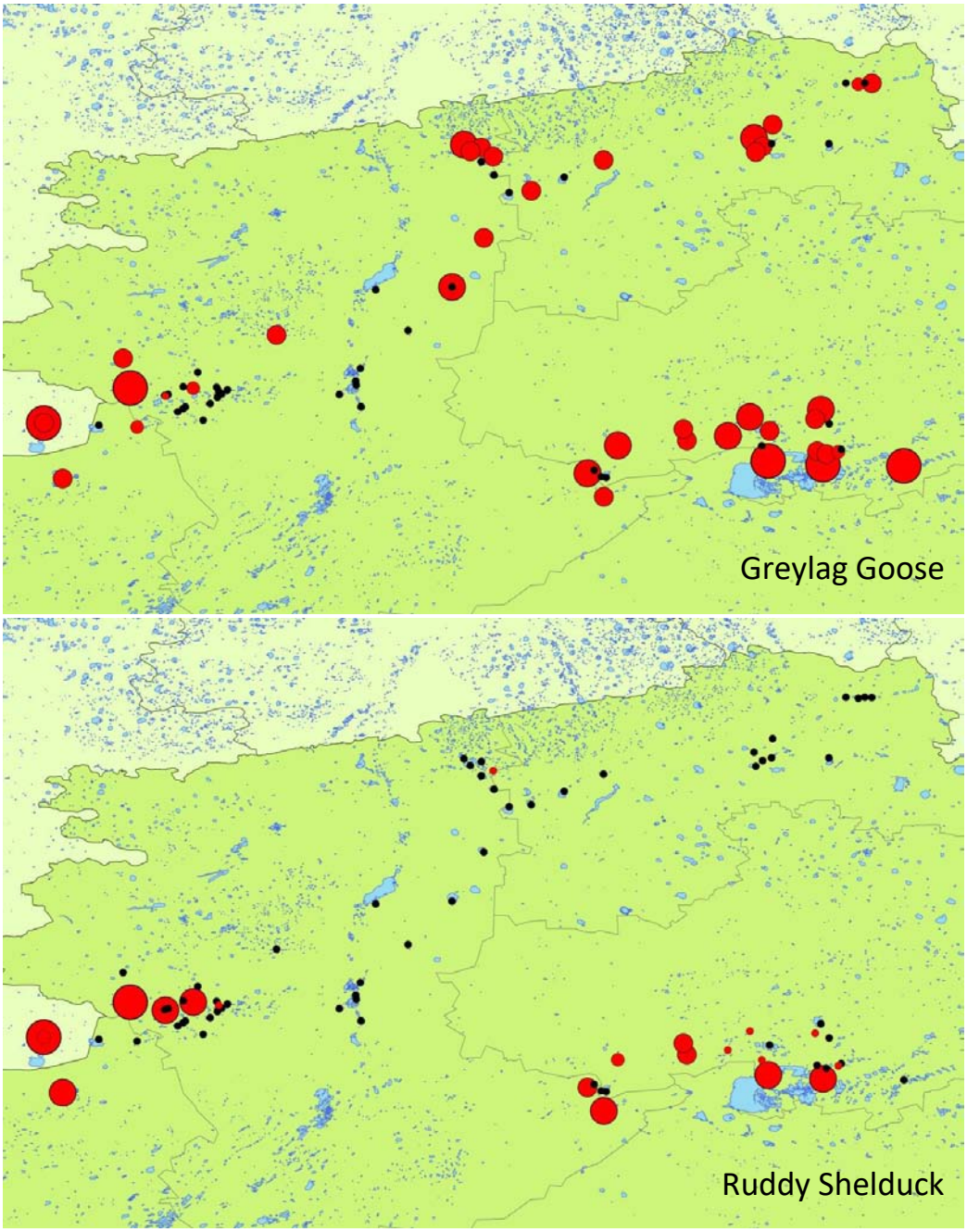


Figure 7 Observations of Greylag Geese and Ruddy Shelducks at lakes in northern regions of Kazakhstan and at Zhetykol and Balakol lakes in Russia. Numbers of birds are indicated with red circles of increasing size from 0-10, 11-100, 101-1000, 1001-10000, 10001-100000 birds and 100001-1000000 birds. Lakes with zero counts of birds are indicated by black circles.

3.6 Migrating birds and timing of survey

Of the total number of geese observed, the majority (98%) were observed on lakes or in stubble fields and considered to be staging. An additional 24,259 geese were seen in flight and based on their height and steady directions of movement were classified as on migration (**Table 2**). As outlined in the methods, this figure is an under-estimate of the total numbers of birds that were migrating, as birds were not counted while teams were driving and many more geese were heard flying overhead at night. Most observations of migrating geese were recorded from the North Kazakhstan (15,887 birds) and Kostanay North (6,230) regions, with the remaining observations from Kostanay West. The majority of observations were of GWfG/LWfG (57% of all birds), with other species or species groupings comprising 5-8% of records. Very small numbers of LWfG (17 birds) were identified during these observations, although many more were likely present within unidentified flocks of GWfG/LWfG. Birds in North Kazakhstan and Kostanay North were seen in a peak of migration between 28 September and 2 October, followed by a smaller pulse of movements from 6-9 October. Large numbers of Common Cranes *Grus grus* were also seen migrating over the same time period in North Kazakhstan, with counts of 816, 94, 1,748 and 130 birds from 29 September to 2 October. This time period coincided with a weather front, which brought clouds and rain and moderate winds from the north, and it seems likely that geese and cranes were using these favourable wind conditions to migrate southwards. The predominant directions of movement of migrating birds are indicated in **Figure 8**.

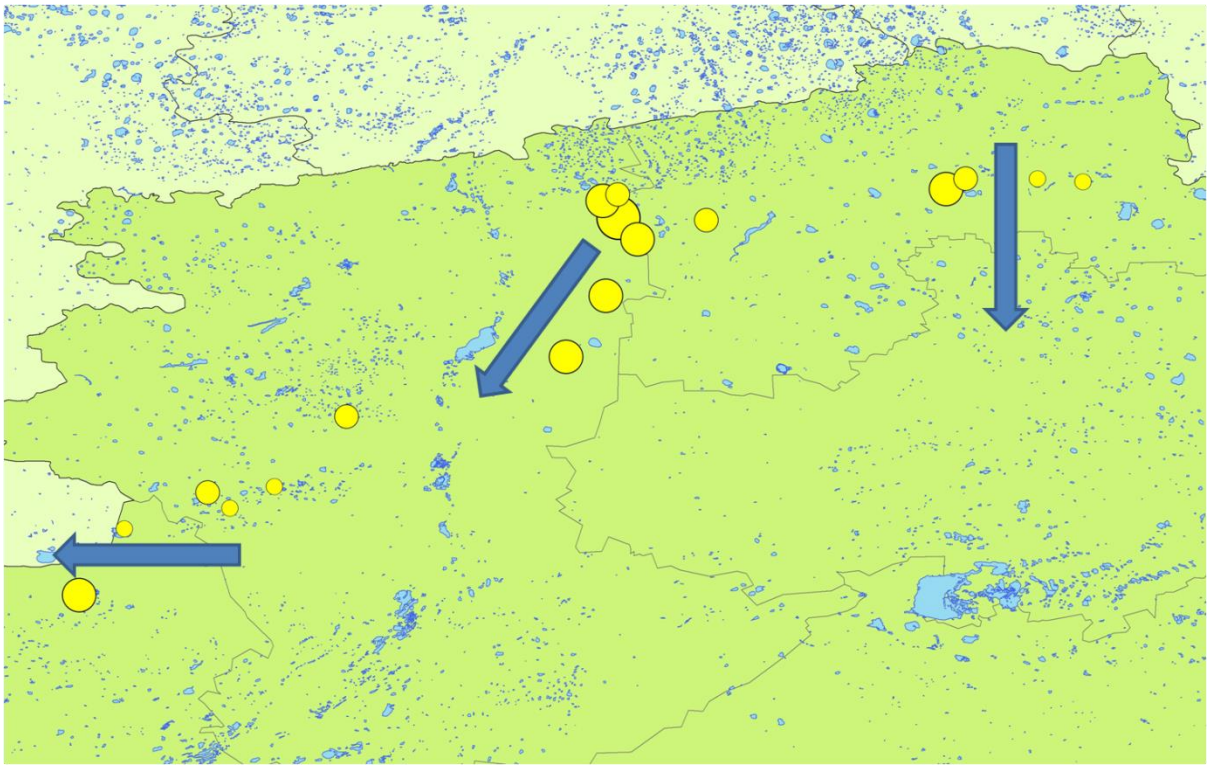


Figure 8 Observations of migrating geese indicating flock size (yellow circles of increasing size indicate 11-100, 101-1000, 1001-10000, and 10001-100000 birds) and the predominant direction of movement (blue arrows).

These patterns suggest that birds in the eastern areas of North Kazakhstan were moving southwards to Akmola, whereas more western birds in North Kazakhstan and Kostanay were heading south-west towards the area of lakes in West Kostanay. Movements of migrating birds in the latter area were primarily in a western direction, suggesting that these birds were departing for their wintering grounds (**Figure 8**).

Many Lesser White-fronted Geese have been tagged with satellite transmitters in Norway and Russia since 1995 (Morozov & Aarvak 2004, Morozov *et al.* 2016, Lorentsen *et al.* 1998) and these have shed valuable information about the major migratory routes and system for this species. Of five birds caught and equipped with satellite transmitters during summer 2016 in Polar Ural Mountains in Russia, four migrated through Kazakhstan in the same time period as the present survey was undertaken. These all staged in the border areas between Orenburg oblast in Russia and Kostanay in Kazakhstan, of which two birds used lake Zhetykol (26/9-21/10 & 29/9-22/10) and two others used Lake Taldykol (29/9-20/10 & 1-15/10) respectively. Mean arrival date in the staging ground was thus 28 September and with a mean departure date of 19 October (BirdLife Norway & Russian Research Institute for Nature Conservation, unpublished data).

3.7 Species relationships and predictors of geese at lakes

Count data for five species (GWfG, LWfG, Greylag Geese, RbG and Ruddy Shelduck) were examined to look at their abundance at surveyed lakes and see if they were selecting the same lakes for roosting sites. These results indicated strong positive correlations among all species for sites when data with zero counts were included (**Table 3**), indicating that geese were generally utilizing the same lakes and avoiding others. Correlations among species at lakes that excluded zero counts of a species indicate that there is a more detailed pattern among species, with numbers of all three *Anser* species of geese being positively correlated with each other and different patterns among other pairs of species (**Table 4**). There was a relatively strong relationship between LWfG numbers and numbers of GWfG, RbG and Ruddy Shelduck, suggesting that they are either settling in mixed species flocks at a lake and/or that these species are independently selecting the same lakes for staging.

Table 3 Pair-wise comparison between species counts (including zero counts) for five species during the survey. Values reported are Pearson correlation coefficients (upper right numbers) and *P* values (lower numbers in italics) for each pair of species.

	GWfG	LWfG	Greylag	Red-breasted	R. Shelduck
GWfG	-	0.669	0.689	0.570	0.697
LWfG	*<0.001*	-	0.590	0.759	0.737
Greylag	*<0.001*	*<0.001*	-	0.462	0.537
Red-breasted	*<0.001*	*<0.001*	*<0.001*	-	0.692
R. Shelduck	*<0.001*	*<0.001*	*<0.001*	*<0.001*	-

Table 4 Pair-wise comparison between species counts when both species were present for five species during the survey. Values reported are Pearson correlation coefficients (upper right numbers) and *P* values (lower numbers in italics) for each pair of species.

	GWfG	LWfG	Greylag	Red-breasted	R. Shelduck
GWfG	-	0.471	0.484	-0.067	0.025
LWfG	*<0.05*	-	0.335	0.653	0.433
Greylag	*<0.01*	*0.069*	-	0.179	0.315
Red-breasted	*N.S.*	*<0.01*	*N.S.*	-	0.569
R. Shelduck	*N.S.*	*<0.05*	*0.094*	*<0.01*	-

Generalized Linear Models with presence or absence of geese as a binary dependent variable and transformed data on lake area, percentage of open water and distance to the nearest village as

factors, indicated relationships between all three variables, although no strong selection for any one candidate model. The top four best-fitting models for the presence of geese (all species combined) at a lake all included Lake Area as a factor, as well as Village Distance and Open Water % (**Table 5**). Plots of the probability of occurrence of geese with these three factors show this relationship; with a strong tendency for geese to occur at lakes of increasing area (**Figure 9**) and weaker relationships between geese and the remaining two factors with the probability of occurrence at a lake increasing with distance from the nearest village and decreasing with the percentage of open water. For the LWfG there was again no clear single candidate model, but the amount of open water was included in the top three models (**Table 6**). **Figure 10** shows these relationships; with the probability of LWfG occurring at lakes decreasing with the amount of open water (i.e. they are more likely in lakes with a high degree of wetland vegetation and cover), and with weaker relationships between the probability of occurrence and increasing lake area and increasing distance from villages. For LWfG the minimum lake size where geese were recorded as present was 280 hectares (median lake area for LWfG = 750 ha).

Image 5 Lesser White-fronted Geese showed a tendency to occur more frequently in lakes with a higher percentage of vegetation cover, as well as in larger lakes (see text). Photo: A. Szilágyi

Table 5 Results for a Generalized Linear Model on the presence/absence of geese (all species) and lake covariates, indicating the model, number of parameters (K), Akaike's Information Criterion (AICc), difference between current and top model (Delta AICc), relative likelihood of the model (Mod Weight), cumulative model weight (Cum Weight) and maximised value of the log-likelihood function (LL).

Model	K	AICc	Delta AICc	Mod Weight	Cum Weight	LL
Lake Area + Village Dist.	3	92.20	0.00	0.41	0.41	-42.93
Lake Area	2	93.42	1.21	0.22	0.63	-44.63
Lake Area + Village Dist. + Water%	4	93.65	1.45	0.20	0.83	-42.54
Lake Area + Water %	3	93.37	2.17	0.14	0.97	-44.02
Village Dist.	2	98.77	6.57	0.02	0.98	-47.30
Null model	1	100.07	7.86	0.01	0.99	-49.01
Village Dist. + Water%	3	100.41	8.21	0.01	1.00	-47.04
Water %	2	101.21	9.00	0.00	1.00	-48.52

Table 6 Results for a Generalized Linear Model on the presence/absence of Lesser White-fronted Geese (LWfG) and lake covariates, indicating the model, number of parameters (K), Akaike's Information Criterion (AICc), difference between current and top model (Delta AICc), relative likelihood of the model (Mod Weight), cumulative model weight (Cum Weight) and maximised value of the log-likelihood function (LL).

Model	K	AICc	Delta AICc	Mod Weight	Cum Weight	LL
Water %	2	84.73	0.00	0.38	0.38	-40.28
Lake Area + Water %	3	86.31	1.58	0.17	0.55	-39.98
Village Dist. + Water%	3	86.78	2.05	0.14	0.69	-40.22
Null model	1	86.95	2.22	0.12	0.81	-42.45
Lake Area + Village Dist. + Water%	4	88.45	3.72	0.06	0.87	-39.94
Lake Area + Water %	3	88.53	3.80	0.06	0.93	-42.18
Village Dist.	2	88.76	4.03	0.05	0.98	-47.30
Lake Area + Village Dist.	3	90.48	5.75	0.02	1.00	-42.07

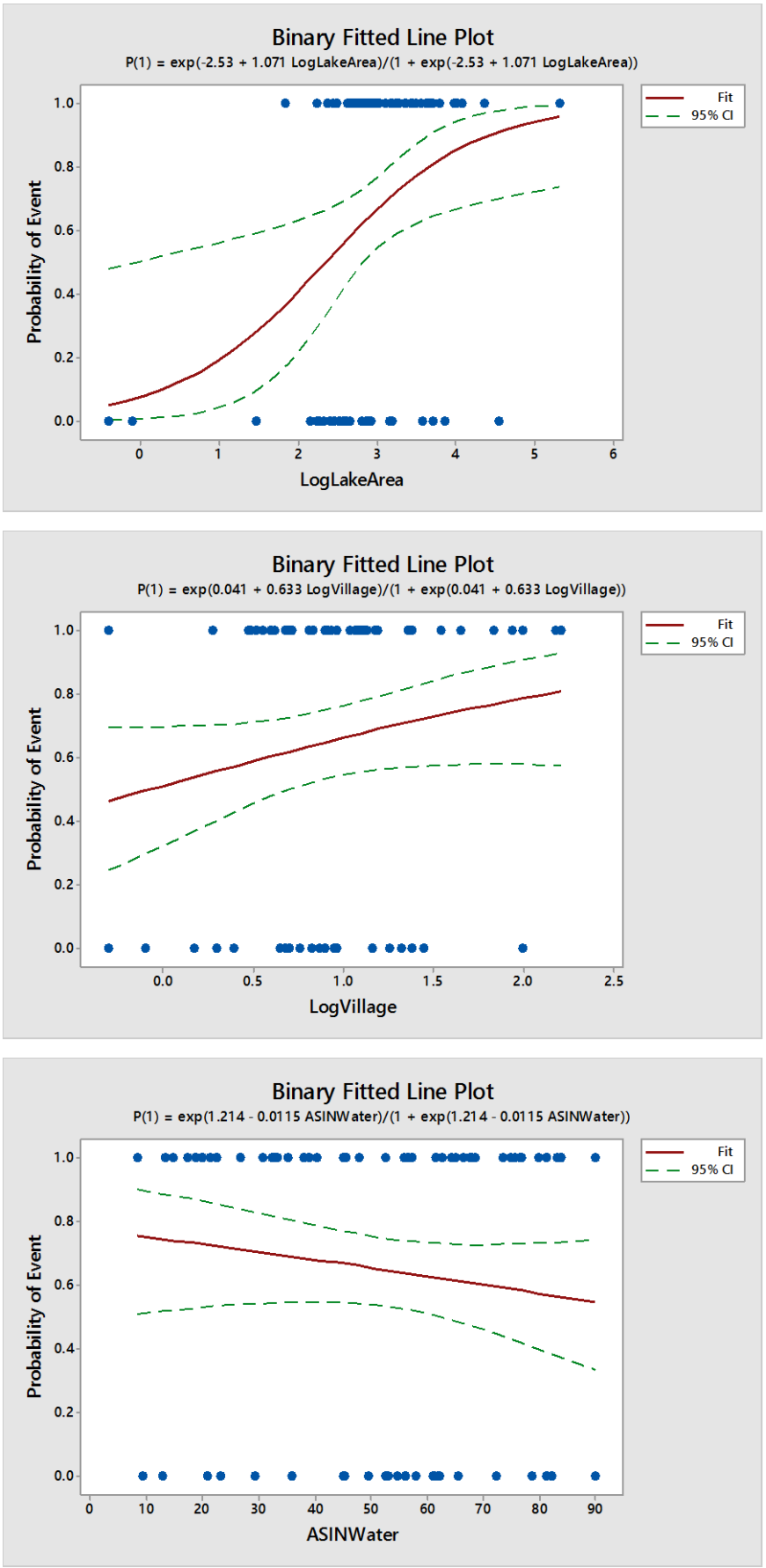


Figure 9 Relationship between lake area, distance to nearest village and the percentage of open water and probability of occurrence (presence/absence) for all geese species combined.

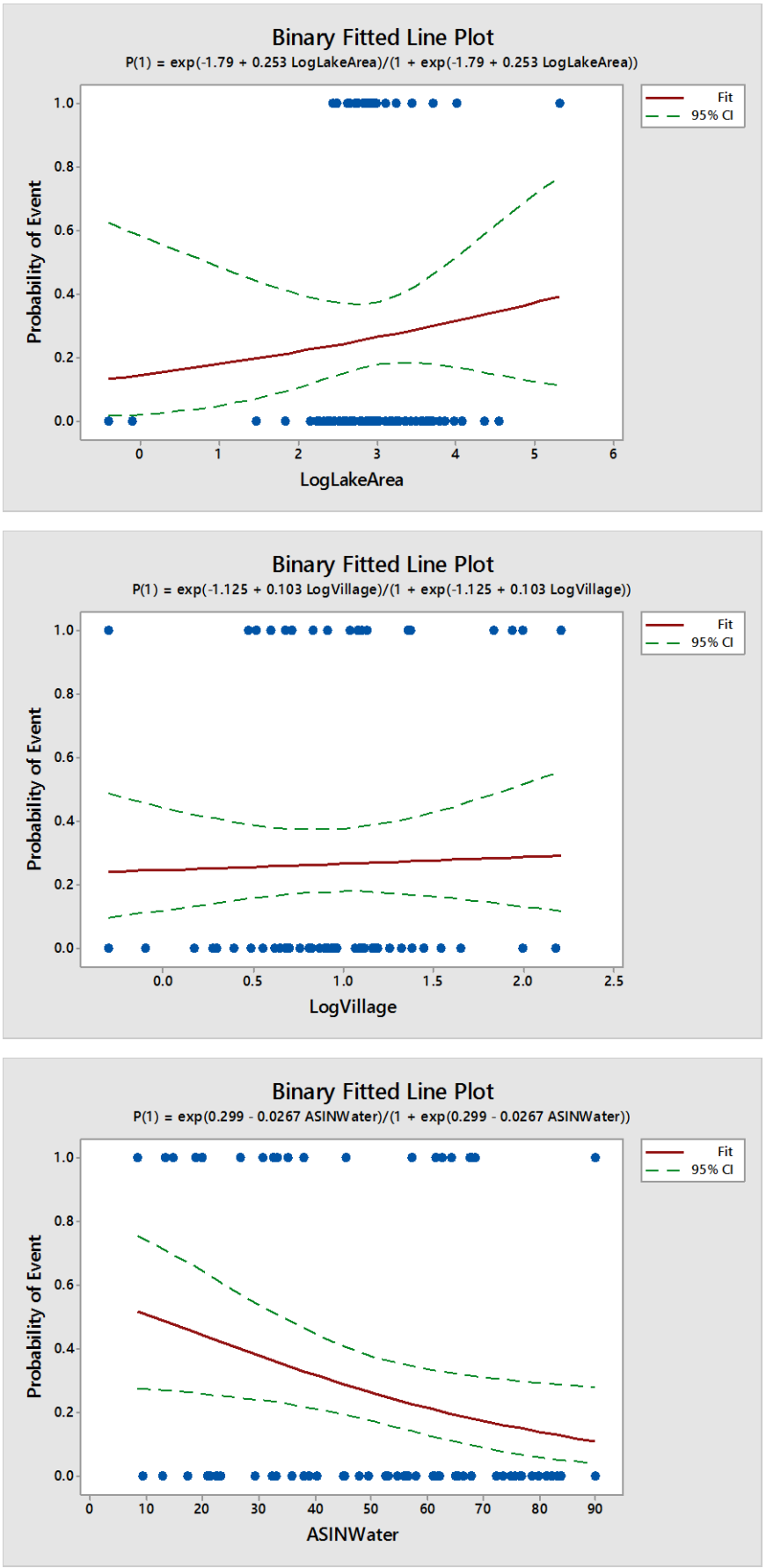


Figure 10 Relationship between lake area, distance to nearest village and the percentage of open water and probability of occurrence (presence/absence) of Lesser White-fronted Geese.

3.8 Population estimates for Lesser White-fronted Goose and Red-breasted Goose

As set out in the methods we made an *a priori* classification of lakes in Kazakhstan for both LWfG and RbG based on previous records (years 1996-2015) of the species in the region and using cut off points of 1% and 10% of the estimated minimum population size to define Category 1 lakes (>10% of the population), Category 2 lakes (1-10%), Category 3 lakes (<1%), and unknown Category 4 lakes where no previous knowledge was available. Sites from all four categories were visited during the expedition, although coverage for LWfG was more comprehensive than for the RbG (**Table 1**). Due to the low coverage of some site categories, the original site categories were combined (**Table 7**) in order to provide more robust sample sizes for boot-strapping. Due to their high numbers of geese and influence on the results, data from Taldykol, Kulikol and Zhetykol lakes were sampled separately, with boot-strapping between the calculated 95% confidence interval for each sites. Mapping the known distribution of each species indicated that birds were mainly occurring in two core areas, with locations distributed across North Kazakhstan and the northern areas of Kostanay Province, along with a further core area in the southern regions of Akmola Province (**Figure 11**). The distribution of birds was strongly associated with mapped areas of cropland (see **Appendix 4** for the GIS data sources), with birds utilizing areas where croplands were 10-25% and 25-50% of the land and avoiding areas with higher and lower prevalence of crops. These core areas are likely to reflect the distribution of wheat and other crops interspersed with non-cultivated land and steppe areas. The distribution of geese (and crop areas) was also associated with areas of low (<10%) forest cover in the region (**Figure 12**).

Table 7 Total number of lakes within each category identified for the study area for Lesser White-fronted Geese and Red-breasted Geese, and the reclassification and grouping of lakes and sample sizes used for the boot-strapping and percentage coverage of lakes.

Lake classification	*N* lakes	Classification for boot strap	Sampled for boot-strap	% Coverage
Lesser White-fronted Geese				
Category 1	28	Category 1*	3	1.00
		Category 1	23	0.92
Category 2	26	Category 2-3	24	0.42
Category 3	31			
Category 4	250	Category 4	30	0.12
Red-breasted Geese				
		Category 1*	3	1.00
Category 1	10			
Category 2	11	Category 1-3	14	0.52
Category 3	6			
Category 4	334	Category 4	63	0.19

* Category 1* sites are Taldykol, Kulikol and Zhetykol lakes

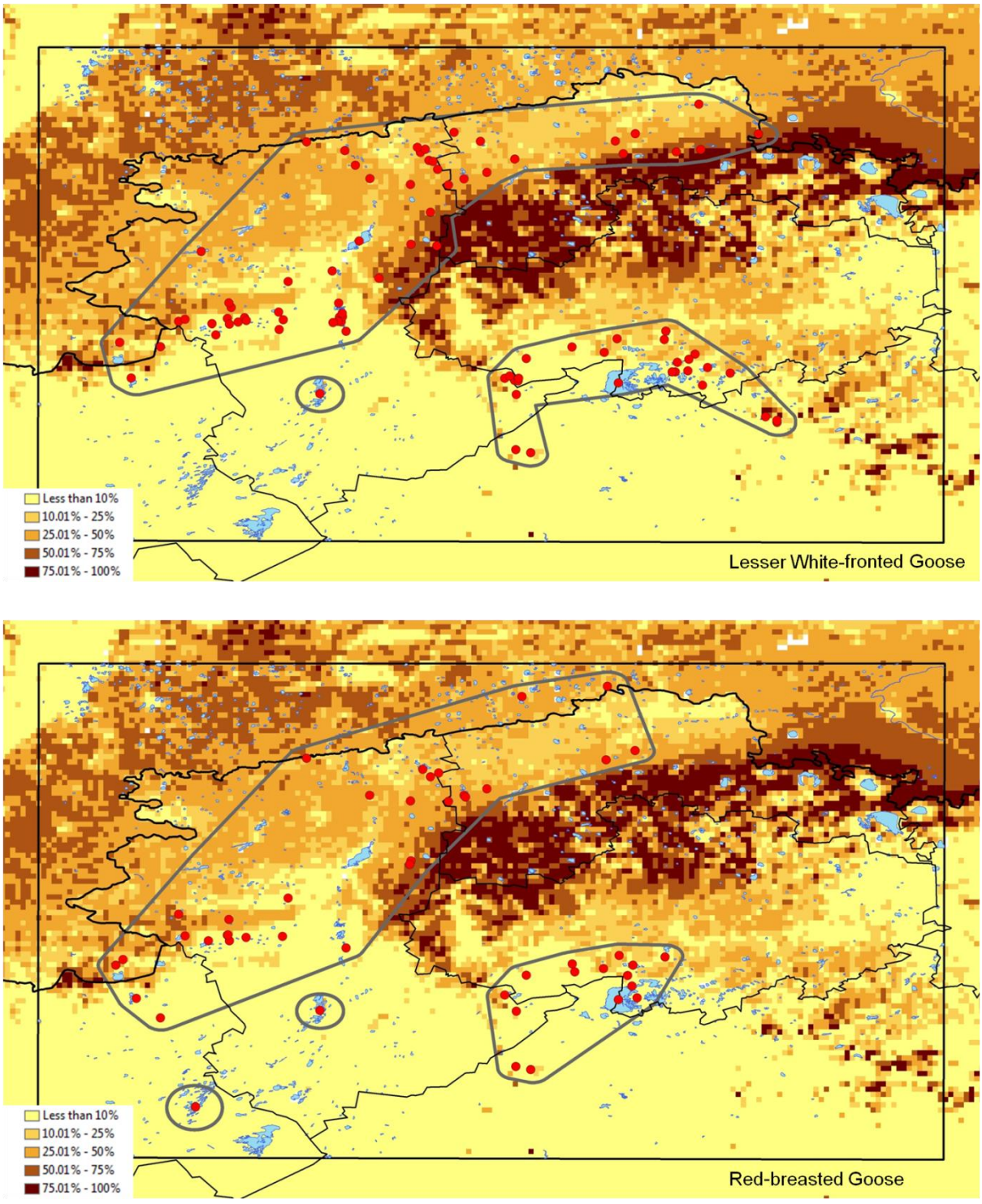


Figure 11 Known locations (red circles) of Lesser White-fronted Geese and Red-breasted Geese and their core areas (polygons with grey lines) in relation to the extent of occurrence of croplands in the region. The overall study area is indicated (rectangle), along with regional and national boundaries.

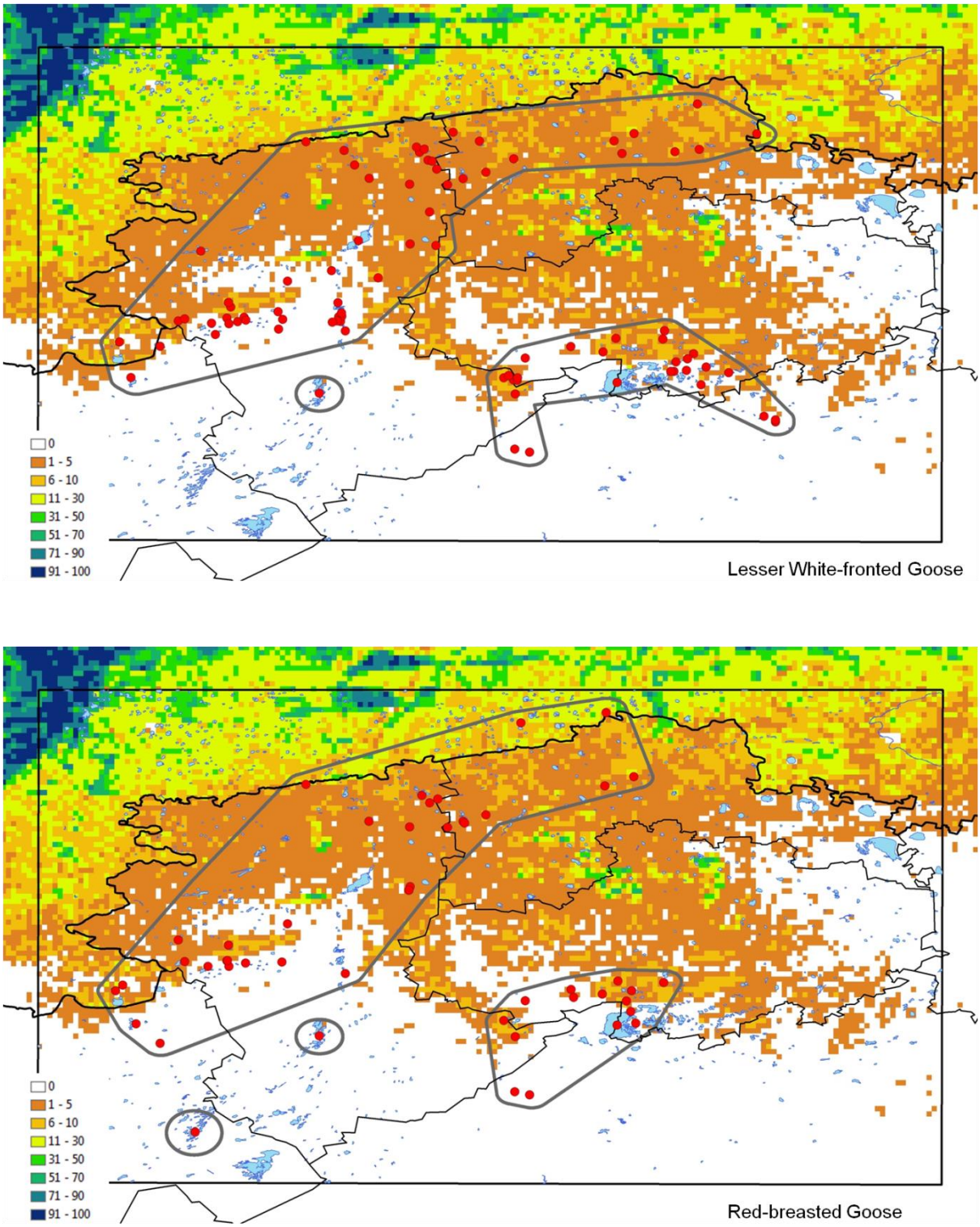


Figure 12 Known locations (red circles) of Lesser White-fronted Geese and Red-breasted Geese and their core areas (polygons with grey lines) in relation to the extent of forest cover in the region. The overall study area is indicated (rectangle), along with regional and national boundaries.

Based on a minimum lake size of 320 hectares, there were a total of 330 lakes within the four core areas of the LWfG. These 330 lakes included Taldykol, Kulikol and Zhetykol and a further 25 Category 1 lakes and 57 Category 2-3 lakes. For the RbG and a minimum lake area of 100 hectares there were a total of 361 lakes within the species core areas, which included Taldykol, Kulikol and Zhetykol and 24 Category 1-3 lakes.

Utilizing these lake categories and boot-strapping from observed count data provide an estimated total population for the Western main population of LWfG of around 34,250 birds (**Table 8**). Based on the observed age ratio of birds in the 2016 expedition, this population is likely to consist of around 23,600 adults and 10,650 juvenile birds. With a theoretical non-breeding part of around 50% of the population (Aarvak & Øien in prep), the number of actual breeding pairs would be approximately 5,900 pairs staging in Kazakhstan during autumn migration.

For RbG we counted around 37,100 during the expedition and following boot-strapping to extrapolate numbers to unvisited lakes we estimate the global population of birds passing through the region to be around 50,100 birds, although there are relatively wide confidence intervals around this figure (**Table 8**).

Table 8 Estimates and 95% confidence intervals for the Western main population of Lesser White-fronted Goose and the global population of Red-breasted Goose.

Lesser White-fronted Geese	Estimate	lower 95%	upper 95%
Total Population	34,250	28,500	40,100
Adults	23,600	19,100	28,350
Juveniles	10,650	8,350	13,250
Red-breasted Geese	**Estimate**	**lower 95%**	**upper 95%**
Total Population	50,100	28,100	72,600

4. Discussion

The 2016 expedition visited a total of 80 lakes in Northern Kazakhstan and adjoining regions of Russia and recorded more than one million geese over the three-week period of the autumn migration. These totals helped provide an understanding of the factors that are important for geese to occur at lakes in the region, as well as providing the first population estimates of LWfG and RbG that extrapolate across sites that were not visited. As expected from previous surveys, large numbers of geese occurred in the Akmola and Kostanay West survey regions, and the Taldykol/Kulikol lake system in the latter area was again very important with a total mixed species flock of around 350,000 geese at this site. Relatively few geese were recorded in the Kostanay North and North Kazakhstan regions in 2016, and observations of migrating birds suggest that most GWfG and LWfG moved straight through to more southerly staging areas.

GWfG and Greylag Geese were the most abundant species, with around 890,000 and 250,000 birds observed, respectively. Ruddy Shelduck, RbG and LWfG were recorded in lower numbers and the latter two species are discussed in more detail below. Factors influencing the occurrence of birds at lakes included the lake size, distance from villages and the amount of vegetation at lakes, with there being a tendency across all species to use larger more vegetated lakes that were more distant from villages, with LWfG showing a more marked preference for lakes with a higher degree of vegetation. Correlations in numbers of different geese species at sites suggest that they were selecting these same factors and/or stopping at lakes that already held geese.

Extrapolating for lakes that were not surveyed produces a total population estimate for LWfG of around 34,250 birds in 2016. This estimate is more than double the previous reported figure for LWfG, which was for an autumn population of around 10,000-21,000 individuals in its Western Palearctic range (Fox *et al.* 2010). This previous estimate was based on surveys of birds in the Kostanay region of Kazakhstan that followed similar methods to the current survey and which also emphasized the importance of the Taldykol/Kulykol lake system for the species. However, the previous surveys recorded far fewer LWfGs at these sites, with 2,400 and 1,420 birds recorded at Taldykol/Kulykol in 1996 and 2,000, respectively (Tolvanen & Pynnönen 1997; Tolvanen *et al.* 2000). The conclusion that there were over 29,000 birds in the Kostanay West region in 2016 depends critically on the interpretation of the counts from Taldykol/Kulikol in 2016 and this is explored in more detail in **Appendix 5** of the report. Assessing numbers at these sites, based on the proportion of LWfG estimated on the same afternoon as the maximum observed count of geese and based upon proportions across 17 separate sampling occasions, produces similar estimates and we are 95% confident that there were between 18,750 to 27,650 birds at these lakes. Other more recent counts of LWfG have also recorded large numbers of LWfG from these areas, with a maximum estimate of 19,566 birds at Taldykol/Kulykol in 2014. Based on these counts alone it is very likely the total Western main LWfG population is considerably higher than the 8,000-13,000 birds previously reported (Jones *et al.* 2008, Fox *et al.* 2010), and extrapolating the results of the 2016 expedition across what appears to be the core staging area of the species produces an estimated total population of 34,250 birds (**Table 8**), consisting of around 23,600 adults and 10,650 juveniles based on the age ratio observed in 2016. This large population estimate has important implications for understanding the extent of occurrence of the Western main LWfG

population on the breeding grounds and also for understanding their distribution during the winter months, as currently winter counts of the species are only known from the border areas of Nakhchivan, Azerbaijan and Iran, in Azerbaijan and possible also Uzbekistan, and consist of a few thousand birds. Based on the numbers recorded in Kazakhstan in 2016, a larger proportion of the population is likely to be wintering in as yet unknown or unsurveyed locations.

It is difficult to assess whether this higher population estimate represents a genuine increase in LWfG numbers over the last 20 years, or instead reflects incomplete sampling of the population in previous years. What is clear is that numbers of LWfG can vary greatly from year to year, and numbers recorded at the Taldykol/Kulykol lake system were 1,552, 207 and 5,400 birds in 2008, 2009 and 2010, respectively, along with records of 19,566, 2,239 and 23,205 LWfG in 2014, 2015 and 2016 (**Figure 13)**. The variation in these six estimates is too extreme to consist exclusively of natural variation in the actual population of LWfG[7], and instead we consider these patterns more likely to represent annual variation in the distribution of birds across the landscape. This conclusion is important for determining the design of further geese surveys in the region and it is recommended that future surveys continue to cover a wide region in order to be able to monitor LWfG in years where they are widely dispersed (see **Annex 1**). It is also possible that larger areas on the Russian side, in Orenburg oblast should be the target of more extensive surveys.

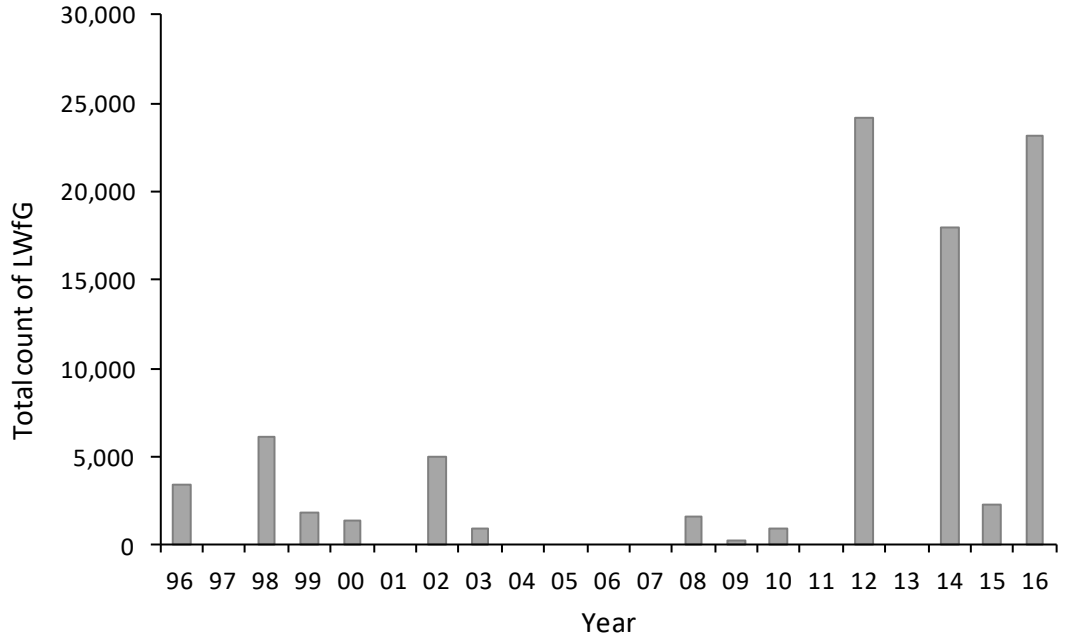


Figure 13 Estimated numbers of Lesser White-fronted Geese recorded at Taldykol/Kulykol lakes in Kostanay over the period 1996 to 2016.

[7] It is possible for LWfG to suffer extremely high mortality and low breeding success and undergo an order of magnitude reduction in numbers. However, it is biologically unfeasible for the population to increase by such an extent in a single year due to the demography of the species.

The surveys in 2016 and extrapolating numbers across unvisited lakes also enabled a global population estimate for RbG to be produced, which is estimated to be around 50,100 birds, although with wide confidence limits around this estimate ranging from 28,100 to 72,600 birds. The population estimate for RbG is again influenced by the observations and interpretation of counts at Taldykol/Kulykol and there is less confidence in the estimate from these lakes than for LWfG due to the highly variable proportions of RbG observed at these lakes (see **Appendix 5**). However, these records from Taldykol/Kulikol only contributed around 47% of the total records of RbG in the region, with more than 19,000 birds observed at other lakes and sites.

The total population estimate of around 50,100 RbG recorded in 2016, after extrapolating for lakes that were not surveyed, is broadly in accordance with other recent estimates for the species. Previous counts include 40,800 birds and 44,300 birds in the spring and winter periods of 2008 (Cranswick *et al.* 2012) and 56,860 in autumn 2010 (Rozenfeld 2011). The 2016 estimate fits within these ranges of counts, and is close to the adjusted population estimate of 55,000 – 56,900 individuals made by Wetlands International (2016) for the period 2009-2013. Rozenfeld *et al.* (2011; 2012) reports counts of 56,860 RbG in 2010 and ~150,000 birds in 2012 based on surveys of migrating geese in the same region of Northern Kazakhstan. The results from 2016 support the former figure, but not the much larger count from 2012. As detailed in **Annex 1** and **Appendix 5**, counts of RbG are complicated by the behaviour of this species and that they appear to depart and return to lakes at different time periods to others species. This behaviour makes obtaining good population estimates of the species difficult, as counts at these times will over-estimate its abundance. Sampling of RbG (and other species) must ideally be undertaken over longer (4-5 hour) periods of time, rather than in small time blocks, where the proportions may vary markedly, in order to obtain more reliable estimates.

5. References

Aarvak, T., Arkiomaa, A., Tolvanen, P. & Øien, I.J. 2004. Inventories and catching attempts of Lesser White-fronted Geese at Lake Kulykol, Kazakstan, in 2002 and 2003. In: Tolvanen, T., Aarvak, T., Øien, I.J. & Timonen, S. (eds.). Fennoscandian Lesser White-fronted Goose conservation project. Report 2001-2003. WWF Finland Report No 20 & Norwegian Ornithological Society, NOF Rapportserie Report No 1-2004: pp. 36-40.

Aarvak, T. & Øien, I.J. in prep. Moult migration in the Fennoscandian Lesser White-fronted Goose *Anser erythropus* population. Unpublished manuscript.

Burnham, K.P. & Anderson, D.R. 2002. *Model Selection and Multimodel Inference: a Practical Information-Theoretic Approach*. 2nd Edition. Springer-Verlag, New York, NY.

Cox, D.R. 1970. The continuity correction. Biometrika. 57: 217-219. 10.1093/biomet/57.1.217.

Cranswick, P.A., Raducescu, L., Hilton G.M. and Petkov, N. 2012. International Single Species Action Plan for the Conservation of the Red-breasted Goose (*Branta ruficollis*). AEWA Technical Series No. 46.

Cresswell, W., Yerokhov, S., Berezovikov, N., Mellanby, R., Bright, S., Chaves, C.J., Freile, J., Gretton, A., Zykin, A., McGregor, R. & McLaughlin, D. 1999. Important wetlands in northern and eastern Kazakhstan. Wildfowl 50: 181-194.

Fox, A.D., Ebbinge, B.S., Mitchell, C., Heinicke, T., Aarvak, T., Colhoun, K., Clausen, P., Dereliev, S., Faragó, S., Koffijberg, K., Kruckenberg, H., Loonen, M.J.J.E., Madsen, J., Mooij, J., Musil, P., Nilsson, L., Pihl, S. & Van Der Jeugd, H. 2010. Current estimates of goose population sizes in western Europe, a gap analysis and an assessment of trends. Ornis Svecica 20: 115–127.

Gurtovaya, E., Tolvanen, P., Eskelin, T., Øien, I.J., Bragina, T., Aarvak, T., Eichhorn, G., Arkiomaa, A., & Timonen, S. 1999. [Preliminary results of the Lesser White-fronted Goose monitoring in Kazakhstan in October 1999] Bulletin of the goose and swan study group of Eastern Europe and North Asia (Casarca) 5: 145-154 (In Russian with English summary).

Jones, T., Martin, K., Barov, B., & Nagy, S. 2008. International Single Species Action Plan: Conservation of the Western Palearctic population of the Lesser White-fronted Goose – *Anser erythropus*. AEWA, Technical Series 36: 69.

Kamp, J., Urazaliev, R., Balmford, A., Donald, P.F., Green, R.E., Lamb, A.J. & Phalan, B. 2015. Agricultural development and conservation of avian biodiversity on Eurasian steppes: a comparison of land-sparing and land-sharing approaches. J. Appl. Ecol. 52: 1578–1587.

Kear, J. 2005. *Ducks, geese and swans volume 1: general chapters; species accounts (*Anhima *to* Salvadorina*)*. Oxford University Press, Oxford, U.K.

Koffijberg, K. & van Winden, E. 2015. In: Jongejans et al. 2015. Naar een effectief en internationaal verantwoord beheer van de in Nederland overwinterende populatie Kolganzen. Sovon-rapport 2014/56, CAPS-rapport 2014/02. Sovon Vogelonderzoek Nederland, Radboud Universiteit en NIOO-KNAW, Nijmegen/Wageningen.

Lorentsen, S.-H., Øien, I.J. & Aarvak, T. 1998. Migration of Fennoscandian Lesser White-fronted Geese *Anser erythropus* mapped by satellite telemetry. Biological Conservation 84:47-52.

Markkola, J., Pynnönen, P., Tolvanen, P., Veersalu, A. & Yerohov, S. 1997. The second international Lesser White-fronted Goose Anser erythropus expedition in NW Kazakstan in May 1997. In: Tolvanen, P., Ruokolainen, K., Markkola, J. & Karvonen, R. (eds). Finnish Lesser White-fronted Goose conservation project. Annual report 1997. WWF Finland Report No 9: pp. 21-22.

Mooji, J.H. 1996. Ecology of geese wintering at the Lower Rhine area (Germany). Thesis (doctoral)-Landbouwuniversiteit te Wageningen.

Morozov, V.V. & Aarvak, T. 2004. [Wintering of lesser white-fronted geese breeding in the Polar Urals]. Casarca 10:156-162. (In Russian with English summary).

Morozov, V.V., Øien, I.J. & Aarvak, T. 2016. Monitoring and satellite tracking of Lesser White-fronted Geese from the Russian European tundra in Russia in 2015. NOF-BirdLife Norway - Report 2-2016. 13pp.

Nagy, S., Flink, S. & Langendoen, T. 2014. Waterbird trends 1988-2012. Results of trend analyses of data from the International Waterbird Census in the African-Eurasian Flyway. Report from Wetlands International, Ede, Netherlands.

Neyeloff, J.L., Fuchs, S.C. & Moreira, L.B. 2012. Meta-analyses and Forest plots using a microsoft excel spreadsheet: step-by-step guide focusing on descriptive data analysis. BMC Research Notes 5:52. Downloaded from http://www.biomedcentral.com/1756-0500/5/52.

Øien I.J., Tolvanen, P., Aarvak, T. & Markkola, J. 1999. Occurrence and identification of Lesser White-fronted Goose. Alula 5: 1-6.

R Core Team 2013. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.URL http://www.R-project.org.

Rozenfeld S. 2011. The number of Red-breasted Goose (*Branta ruficollis*) and Lesser White-fronted Goose (*Anser erythropus*) on the migration routes in 2010. Goose Bulletin. Issue 12. Goose Specialist Group of Wetlands International and IUCN.

Rozenfeld, S. & Timoshenko, A. 2009. The results of waterfowl counts in northern Kazakhstan in 2009. Unpubl. note, 7pp.

Rozenfeld, S., Timoshenko, A., Kovalenko, A. & Smbaev, I. 2010. The results of autumn 2010 geese counting in Northern Kazakhstan. Unpubl. note, 6pp.

Rozenfeld, S., Timoshenko, A.Yu. & Salemgareev, A.R. 2009. [Autumn migration of geese in Kostanay oblast, Kazakhstan, in 2008.] Bulletin of the goose, swan and duck study group of northern Eurasia (Casarca) 12: 114-137 (In Russian with English summary)

Rozenfeld, S., Timoshenko, A.Yu. & Vilkov, V.S. 2012. [The results of goose counts on the North-Kazakhstan stopover site in autumn 2012.] Bulletin of the goose, swan and duck study group of northern Eurasia (Casarca) 15(2): 164-175. (In Russian with English summary)

Rozenfeld, S., Timoshenko, A. & Vilkov, V. 2012. [The results of goose counts on the North Kazakhstan stopover site in autumn 2012]. Casarca 15(2): 164-176. (In Russian with English summary).

Tolvanen, P., Aarvak, T. & Bragina, T. 2001. Conservation work for wetlans and monitoring the autumn staging of Lesser White-fronted Goose in the Kustanay region, north-west Kazakhstan, in 2000. In: Tolvanen, P., Øien, I.J. & Ruokolainen, K. (eds.). Fennoscandian Lesser White-fronted Goose conservation project. Annual report 2000. WWF Finland Report 13 & Norwegian Ornithological Society, NOF Rapportserie Report No 1-2001: pp. 30-33.

Tolvanen, P., Eskelin, T., Aarvak, T., Eichhorn, G., Øien, I.J. & Gurtovaya, E. 2000. Monitoring the autumn staging of Lesser White-fronted Geese in Kazakhstan, October 1999. In: Tolvanen, P., Øien, I.J. & Ruokolainen, K. (eds.). Fennoscandian Lesser White-fronted Goose conservation project. Annual report 1999. WWF Finland Report 12 & Norwegian Ornithological Society, NOF rapportserie Report No 1-2000: pp. 43-50.

Tolvanen, P., Litvin, K.E. & Lampila, P. 1999a. Monitoring the autumn staging of Lesser White-fronted Geese in north-western Kazakhstan, October 1998. In: Tolvanen, P., Øien, I.J. & Ruokolainen, K. (eds.). Fennoscandian Lesser White-fronted Goose conservation project. Annual report 1998. WWF Finland Report 10 & Norwegian Ornithological Society, NOF rapportserie Report No 1-1999.: pp. 42-46.

Tolvanen, P. & Pynnönen, P. 1997. Monitoring the autumn migration of Lesser White-fronted Goose Anser erythropus and other geese in NW Kazakhstan in October 1996. In: Tolvanen, P., Ruokolainen, K., Markkola, J. & Karvonen, R. (eds). Finnish Lesser White-fronted Goose conservation project. Annual report 1997. WWF Finland Report No 9: pp. 19-20.

Tolvanen, P., Pynnönen, P., Markkola, J., Aarvak, T. & Øien, I.J. 1999b. Monitoring instructions for Lesser White-fronted Goose surveys. In: Tolvanen, P., Øien, I.J. & Ruokolainen, K. (eds.). Fennoscandian Lesser White-fronted Goose conservation project. Annual report 1998. WWF Finland Report 10 & Norwegian Ornithological Society, NOF rapportserie Report No 1-1999.: pp. 68-71.

Wetlands International 2016. Waterbird Population Estimates. Available at: wpe.wetlands.org. (Accessed: 14/12/2016).

Yerokhov, S.N., 2006. Past and current status of Anatidae populations in Kazakhstan. In: Boere, G.C., Galbraith, C.A. & Stroud, D.A. (eds). *Waterbirds around the world.* The Stationery Office, Edinburgh, UK. pp. 269-274.

Yerokhov, S.N., 2013. The current status of the Lesser White-fronted Goose *Anser erythropus* in Kazakhstan: monitoring, threats and conservation measures. Ornis Norvegica 36: 47-51.

Yerokhov, S.N., Beryozovikov, N.N., Kellomäki, E.N. & Ripatti, N.L. 2000. [Lesser White-fronted and other goose species in Kazakhstan during migration.] Bulletin of the goose and swan study group of Eastern Europe and North Asia (Casarca) 6: 121-159 (In Russian with English summary).

Yerokhov, S.N., Kellomaki, E.N., Beryozovikov, N.N. & Ripatti, N.L. 2004. [Autumn numbers and distribution of lesser white-fronted geese and other goose species in the Kostanay oblast ,Kazakhstan, in 2002-2004.] Bulletin of the goose, swan and duck study group of northern Eurasia (Casarca) 10: 163-167 (In Russian with English summary).

Annex 1 – Survey methods and design

The results of the 2016 expedition and previous surveys of geese in the region depend critically upon the methods that are used and the robustness of the overall sampling design. As previously noted, there have been highly variable results observed from previous surveys in the region, with there being high levels of inter-annual variability both within and among sites. These results could be an indication of real changes in abundance in numbers of geese (process variation) that reflect patterns of adult mortality, breeding success and population trends. Or they could be a consequence of the difficulty in accurately assessing geese numbers (sampling variation) due to inherent errors in census methods and differences among observers and surveys in the methods employed.

A detailed assessment of whether the observed trends are likely to be a consequence of environmental factors and process variation is beyond the scope of this report. Instead, the focus is on reviewing aspects of the methodology in order to make recommendations and ensure consistency of future surveys.

In this context we review the survey methodology in relation to:

- Estimating total bird numbers at a lake
- Estimating species composition
    (a) Direct counts and sampling
    (b) Random sampling procedures
    (c) Proportion of the flock to be sampled
    (d) Timing of observations and counts
- Standardizing count locations for lakes
- Overall survey design for monitoring and population estimates

These topics are outlined below, utilizing data from the 2016 expedition as well as (where available) information from previous surveys. An important point to make is that sampling errors exist in all ecological studies and this is not a criticism of previous surveys. Recognizing that these errors exist and attempting to minimise them is important in order to evaluate the conclusions that can be drawn from the study. Following the definitions outlined in Gregory *et al.* (2004)[8] it is also important to distinguish between *Accuracy*, which is a measure of how close estimates are to the true population size, and *Precision*, which is a measure of how close replicated estimates are from each other (and may not necessarily be related to the true population size) and which is commonly expressed as the error (typically a standard deviation or 95% confidence intervals) around a mean estimate.

[8] Gregory R.D., Gibbons D.W. & Donald P.F. 2004: Bird census and survey techniques. Pp. 17-56 in: Sutherland W.J., Newton I. & Green R.E. [eds.]: *Bird Ecology and Conservation; a Handbook of Techniques*. Oxford University Press, Oxford.

Estimating total numbers

Estimates of the total number of geese and other wildfowl typically depend on observations of flocks of birds, with large flocks often being counted in smaller units of 10, 50, 500 or 1,000 birds. Such methods have been utilized in all surveys in Kazakhstan and depend critically on the experience of observers at being able to count flocks in units of an appropriate size and to follow and count the often very large numbers of geese (>10,000 or >100,000 birds) that are present and moving rapidly to and from lakes at dusk and dawn. Reviewing the accuracy of such counts is beyond the scope of this report and the issue of the relative accuracy of such counts is applicable to almost all studies of geese and ducks.

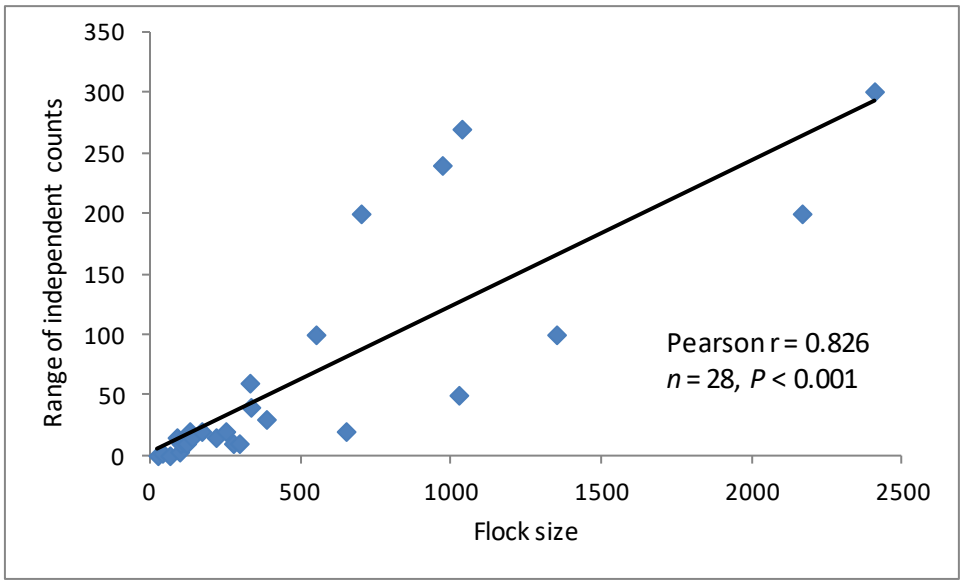
While it is not possible to evaluate the accuracy of these counts, we instead evaluated the precision of such counts through 28 independent sets of observations of the same flocks that were undertaken by different observers at the same time. These independent observations indicate that the observed range of independent counts increased with increasing flock size (**Box 1**). However, when the range of estimates was converted to a percentage of the total flock size there was no statistically significant relationship between flock size and the magnitude of error. Based on the percentage error of each independent pair of estimates, the average (mean) error among observers was 10.7% (95% confidence intervals 7.8 – 13.6%).

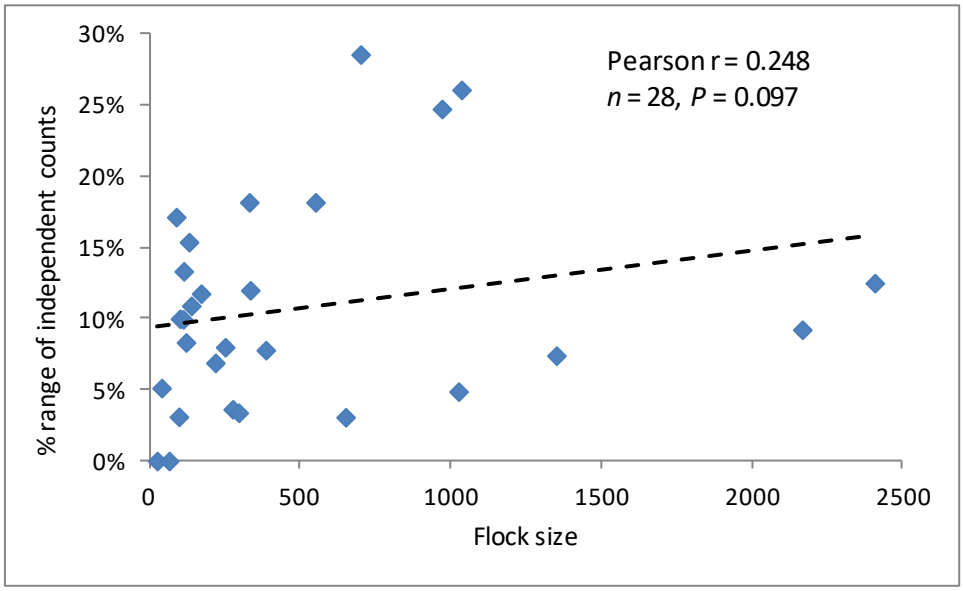
These results indicate that the *precision* of flock size estimates are typically around 10-11%, though other studies generally find an increasing error with increasing flock size[9]. Some caution should be applied to this estimate as these paired sets of observations were generally for relatively small flocks of geese in the North Kazakhstan survey area and do not include observations for the very large flocks of geese (10,000s to 100,000s of birds) that were observed in southern areas of Kostanay and Akmola. Observers in the 2016 expedition agreed that accurate estimation of flock size depends on the experience of observers, good communication among observers in the field to avoid duplicate counts of flocks, and frequent "re-calibration" of the sampling units (i.e. recounting and agreeing upon flock units of 50, 100, 1,000 birds etc) by all observers. Good communication between observers is particularly important when there are very large numbers or birds and/or when flocks of birds are arriving or departing in different directions or repeatedly rising up and settling on a lake. In such situations ensuring that there is a common language between the observers is important for rapidly agreeing on which flocks have or have not been sampled. The field teams in the 2016 expeditions generally consisted of international observers of the same nationality and the team agreed that this helped in such situations. Communication between the Kazakh observers and international observers was more difficult, due to the absence of a shared first language. However, both English and Russian were used for communications, and having an additional Kazakh translator in the North Kazakhstan team greatly assisted this team.

[9] Bibby, C.J., Burgess, N.D., Hill, D.A. & Mustoe, S. 2000. *Bird census techniques*. Academic Press, London.

Box 1 Precision of counts

The figures below show the relationship between flock size and the range of count estimates based on a set of 28 independent pairs of observations of the same flocks in North Kazakhstan. The top figure shows the actual range of count estimates against the total flock, whereas the bottom figure shows the range expressed as a percentage of the total flock. The Pearson correlation coefficient (r) and *P* value are presented in both figures, showing a significant positive relationship between the magnitude of the difference and flock size, but no significant relationship in the range when this is expressed as a percentage.





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Estimating species composition

(a) Direct counts and sampling

The majority of counts and species identification during the 2016 expedition was through direct counts of birds where all individuals were classified to species or species groups. Such an approach is likely to be the most appropriate procedure for lakes where there are relatively few birds (hundreds or thousands), but become increasingly difficult for sites where there are ten thousand birds or more. Lakes with tens- or hundreds of thousands of birds will obviously have the most influence on the overall population estimate for all species and sampling of returning birds is essential along with an accurate estimate of the total number of birds present. Sampling of flocks of ~5,000 or more geese is also recommended because it allows confidence intervals to be fitted onto the figures and enables the precision of the counts to be assessed. While the resulting ranges may be wide, they provide a more accurate assessment of the inherent error involved in field observations. Direct counts of birds typically involve some estimation on the species composition by the observer, unless every single bird can be viewed and positively identified, but the sampling error inherent in this approach is hidden. As a consequence, sampling of species composition is strongly recommended for all observations of ~5,000 or more geese. The exact cut-off point between direct observations and sampling will also vary from site to site: for example, geese may return to lakes in 50 flocks of 100 birds making it feasible to identify all birds in this scenario, whereas five flocks of 1,000 birds or a single flock of 5,000 will require sampling in order to obtain a robust estimate of species composition.

(b) Random sampling procedures

Sampling of geese at lakes is complicated by the fact that birds do not typically occur at random, but instead are more likely to occur in flocks of the same species. This pattern and the previous field instructions for LWfG monitoring of taking random samples of a fixed size (typically 30 birds) from across the whole flock violate the statistical assumption of randomness of samples because each individual is not independent of others as geese tend to travel in family groups. In addition, family group size can vary systematically between years, with brood size fluctuating with lemming/rodent cycles in 3-4 year periods[10]. As a consequence, sampling in this manner will produce estimates that decrease in precision with increased grouping of birds into flocks of the same kind. Simulating sampling in this manner from a large flock of mixed geese with known proportions of LWfG demonstrates this pattern (see **Box 2** on the following page). However, a strict succession/order in sampling individuals is necessary to avoid the effect of the observer skipping difficult birds (like juvenile LWfG versus juvenile GWfG), so that easily identified species like Red-breasted or adult Greylags are being overrepresented. A more appropriate and random approach to sampling can be achieved through sampling every fifth or tenth bird across the whole

[10] Bêty, J., Gauthier, G., Giroux, J.-F. & Korpimäki, E. 2001. Are goose nesting success and lemming cycles linked? Interplay between nest density and predators. Oikos 93: 388–400; Nolet, B.A., Bauer, S., Feige, N., Kokorev, Y.I., Popov, I.Yu. & Ebbinge. B.S. 2013. Faltering lemming cycles reduce productivity and population size of a migratory Arctic goose species. J. Anim. Ecol. 82: 804-813.

flock, rather than sampling every bird in succession in samples of 20-30 birds or similar. Both of these approaches have a similar overall accuracy, however the random sampling of every fifth or tenth bird is more precise, and remains as precise even with increasing "clumping" of LWfG in the model (see **Box 2**).

Random sampling in this manner was undertaken at Taldykol and Kulikol and the results from this sampling should be more precise as a result. The observers involved reported that sampling in this manner was very intensive and that 10 minute periods of sampling, followed by a ten-minute break, were required in order to maintain concentration for accurate species identification of sampled birds. This approach is recommended for future surveys of geese in the region where sampling is required in order to evaluate species composition.

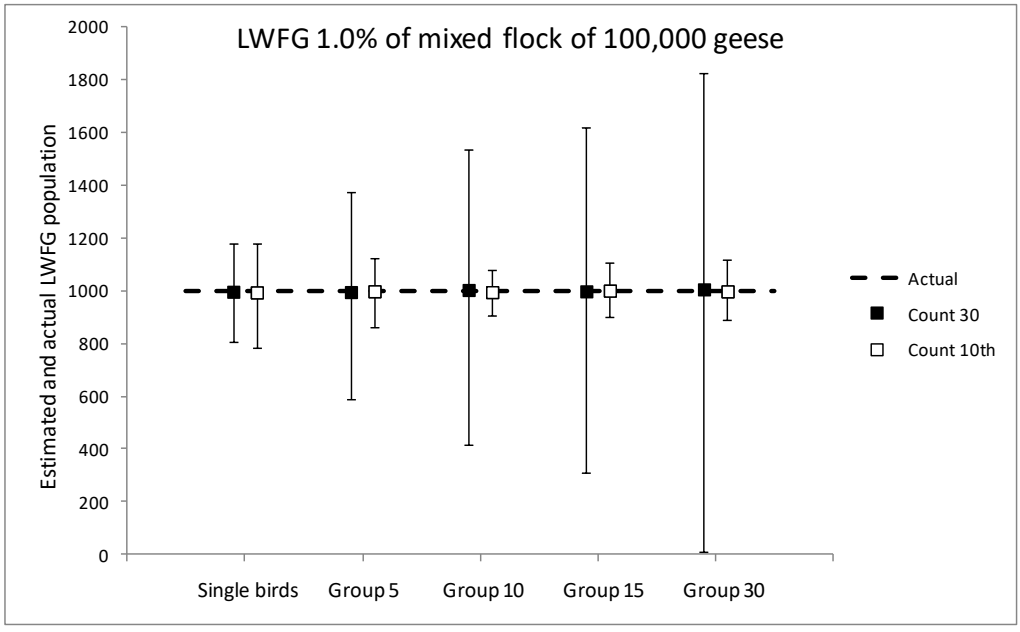
Box 2 Simulation on sampling design for identifying LWfG in flocks

In the simulation a known proportion of birds in a mixed species flock of 100,000 geese are known to be LWfG. Based on the count data from 2014 and 2015 the proportion of LWfG in this flock of 100,000 birds was set at 1.0%, which is close to the mean proportion observed in the field (1.09%) in these years. In the model we sample this flock by:

(a) Counting random groups of 30 birds and recording species
(b) Counting every 10th bird and recording species

In the model each sample is of 10,020 birds (~10% of flock), through counting 334 groups of 30 birds, or through counting every 10th bird this number of times (10,020 in total). We then compare estimated total of LWfG from method (a) and (b) with the actual known proportion of LWfG in the model. This process was then repeated 1,000 times and selected the lower 2.5% and upper 97.5% quantiles in order to bootstrap the 95% confidence interval. This was repeated under five different scenarios of "grouping" based on:

(i) Random assortment of individual birds (i.e. no tendency for LWfG to group in the flock),
(ii) Group sizes of LWfG of 5 birds (close to a typical family group size in a good year (2 adult + 3 surviving fledglings),
(iii) Group sizes of LWfG of 10 birds,
(iv) Group sizes of LWfG of 15 birds,
(v) And group sizes of LWfG of 30 birds (an extreme scenario).



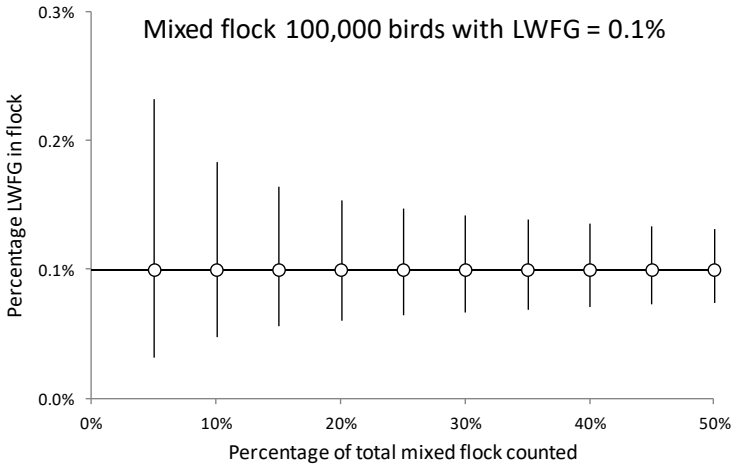
Results of simulation modelling of counting every 10th bird or groups of 30 birds, for LWfG where this species consisted of 1% of a mixed flock of 100,000 geese and for varying group sizes of LWfG in the flock (single, 5, 10, 15 and 30 birds). The solid dashed horizontal line indicates the actual known population size of LWFG in the flock (1,000 birds), filled and unfilled square symbols indicate the average population size from counting groups of 30 birds and every tenth bird, vertical lines are 95% confidence limits. Both methods have a similar accuracy, but counting every 10th bird is considerably more precise for when LWFG are grouped together within the flock. The precision of the counts gets worse (when counting in groups of 30) with more grouping in the flock.

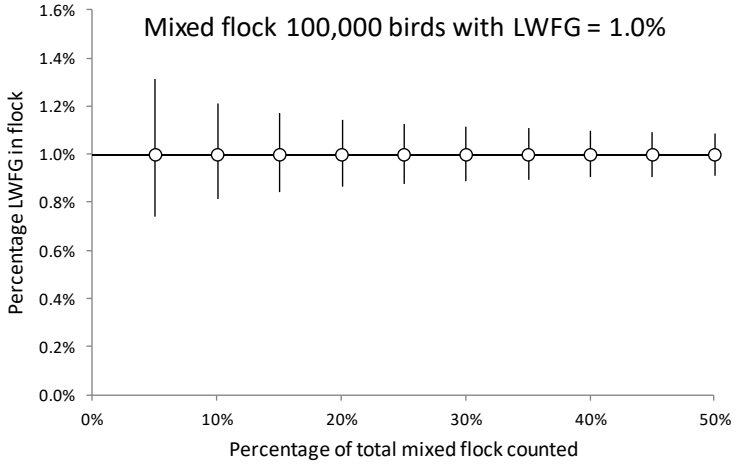
(c) Proportion of the flock to be sampled

Sampling of large flocks of geese requires a proportion of the total flock to be counted and identified, and the precision of the resulting total estimates will depend on how many birds are sampled and the proportion of the flock of the species of interest. The precision of such estimates is shown in **Box 3** below which indicates the estimated precision of counts for varying proportions of LWfG and the proportion of the total flock sampled. The precision of the counts increases markedly when a greater proportion of the flock is counted, but there are diminishing returns on the precision after around 20-25% of the flock is counted. Previous instructions for monitoring LWfG have recommended that a minimum of 10% of the total flock should be sampled, however the figure below indicates that around 20% should ideally be counted (i.e. counts of every 5th bird).

Box 3 Proportion of the flock to be sampled

The graphs below indicate the precision of resulting population estimates for sampling LWfG within a large (100,000) mixed flock of geese with LWfG comprising 0.1% and 1.0% of the total flock and for sampling 5% to 50% of the total flock. The solid horizontal line shows the actual known proportion and the unfilled circles shows the estimated proportion. Vertical lines are 95% binomial confidence intervals around the estimated proportion.





(d) Timing of observations and counts

Previous surveys from Kazakhstan and observations from this year's expedition have emphasized that the timing of movements of birds at lakes possible differs between species, with certain species departing earlier from lakes and subsequently returning to lakes from feeding at different time of the day, though no such data exist to date to support such an impression. Such a pattern will again violate the assumptions of there being a random composition of species in flocks for the purpose of species identification.

This was investigated further through looking at multiple days of sampling from Taldykol and Kulikol lakes where large numbers of birds occurred and where geese observations could be grouped into hourly blocks of time. While there was a large degree of variation, there was an observed tendency for different species to occur in greater proportions at different times of the day (see **Box 4**). These patterns may under-represent the true situation for certain species, as they do not include observations at or before dawn, when it was too dark to objectively identify or count species but where the voice of the birds suggested that large numbers of GWfG were departing before other species. The high proportion of unidentified *Anser/Branta/Tadorna* geese from 07:00 to 08:00 may also largely consist of GWfG and the apparent peak in GWfG numbers at around 10:00 – 12:00 most likely reflects observations of this species returning to the lakes after feeding. In contrast, the earlier observed peaks of departures of Ruddy Shelduck and RbG may reflect peaks of birds departing from the lake. The figure in **Box 4** also suggest that RbG are generally returning to lakes earlier in the day (from around 14:00 – 16:00) in comparison to other species.

Accurately sampling species composition under these situations is difficult, although it should be noted that the very large numbers of birds at Taldykol and Kulikol (a maximum of ~348,000 birds) are very likely to represent a worst case scenario for assessing species composition.

The figure in **Box 4** suggests that the following points should be considered when sampling:

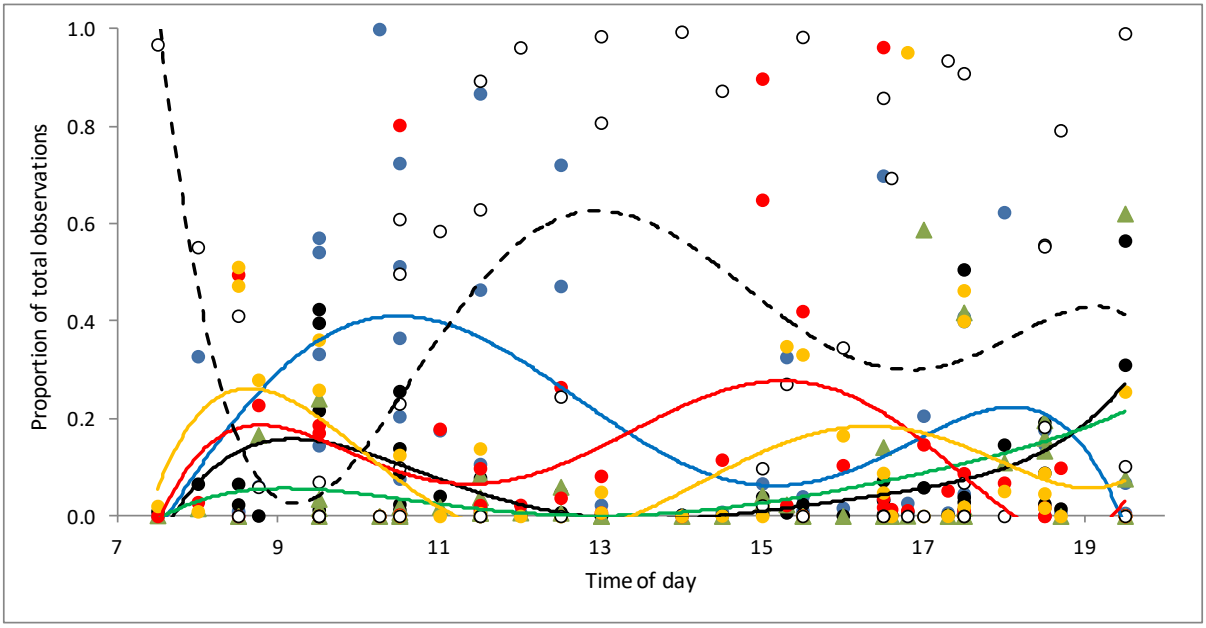
- The pattern of species composition appears most variable in the early morning and the dawn departure of GWfG will mean that species composition is highly skewed at this time of day,
- A single narrow window of time (e.g. 1 or 2 hours) is unlikely to produce robust results due to the varying patterns of species composition against time. Observations and sampling of species composition across longer periods of time (4 – 5 hours) and in the afternoon (starting from ~15:00 onwards) when birds are mostly returning to lakes to roost may be most likely to produce a representative sample across all species that are present.

Under the above scenarios, the most robust population estimates for geese species will likely arise when species composition is determined in the afternoon and early evening during the period when birds are returning to lakes to roost, in combination with total counts of all geese at the lake made either during the same afternoon/evening or the following morning when species composition should not have altered for the total flock. Species composition in the afternoon following a total dawn count is less likely to be representative of the species present due to the

potential arrival of new birds at the site during the day and/or the departure of birds during the day that were present at dawn. These results also emphasize the need to accurately record geese in defined time periods, and it is recommended that all field observations are recorded in 15 minute or 30 minute periods to enable these issues to be investigated further.

Box 4 Patterns of geese movement and time of day

Observations of geese from nine days of records from Taldykol and Kulikol were utilized in order to plot the hourly proportions of identified species or species groups. These species and groups were GWfG (blue circles and line), LWfG (black), Greylag Geese (green), RbG (red), Ruddy Shelduck (orange) and unidentified *Anser/Branta/Tadorna* geese (unfilled circles and dashed line). Points are actual observations; lines are 5th order polynomials to represent the broad overall patterns in the data.



Standardizing count locations for lakes

As far as possible, in the 2016 expedition, observation points were located at a raised view-point (where available); close to the mid-point on the longer length of a lake (where applicable); and sufficiently near to be able to identify species, but also far enough to scan the whole lake area for birds. Selecting the observation point also depended on roads and tracks for vehicles to access the lake (or a close enough point to walk) and the time of day that the team arrived at a lake, as the presence of returning birds meant that there was sometimes insufficient time to find the optimum count site. The influence of the observation point on the accuracy and precision of counts is unknown, however it is recommended that, as far as possible, the same observation points are used for future counts. **Appendix 1** lists the latitude and longitude of all observation points used in the 2016 survey. These locations should be the starting point for future surveys of the same lakes and will help reduce sampling error associated with counting lakes from different observation points. Using these locations will also reduce the time taken in visiting and assessing different observations at a site. An exception to using fixed locations will occur if flocks of geese are congregated in areas of the lake that are too distant from the recommended observation site. In these situations, field teams will need to use their experience to select the optimum count location to obtain the best possible count. Such a situation occurred at Balikty in North Kazakhstan where a previous survey point on the lake was visited, however birds were found to be roosting in more vegetated wetland areas to the east of the main lake (**Box 5**) necessitating a new vantage point for the counts.

Box 5 Observation points

Survey locations (GPS coordinates and yellow marker) at Balikty Lake in North Kazakhstan and the location of roosting birds (yellow circle).

Overall survey design for monitoring and population estimates

Surveys of migratory geese in Kazakhstan will always be a compromise between the number of lakes to be visited and the time required to produce the best possible estimate at visited lakes. These issues are further influenced by the migratory behaviour of LWfG and other geese in a given year, with differences in the timing of the arrival of birds at lakes and also in the numbers present. The sampling design also depends on the key question to be asked: whether we are trying to obtain a total population estimate (in which case as many lakes as possible should be visited) or if the objective is to monitor a representative part of the population (allowing surveys to potentially be restricted to a smaller area containing key sites).

Observations of LWfG in 2016 confirmed the general pattern of previous years: the majority of birds were located in western areas of Kostanay and adjoining area of Russia, with further large numbers of birds in the southern region of Akmola (see **Box 6**). Counts in these two areas will be highly important for all future surveys. However, caution should be noted in that the distribution of geese does change markedly from year to year. For example, Taldykol and Kulikol lakes recorded just 2239 LWfG during surveys in 2015, an order of magnitude less than the 22,995 birds estimated in the 2016 expedition. Similarly, Bolshoy Kay and Zakzhysharkol lakes in North Kazakhstan recorded 870 and 257 birds in 2003 and 2004, whereas no birds were recorded at either site in 2016 (**Box 6**). These large annual differences in LWfG numbers at sites are unlikely to be due to variation in the actual population of birds and most likely to represent differences in the distribution of birds across the landscape. As a consequence, just focusing surveys at Taldykol and Kulikol in 2015 would miss the (likely) large numbers of LWfG present at other lakes in this year.

While the main objectives of surveys may vary from year to year, a potential "optimum" survey design for four field teams – that allows for more time at key lakes such as Taldykol/Kulikol, as well as visiting a good sample of sites – may consist of:

- Two survey teams in the western areas of Kostanay and Russia, allowing two teams of observers to obtain good estimates from Taldykol/Kulikol lakes and to visit other lakes in this area
- One team in the southern Akmola area to survey key lakes and other lakes in this region
- One "roving team" that moves across northern and eastern areas of Kostanay and North Kazakhstan in order to survey as many lakes as possible and ensure that these areas are covered in years when birds are more widely distributed across the region.

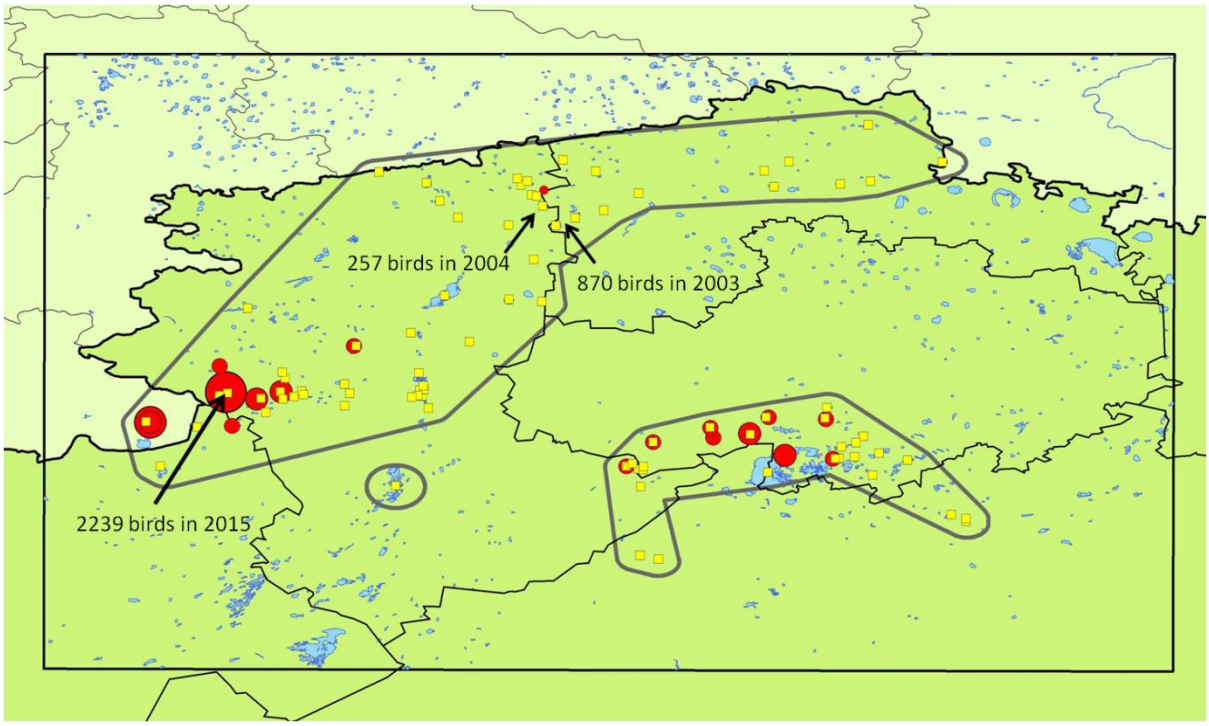
If only three field teams are available then it is still recommended that one team surveys areas in Kostanay North and North Kazakhstan, as this is the only way to ensure comprehensive coverage of the core areas for birds, and will allow better estimates in years when birds stage in higher latitude areas.

As well as surveying lakes in what appears to be core areas for LWfG and RbG it will also be important to sample lakes outside this area to substantiate that these core areas are accurate.

Further surveys that help reduce these core areas will also help prioritize the locations of lakes to be visited and to produce more accurate total population estimates.

Box 6 Distribution of Lesser White-fronted Geese and previous years

The map below indicates the survey results for LWfG from the 2016 expedition indicating locations where birds were recorded (red circles) with increasing size of the circles representing 0-10, 11-100, 101-1000, 1001-10000, and 10001-100000 birds. Lakes where LWfG have previously been recorded at are indicated by yellow squares. Information on previous counts of birds are presented for Taldykol/Kulikol (in 2015), Bolshoy Kak (2003) and Zakhzysharkol (2004).



Appendices

Appendix 1 **Latitude and longitude for lake count locations in the 2016 survey**

Appendix 2 **Counts of geese at lakes for all four survey regions**

Appendix 3 **Records of other species for all four survey regions**

Appendix 4 **Sources of GIS information used in the analyses**

Appendix 5 **Estimating numbers at Taldykol and Kulikol lakes**

Appendix 6 **Modified field monitoring instructions for Lesser White-fronted Goose**

Appendix 1 ***Latitude and longitude for lake count locations in the 2016 survey***

*Coordinates in italics (all sites in Akmola) are lake locations and not the exact survey location.

Survey team	Lake name	Date	Lat N	Lon E
Akmola	Russky Zharkol	26.09.2016	*50.20323*	*67.29406*
Akmola	Kazakhskiy Zharkol	27.09.2016	*50.4272*	*67.2626*
Akmola	Taldykol	28.09.2016	*50.46368*	*67.10831*
Akmola	Shoindykol	28.09.2016	*50.41917*	*67.32087*
Akmola	Sabyndy	28.09.2016	*50.5001*	*67.18556*
Akmola	Koskakol	28.09.2016	*50.77859*	*67.45296*
Akmola	Aupeldik	29.09.2016	*50.83452*	*68.23135*
Akmola	Szocsinszkoe	01.10.2016	*50.96032*	*68.19196*
Akmola	Kubikol	03.10.2016	*50.88503*	*68.6954*
Akmola	Korzhakol	04.10.2016	*51.0975*	*68.94458*
Akmola	Kozhakol	05.10.2016	*50.94186*	*69.16685*
Akmola	Samtas	05.10.2016	*50.77604*	*69.08002*
Akmola	Tengiz	06.10.2016	*50.60521*	*69.15307*
Akmola	Saumalkol	06.10.2016	*50.71373*	*69.70505*
Akmola	Sholak	08.10.2016	*50.56221*	*69.77075*
Akmola	Zhumay	08.10.2016	*50.68046*	*69.80665*
Akmola	Temirastau	08.10.2016	*50.7069*	*69.94308*
Akmola	Mayshukur	08.10.2016	*50.73282*	*69.97643*
Akmola	Kumdykol, Ashu-Kumkol, Uzynkol, Zharlykol	09.10.2016	*50.55003*	*70.68375*
Akmola	Zharlykol (Burevestnik)	12.10.2016	*51.02335*	*69.84106*
Akmola	Shandykol	12.10.2016	*51.07399*	*69.68269*
Akmola	Alakol	12.10.2016	*51.1795*	*69.74598*
Kostanay North	Shoskaly	25.09.2016	51.35068	64.30791
Kostanay North	Kulakol	26.09.2016	51.21279	64.54955
Kostanay North	Karashar	26.09.2016	51.50514	64.50996
Kostanay North	Mala Aksuat	26.09.2016	51.51217	64.49281
Kostanay North	Sharkol	27.09.2016	51.64456	64.543
Kostanay North	Bolshoy Aksuat	27.09.2016	51.4999	64.51659
Kostanay North	Kushmurun	28.09.2016	52.52599	64.71681
Kostanay North	Bidaik	Multiple	52.31543	64.55584
Kostanay North	Koybagar	Multiple	52.55561	65.58037
Kostanay North	Tjyuntjugur	29.09.2016	52.70992	65.78412
Kostanay North	Boshakol	Multiple	53.10814	65.9401
Kostanay West	Urkash, by the village	28.09.2016	51.33999	62.3323
Kostanay West	Urkash, Lake Sukurkol	28.09.2016	51.35222	62.37222
Kostanay West	Urkash, small pond	28.09.2016	51.4397	62.5421
Kostanay West	Batpakkol	29.09.2016	51.42462	62.65553
Kostanay West	Mamyrkol	29.09.2016	51.59927	62.70814
Kostanay West	Druzhba	29.09.2016	51.4332	62.92226
Kostanay West	Jegisbay(?)	29.09.2016	51.38689	62.94564
Kostanay West	Unknown 1	29.09.2016	51.35676	62.97708
Kostanay West	Unknown 2	29.09.2016	51.31809	62.9296
Kostanay West	Unknown 3	29.09.2016	51.24699	62.84895
Kostanay West	Shoptykol N (?)	29.09.2016	51.06071	62.767
Kostanay West	Unknown 4	29.09.2016	51.21115	62.56756
Kostanay West	Unknown 5	29.09.2016	51.19333	62.54273
Kostanay West	Urkash, Lake Tenis	30.09.2016	51.33212	62.34128
Kostanay West	Bliskopa	04.10.2016	51.75683	61.86366
Kostanay West	Ayke	04.10.2016	51.00559	61.58998
Kostanay West	Shelkar Karashatau	05.10.2016	50.40819	61.1827

Survey team	Lake name	Date	Lat N	Lon E
Kostanay West	Sulukol	05.10.2016	50.98702	62.02286
Kostanay West	Kulikol	Multiple	51.34146	61.7702
Kostanay West	Taldykol	Multiple	51.39053	61.96859
Kostanay West	Zhetykol (Russia)	09.10.2016	51.03102	60.96978
Kostanay West	Balakol (Russia)	09.10.2016	51.03102	60.96978
Kostanay West	Lake Zharsor	13.10.2016	51.4042	63.04187
Kostanay West	Lake Diyevka	14.10.2016	52.01723	63.59707
North Kazakhstan	Akzhan	26.09.2016	54.15594	65.71372
North Kazakhstan	Sarayoban	27.09.2016	54.12393	65.91022
North Kazakhstan	Retchnoe	28.09.2016	54.08017	65.78692
North Kazakhstan	Lebyazhe	29.09.2016	53.9631	65.91216
North Kazakhstan	Zhaman Sharkol	29.09.2016	53.9631	65.91216
North Kazakhstan	Shoshkaly	29.09.2016	54.02192	66.04486
North Kazakhstan	Zhaksysharkol	30.09.2016	53.8108	66.05495
North Kazakhstan	Bolshoy Kak	01.10.2016	53.61633	66.22688
North Kazakhstan	Aksuat	01.10.2016	53.63784	66.47507
North Kazakhstan	Maliy Kak	01.10.2016	53.79212	66.84679
North Kazakhstan	Zhaltyr	02.10.2016	53.9813	67.29217
North Kazakhstan	nr Balikty	03.10.2016	54.22829	68.98962
North Kazakhstan	Uzynkol	04.10.2016	54.13502	69.08708
North Kazakhstan	Kumdykol	05.10.2016	54.06979	69.01241
North Kazakhstan	Karasor	06.10.2016	54.16415	69.18821
North Kazakhstan	Terenkol	07.10.2016	54.38099	69.20073
North Kazakhstan	Shagly Teniz	08.10.2016	54.16486	69.83712
North Kazakhstan	Tayinsha	08.10.2016	54.13863	70.24908
North Kazakhstan	Solenoe	09.10.2016	54.84401	70.32056
North Kazakhstan	Sukhoe (Kamyshlovo)	10.10.2016	54.84722	70.2425
North Kazakhstan	Kamyshlovo	11.10.2016	54.83636	70.16959
North Kazakhstan	Polovinnoe	11.10.2016	54.84865	70.02918

Appendix *2* *Counts of geese at lakes for all four survey regions*

Table A2(a) Akmola survey region: Survey sites, date of count, GPS coordinates, staging or migratory behaviour and geese numbers recorded. Values in square brackets are 95% confidence intervals at the sites indicated and where sampling was undertaken. A=*Anser*, B=*Branta*, T=*Tadorna*.

Lake name	Date	Lat N	Lon E	Behaviour	Total flock	A. alb	A. ery	A. ans	A. fab	Bra ruf	Tad fer	A. alb/ery	A. sp	A/B	A/B/T
Russky Zharkol	26/9/2016	50.20323	67.29406	Staging	11,200	9,500	1	500	0	2	1,200	0	0	0	0
Kazakhskiy Zharkol	27/9/2016	50.42720	67.26260	Staging	0	0	0	0	0	0	0	0	0	0	0
Taldykol	28/9/2016	50.46368	67.10831	Staging	12,240	10,000	16	2,200	0	1	300	0	0	0	0
Shoindykol	28/9/2016	50.41917	67.32087	Staging	0	0	0	0	0	0	0	0	0	0	0
Sabyndy	28/9/2016	50.50010	67.18556	Staging	0	0	0	0	0	0	0	0	0	0	0
Koskakol	28/9/2016	50.77859	67.45296	Staging	12,500	11,000	54	1,500	0	45	70	0	0	0	0
Aupeldik	29/9/2016	50.83452	68.23135	Staging	18,200	17,300	32	500	0	174	180	0	0	0	0
Szocsinszkoe	01/10/2016	50.96032	68.19196	Staging	20,700	20,000	57	530	0	160	180	0	0	0	0
Kubikol	03/10/2016	50.88503	68.69540	Staging	200,000	198,198 [197,812-198,531]	937 [701-1,227]	1,565 [1,339-1,845]	0	21	2	0	0	0	0
Korzhakol	04/10/2016	51.09750	68.94458	Staging	27,500	25,735 [25,538-25,903]	13 [13-56]	1,765 [1,597-1,962]	0	17	3	0	0	0	0
Kozhakol	05/10/2016	50.94186	69.16685	Staging	45,000	0	0	400	0	6	0	0	45,000	0	0
Samtas	05/10/2016	50.77604	69.08002	Staging	30,000	30,000	0	0	0	4	7	0	0	0	0
Tengiz	06/10/2016	50.60521	69.15307	Staging	218,000	168,080 [167,246-168,852]	412 [235-667]	49,508 [48,758-50,321]	0	27	10,000	0	0	0	0
Saumalkol	06/10/2016	50.71373	69.70505	Staging	1,000	0	0	300	0	0	0	0	700	0	0
Sholak	08/10/2016	50.56221	69.77075	Staging	25,000	12,000	54	13,000	0	0	3,000	0	0	0	0
Zhumay	08/10/2016	50.68046	69.80665	Staging	390	90	0	300	0	0	0	0	0	0	0
Temirastau	08/10/2016	50.70690	69.94308	Staging	884	800	0	84	0	0	2	0	0	0	0
Mayshukur	08/10/2016	50.73282	69.97643	Staging	0	0	0	0	0	0	0	0	0	0	0
Kumdykol	09/10/2016	50.55003	70.68375	Staging	65,000	34,286 [34,082-34,459]	51	30,714 [30,541-30,918]	0	0	0	0	0	0	0
Zharlykol (Burevestnik)	12/10/2016	51.02335	69.84106	Staging	500	0	0	0	0	0	0	0	500	0	0
Shandykol	12/10/2016	51.07399	69.68269	Staging	50,000	49,903 [49832-49,950]	97 [50-168]	300 [300-300]	0	9	6	0	0	0	0
Alakol	12/10/2016	51.17950	69.74598	Staging	1,300	15	0	1,300	0	0	0	0	0	0	0

Table A2(b) Kostanay West survey region: survey sites, date of count, GPS coordinates, staging or migratory behaviour and geese numbers recorded. Values in square brackets at the Taldykol/Kulikol and Zhetykol sites are 95% confidence intervals calculated from repeated sampling of species composition (see Methods). A=*Anser*, B=*Branta*, T=*Tadorna*.

Lake name	Date	Lat N	Lon E	Behaviour	Total flock	A. alb	A. ery	A. ans	A. fab	Bra ruf	Tad fer	A. alb/ery	A. sp	A/B	A/B/T
Urkash, on the village	28-09-16	51.33999	62.33230	Staging	0	0	0	0	0	0	0	0	0	0	0
Urkash, Lake Sukurkol	28-09-16	51.35222	62.37222	Staging	0	0	0	0	0	0	0	0	0	0	0
Urkash, small pond	28-09-16	51.43970	62.54210	Staging	0	0	0	0	0	0	0	0	0	0	0
Batpakkol	29-09-16	51.42462	62.65553	Staging	7,857	1,025	461	24	0	3,317	1,581	423	456	570	0
Mamyrkol	29-09-16	51.59927	62.70814	Staging	0	0	0	0	0	0	0	0	0	0	0
Druzhba	29-09-16	51.43320	62.92226	Staging	0	0	0	0	0	0	0	0	0	0	0
Jegisbay	29-09-16	51.38689	62.94564	Staging	12	0	0	0	0	10	2	0	0	0	0
Jegisbay	29-09-16	51.38689	62.94564	Migration	58	58	0	0	0	0	0	0	0	0	0
Unknown 1	29-09-16	51.35676	62.97708	Staging	0	0	0	0	0	0	0	0	0	0	0
Unknown 2	29-09-16	51.31809	62.92960	Staging	0	0	0	0	0	0	0	0	0	0	0
Unknown 3	29-09-16	51.24699	62.84895	Staging	0	0	0	0	0	0	0	0	0	0	0
Shoptykol N (?)	29-09-16	51.06071	62.76700	Staging	0	0	0	0	0	0	0	0	0	0	0
Unknown 4	29-09-16	51.21115	62.56756	Staging	0	0	0	0	0	0	0	0	0	0	0
Unknown 5	29-09-16	51.19333	62.54273	Staging	0	0	0	0	0	0	0	0	0	0	0
Unknown 5	29-09-16	51.19333	62.54273	Migration	58	58	0	0	0	0	0	0	0	0	0
near Lake Jarkol	29-09-16	51.15514	62.48180	Staging	0	0	0	0	0	0	0	0	0	0	0
Urkash, Lake Tenis	30-09-16	51.33212	62.34128	Migration	1,000	0	0	0	0	0	1,000	0	0	0	0
Urkash, Lake Tenis	30-09-16	51.33212	62.34128	Staging	13,029	2,039	249	8	0	103	2,145	245	8,240	0	0
Bliksopa	04-10-16	51.75683	61.86366	Staging	2,605	137	25	421	0	1,436	0	586	0	0	0
Ayke	04-10-16	51.00559	61.58998	Staging	0	0	0	0	0	0	0	0	0	0	0
Ayke	04-10-16	51.00559	61.58998	Migration	11	11	0	0	0	0	0	0	0	0	0
Shelkar Karashatau	05-10-16	50.40819	61.18270	Migration	2,450	0	0	150	0	0	0	0	0	750	1,550
Shelkar Karashatau	05-10-16	50.40819	61.18270	Staging	6,945	100	0	205	0	50	4,000	400	0	2,000	190
Sulukol	05-10-16	50.98702	62.02286	Staging	118	0	75	43	0	0	0	0	0	0	0
Taldykol & Kulikol	06-10-16*	51.42329	61.94631	Staging	348,150	220,184 [140,969-299,398]	23,205 [18,762-27,648]	79,261 [16,304-142,217]	50	17,549 [1,554-33,544]	7,952 [713-15,191]	0	0	0	0
Zhetykol (Russia)	09-10-16**	51.03102	60.96978	Staging	73,500	18,887 [6,098-29,674]	4,669 [3,228-6,111]	19,143 [13,737-24,550]	2 [1-5]	10,358 [4,333-16,382]	10,800 [9,178-12,620]	0	0	0	0
Balakol (Russia)	09-10-16	51.03102	60.96978	Staging	1,041	0	500	500	0	21	20	0	0	0	0
Lake Zharsor	13-10-16	51.40420	63.04187	Staging	0	0	0	0	0	0	0	0	0	0	0
Lake Diyevka	14-10-16	52.01723	63.59707	Migration	270	0	0	0	0	150	120	0	0	0	0
Lake Diyevka	14-10-16	52.01723	63.59707	Staging	848	100	45	408	0	0	0	45	250	0	0

Table A2(c) Kostanay North survey region: Survey sites, date of count, GPS coordinates, staging or migratory behaviour and geese numbers recorded. A=*Anser*, B=*Branta*, T=*Tadorna*.

Lake name	Date	Lat N	Lon E	Behaviour	Total flock	A. alb	A. ery	A. ans	A. fab	Bra ruf	Tad fer	A. alb/ery	A. sp	A/B	A/B/T
Shoskaly	25-09-16	51.35068	64.30791	Staging	49	49	0	0	0	0	0	0	0	0	0
Kulakol	26-09-16	51.21279	64.54955	Staging	25	25	0	0	0	0	0	0	0	0	0
Karashar	26-09-16	51.21100	64.55254	Staging	40	40	0	0	0	0	0	0	0	0	0
Mala Aksuat	26-09-16	51.50476	64.4919	Staging	0	0	0	0	0	0	0	0	0	0	0
Sharkol	27-09-16	51.64452	64.54305	Staging	0	0	0	0	0	0	0	0	0	0	0
Bolshoy Aksuat	27-09-16	51.45321	64.49883	Staging	5	5	0	0	0	0	0	0	0	0	0
Kushmurun	28-09-16	52.52599	64.71681	Staging	0	0	0	0	0	0	0	0	0	0	0
Bidak	28-09-16	52.55608	65.5783	Staging	44	0	0	0	0	44	0	0	0	0	0
Koybagar	29-09-16	52.55609	65.57835	Staging	10,761	0	0	1,301	0	3,123	0	3,708	0	2,629	0
Koybagar	29-09-16	52.55609	65.57835	Migration	2,399	0	12	0	0	95	0	991	0	0	0
Tjyuntjugur	29-09-16	52.06898	65.08462	Staging	0	0	0	0	0	0	0	0	0	0	0
Boshakol	29-09-16	53.10814	65.9401	Staging	2,251	0	0	110	0	0	0	1,196	0	945	0
Boshakol	01-10-16	53.10814	65.9401	Migration	3,427	110	0	165	0	7	0	2,200	0	945	0

Table A2(d) North Kazakhstan survey region: survey sites, date of count, GPS coordinates, staging or migratory behaviour and geese numbers recorded A=*Anser*, B=*Branta*, T=*Tadorna*.

Lake name	Date	Lat N	Lon E	Behaviour	Total flock	A. alb	A. ery	A. ans	A. fab	Bra ruf	Tad fer	A. alb/ery	A. sp	A/B	A/B/T
Akzhan	26-Sep-16	54.15594	65.71372	Staging	2,460	0	0	1150	0	0	0	0	1310	0	0
Sarayoban	27-Sep-16	54.12393	65.91022	Staging	270	0	0	245	0	0	0	0	25	0	0
Retchnoe	28-Sep-16	54.08017	65.78692	Staging	497	0	0	495	0	2	0	0	0	0	0
Lebyazhe/Zhaman Sharkol	28-Sep-16	53.96310	65.91216	Migration	1,555	1076	0	0	0	72	0	207	200	0	0
Lebyazhe	29-Sep-16	53.96310	65.91216	Staging	0	0	0	0	0	0	0	0	0	0	0
Zhaman Zarkol	29-Sep-16	53.96310	65.91216	Staging	22	0	0	0	0	22	0	0	0	0	0
Shoshkaly	29-Sep-16	54.02192	66.04486	Staging	1,131	324	2	766	1	36	2	0	0	0	0
Shoshkaly	29-Sep-16	54.02192	66.04486	Migration	129	0	0	0	0	0	0	129	0	0	0
Zhaksysharkol	29-Sep-16	53.81080	66.05495	Migration	10,192	215	5	0	0	0	0	9282	690	0	0
Zhaksysharkol	30-Sep-16	53.81080	66.05495	Staging	0	0	0	0	0	0	0	0	0	0	0
Bolshoy Kak	30-Sep-16	53.61633	66.22688	Migration	1,056	0	0	0	0	0	0	1056	0	0	0
Bolshoy Kak	1-Oct-16	53.61633	66.22688	Staging	1	1	0	0	0	0	0	0	0	0	0
Aksuat	1-Oct-16	53.63784	66.47507	Staging	340	11	0	269	0	60	0	0	0	0	0
Maliy Kak	1-Oct-16	53.79212	66.84679	Staging	1,040	0	0	0	0	0	0	0	1040	0	0
Maliy Kak	2-Oct-16	53.79212	66.84679	Migration	662	15	0	240	0	0	0	17	190	200	0
Zhaltyr	2-Oct-16	53.98130	67.29217	Staging	395	0	0	245	0	0	0	150	0	0	0
nr Balikty	4-Oct-16	54.22829	68.98962	Staging	5,566	32	0	5493	1	0	0	40	0	0	0
Uzynkol	4-Oct-16	54.13502	69.08708	Staging	824	110	0	464	0	0	0	250	0	0	0
Kumdykol	5-Oct-16	54.06979	69.01241	Staging	1,853	0	3	680	0	0	0	0	1170	0	0
Kumdykol	6-Oct-16	54.06979	69.01241	Migration	2,039	2	0	1097	0	0	0	0	940	0	0
Karasor	6-Oct-16	54.16415	69.18821	Migration	152	112	0	0	0	0	0	25	15	0	0
Karasor	7-Oct-16	54.16415	69.18821	Staging	0	0	0	0	0	0	0	0	0	0	0
Terenkol	7-Oct-16	54.38099	69.20073	Staging	952	0	0	950	0	2	0	0	0	0	0
Shagly Teniz	8-Oct-16	54.16486	69.83712	Staging	2	0	0	0	2	0	0	0	0	0	0
Shagly Teniz	8-Oct-16	54.16486	69.83712	Migration	38	38	0	0	0	0	0	0	0	0	0
Tayinsha	8-Oct-16	54.13863	70.24908	Migration	64	57	0	7	0	0	0	0	0	0	0
Solenoe	10-Oct-16	54.84401	70.32056	Staging	380	200	0	180	0	0	0	0	0	0	0
Sukhoe (Kamyshlovo)	10-10-16	54.84722	70.24250	Staging	0	0	0	0	0	0	0	0	0	0	0
Kamyshlovo	10-Oct-16	54.83636	70.16959	Staging	390	340	0	50	0	0	0	0	0	0	0
Polovinnoe	11-Oct-16	54.84865	70.02918	Staging	0	0	0	0	0	0	0	0	0	0	0

Appendix 3 ***Records of other species for all four survey regions***

Count estimates are reported are reported unless recorded as “Present” or x = tens, xx = hundreds, xxx = thousands

Akmola		Russky Zharkol	Taldykol	Koskakol	Koskakol	Aupeldik	Szocsinszkoe	Kubikol	Korzhakol	Kozhakol	Samtas	Tengiz	Saumalkol
Scientific name	**Red List**	**26-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**30-09-16**	**01-10-16**	**02-10-16**	**04-10-16**	**05-10-16**	**05-10-16**	**06-10-16**	**06-10-16**
Anas acuta	LC	30	400	15		60	60	present	400			3000	present
Anas clypeata	LC		700	2	present	30	120	present				50	present
Anas crecca	LC	300	500	120		120		present	100			110	present
Anas penelope	LC	10	100	10	present	10	10	present	20			70	present
Anas platyrhynchos	LC	300	400	60		40	15	present	50				present
Anas querquedula	LC			1	1								
Anas strepera	LC		2000	80		125	125	present				80	present
Aythya ferina	VU		40			10	10		350			30	present
Aythya fuligula	LC		120			8	8	900	850			25	1000
Aythya nyroca	LC									1		1	
Branta leucopsis	LC												
Bucephala clangula	LC		35			4	5	100	150			5	100
Cygnus cygnus	LC	30	126		130	5	115	120	105				800
Cygnus olor	LC						1	3	2			100	
Mergellus albellus	LC								3				
Netta rufina	LC		35			35	35					25	
Oxyura leucocephala	EN		11						17				170
Tadorna tadorna	LC	30	20	5	5	6	6		3			2	
Gavia arctica	LC						2						
Pelecanus crispus	VU	6											
Phalacrocorax carbo	LC	5	2			15	15	3	25				20

Akmola		Russky Zharkol	Taldykol	Koskakol	Koskakol	Aupeldik	Szocsinszkoe	Kubikol	Korzhakol	Kozhakol	Samtas	Tengiz	Saumalkol
Scientific name	**Red List**	**26-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**30-09-16**	**01-10-16**	**02-10-16**	**04-10-16**	**05-10-16**	**05-10-16**	**06-10-16**	**06-10-16**
Ardea alba	LC		3	1		4	4		1	5			
Ardea cinerea	LC				10	7	4		1				
Botaurus stellaris	LC				voice		1						
Phoenicopterus roseus	LC	247							4			300	1050
Podiceps auritus	VU					2		6	7				5
Podiceps cristatus	LC		10			100	100		30			70	present
Podiceps grisegena	LC											1	
Podiceps nigricollis	LC								3				10
Tachybaptus ruficollis	LC		1						1				
Aquila chrysaetos	LC												
Aquila heliaca	VU	1	1		1			3					
Aquila nipalensis	EN		2	1	1			3					
Circus macrourus	NT	1	2					1		1	1		1
Haliaeetus albicilla	LC	2	4	3	3			1	2			3	
Fulica atra	LC		500			50	20	present	300			3000	1000
Grus grus	LC	300	280	900	700								
Tetrax tetrax	NT	4			3		8				6		
Recurvirostra avosetta	LC	50	2										
Charadrius hiaticula	LC		2		1								
Numenius arquata	LC								1				1
Pluvialis apricaria	LC								5				
Pluvialis fulva	LC		5										
Pluvialis squatarola	LC	2							1				2
Vanellus vanellus	NT	120	5	2		6	6		200				4

Akmola		Russky Zharkol	Taldykol	Koskakol	Koskakol	Aupeldik	Szocsinszkoe	Kubikol	Korzhakol	Kozhakol	Samtas	Tengiz	Saumalkol
Scientific name	**Red List**	**26-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**30-09-16**	**01-10-16**	**02-10-16**	**04-10-16**	**05-10-16**	**05-10-16**	**06-10-16**	**06-10-16**
Arenaria interpres	LC	2											
Calidris alpina	LC	120	10			6	6		35			55	10
Calidris minuta	LC								5				
Gallinago gallinago	LC		3	2					1				2
Limosa limosa	NT	1	1	6		1	1		1				
Philomachus pugnax	LC	60				5	3		15			6	5
Tringa erythropus	LC	15	5	2	3		5	1	5				1
Tringa totanus	LC								2				
Chlidonias hybridus	LC												
Chlidonias leucopterus	LC	2							1				
Chlidonias niger	LC							1					
Larus cachinnans	LC	50	5	3	10	20	20	15	10			5	
Larus canus	LC	10	10		15	30	30	present	30			present	present
Larus fuscus	LC	1											
Larus genei	LC								3			5	
Larus ichthyaetus	LC					2	2		3				
Larus ridibundus	LC	300	30	1	5	30	150	present	40			10	present

Akmola		Sholak (Salkar)	Temirastau	Mayshukur	Kumdykol, Ashu-Kumkol, Uzynkol, Zharlykol	Shandykol
Scientific name	**Red List**	**08-10-16**	**08-10-16**	**08-10-16**	**09-10-16**	**12-10-16**
Anas acuta	LC	present	present			
Anas clypeata	LC	present				
Anas crecca	LC	present	present			20
Anas penelope	LC					
Anas platyrhynchos	LC	3000	present			3500
Anas querquedula	LC					
Anas strepera	LC					2
Aythya ferina	VU	present				20
Aythya fuligula	LC	present			present	150
Aythya nyroca	LC					
Branta leucopsis	LC					1
Bucephala clangula	LC	present	100		present	50
Cygnus cygnus	LC	50	10		30	30
Cygnus olor	LC		2			
Mergellus albellus	LC	150			28	350
Netta rufina	LC					32
Oxyura leucocephala	EN		490	647	6	
Tadorna tadorna	LC	2	3			
Gavia arctica	LC					
Pelecanus crispus	VU					
Phalacrocorax carbo	LC	20			present	170
Ardea alba	LC		5		present	4
Ardea cinerea	LC		2			
Botaurus stellaris	LC					

Akmola		Sholak (Salkar)	Temirastau	Mayshukur	Kumdykol, Ashu-Kumkol, Uzynkol, Zharlykol	Shandykol
Scientific name	**Red List**	**08-10-16**	**08-10-16**	**08-10-16**	**09-10-16**	**12-10-16**
Phoenicopterus roseus	LC	2320				
Podiceps auritus	VU	5				
Podiceps cristatus	LC	present			80	175
Podiceps grisegena	LC	4				2
Podiceps nigricollis	LC	6				
Tachybaptus ruficollis	LC	3				
Aquila chrysaetos	LC				1	
Aquila heliaca	VU				3	2
Aquila nipalensis	EN	1			2	
Circus macrourus	NT	1				
Haliaeetus albicilla	LC	2			15	4
Fulica atra	LC	present	present		present	400
Grus grus	LC	54			100	
Tetrax tetrax	NT					
Recurvirostra avosetta	LC					
Charadrius hiaticula	LC					
Numenius arquata	LC					
Pluvialis apricaria	LC					
Pluvialis fulva	LC					
Pluvialis squatarola	LC		4		1	
Vanellus vanellus	NT	present	present		present	3
Arenaria interpres	LC					
Calidris alpina	LC		200			4
Calidris minuta	LC		5			

Akmola		Sholak (Salkar)	Temirastau	Mayshukur	Kumdykol, Ashu-Kumkol, Uzynkol, Zharlykol	Shandykol
Scientific name	**Red List**	**08-10-16**	**08-10-16**	**08-10-16**	**09-10-16**	**12-10-16**
Gallinago gallinago	LC					
Limosa limosa	NT					
Philomachus pugnax	LC		5			
Tringa erythropus	LC				1	4
Tringa totanus	LC					
Chlidonias hybridus	LC				1	
Chlidonias leucopterus	LC		2		3	
Chlidonias niger	LC					
Larus cachinnans	LC					2
Larus canus	LC	present			present	60
Larus fuscus	LC					
Larus genei	LC					
Larus ichthyaetus	LC				1	
Larus ridibundus	LC	present			present	70

Kostanay North		Shoskaly	Kulakol	Karashar	Mala Aksuat	Sharkol	Bolshoy Aksuat	Kushmurun	Bidak	Koybagar	Boshakol	Sharman Zharkol	Zhaksizharkol
Scientific name	Red List	25-09-16	26-09-16	26-09-16	26-09-16	27-09-16	27-09-16	28-09-16	28-09-16	28-09-16	29-09-16	30-09-16	30-09-16
Anas acuta	LC	200		200	200							100	
Anas clypeata	LC	51											
Anas crecca	LC	83		1500	200				200			1000	200
Anas penelope	LC	100		4000	2500							200	
Anas platyrhynchos	LC		6	300	100							600	100
Anas querquedula	LC	3											
Anas sp.	LC		10			25	4000						
Anas strepera	LC	100		300	30	18							100
Aythya ferina	VU	160		1480			300		370		400	3	300
Aythya fuligula	LC	115		20	30				10		30	30	30
Bucephala clangula	LC				3				15		15	6	
Cygnus columbianus	LC									25		22	
Cygnus cygnus	LC			245		14	155			120	180	48	16
Cygnus olor	LC	3		132		20	11			10	10		
Cygnus sp.	LC							60					
Mergellus albellus	LC				2						20	1	
Netta rufina	LC	91			50								
Oxyura leucocephala	EN			10	2				44				
Tadorna tadorna	LC					16							
Waterfowl	LC							3500	150	5500	thousands		
Pelecanus crispus	VU								81	1			
Phalacrocorax carbo	LC	41								10	8	1	
Ardea alba	LC	1		10						140	6	9	4
Ardea cinerea	LC	11		22	3	11	1			60		2	2
Botaurus stellaris	LC	tens											
Podiceps auritus	VU	6			1				20				
Podiceps cristatus	LC	4			15	15			30	450	10	2100	1400
Podiceps grisegena	LC	5			4							1	
Podiceps nigricollis	LC	4		4	9				20			3	
Aquila clanga	LC			1									
Circus aeruginosus	LC	2	2	11		3		1		15		1	

Kostanay North		Shoskaly	Kulakol	Karashar	Mala Aksuat	Sharkol	Bolshoy Aksuat	Kushmurun	Bidak	Koybagar	Boshakol	Sharman Zharkol	Zhaksizharkol
Scientific name	**Red List**	**25-09-16**	**26-09-16**	**26-09-16**	**26-09-16**	**27-09-16**	**27-09-16**	**28-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**30-09-16**	**30-09-16**
Circus cyaneus	LC			2		4			1	15			
Circus macrourus	LC		2	1		3	2			6	3		
Haliaeetus albicilla	LC		1	7		2		1	1	2			2
Fulica atra	LC	2200		2000	1000		900		300		500	600	300
Rallus aquaticus	LC	tens											
Charadrius hiaticula	LC				1								
Pluvialis squatarola	LC				1	1				2	1		
Vanellus vanellus	NT				5								
Calidris alba	LC				1								
Calidris alpina	LC					44	110						
Calidris minuta	LC					16	20						
Calidris pugnax	LC				3	2	8						
Calidris temminckii	LC					1							
Gallinago gallinago	LC					1							
Limosa limosa	NT						7						
Numenius arquata	NT									2			
Tringa erythropus	LC	1		1		9				1		1	
Tringa nebularia	LC						1						
Chlidonias leucopterus	LC			2									
Chroicocephalus ridibundus	LC	25			5	110				2000	100	300	100
Ichtyaetus ichtyaetus	LC								1				6
Larus cachinnans	LC									1			4
Larus canus	LC					40				500	50	1	60
Larus fuscus	LC									40			1
Larus sp.	LC							6000		200			

Kostanay West		Kostanay-Tobol	fishpond 1 and 2	River Tobol	road+Kulikol	Kulikol-Taldykol	Taldykol-Urkash-Babatkol	Tenis	Babatkol	Babatkol-Urkash	Babatkol	Urkash-KulikolN	Kulikol-Taldykol
Scientific name	**Red List**	**25-09-16**	**25-09-16**	**26-09-16**	**26-09-16**	**27-09-16**	**28-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**29-09-16**	**30-09-16**	**01-10-16**
Anas acuta	LC	30	25		50	60	8200	8000	200	300	50	2500	300
Anas clypeata	LC	50	45			2	1100	1000	100	35	35	800	20
Anas crecca	LC	120	3		60	100	1200	1000	200	3100	100	1000	100
Anas penelope	LC	50	25		20	15	700	600	100	100	100	500	50
Anas platyrhynchos	LC	2000	750		220	200	5500	5000	500	2000	200	2000	200
Anas querquedula	LC									30	30	8	
Anas strepera	LC					3	1200	1000	200	400	100	1000	10
Anser indicus	LC					1							
Aythya ferina	VU	200	200			50	2500	2000	500	600	100	1500	50
Aythya fuligula	LC	150	150			100	520	500	20	120	20	500	
Aythya marila	LC									11	11		
Branta bernicula	LC												
Bucephala clangula	LC	1	1				2		2	10	6	20	
Cygnus columbianus	LC												
Cygnus olor	LC	10	2	1	2ad2juv	9	55	50	5	10	10	55	5
Cygnus sp.	LC	27	22	8		2ad4juv	650	600	15	45	35	300	6
Mergellus albellus	LC												
Netta rufina	LC						1		1	50	49	1	41
Oxyura leucocephala	EN						326	326		2		300	
Gavia arctica	LC	17											
Phalacrocorax carbo	LC	1	1		6	60	3	2	1	10	10	1	2
Ardea alba	LC	4		5		10				19	18	8	1
Ardea cinerea	LC	3	1	26			15	5	5	11	10	20	6
Botaurus stellaris	LC						2		2	3	3		
Egretta/Ardea sp.	LC												
Ixobrychus minutus	LC	1											
Podiceps auritus	VU									10	5		
Podiceps cristatus	LC	500	50		2		50	40	10	15	5	50	1
Podiceps grisegena	LC	2ad1juv	2ad1juv				1		1	4	4		
Podiceps nigricollis	LC	70	50				17	3	14	20	15	20	
Podiceps sp.	LC												

Kostanay West		Kostanay-Tobol	fishpond 1 and 2	River Tobol	road+Kulikol	Kulikol-Taldykol	Taldykol-Urkash-Babatkol	Tenis	Babatkol	Babatkol-Urkash	Babatkol	Urkash-KulikolN	Kulikol-Taldykol
Scientific name	**Red List**	**25-09-16**	**25-09-16**	**26-09-16**	**26-09-16**	**27-09-16**	**28-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**29-09-16**	**30-09-16**	**01-10-16**
Accipiter nisus	LC	10	3	3	2	8	20	3	5	5	2	4	6
Accipter gentilis	LC												
Aquila clanga	VU	2ad			1ad	3	1	1		2	1	1	2ad4juv
Aquila heliaca	VU	2 2cy					1					1	1ad1juv
Aquila nipalensis	EN				1juv								
Buteo buteo	LC	1											
Buteo lagopus	LC												
Buteo rufinus	LC				1					1	1		
Circus aeruginosus	LC	1	1	1	4	7	15	5	5	6	3	2	3
Circus cyaneus	LC	2		1	1	3	2		1	2	2	5	3
Circus macrourus	NT	2		2	3	7	13	3	5	13	5	8	10
Circus pygargus	LC												
Circus sp.	LC	1											
Haliaeetus albicilla	LC						6	2	2	2	1	1	5
Pandion haliaetus	LC											1	
Falco columbarius	LC				2		1			2	1	1	1
Falco naumanni	LC												
Falco peregrinus	LC												
Falco sp.	LC	1											
Falco tinnunculus	LC	5	2		3		7	2	2	5	2	4	5
Falco vespertinus	NT			2									
Fulica atra	LC	200	200		200	5500	500	500		5	5	700	
Porzana porzana	LC											2	
Rallus aquaticus	LC						1		1	1	1	1	1
Grus grus	LC	317	114		2000		5500	300	2500	4500	1500	5000	9000
Tetrax tetrax	NT									1+15	1		
Recurvirostra avosetta	LC												
Charadrius hiaticula	LC												
Pluvialis apricaria	LC	1	1										
Pluvialis squatarola	LC			1			9	9		1		3	
Vanellus vanellus	NT	2	2			2	3	3		3	3	1	1

Kostanay West		Kostanay-Tobol	fishpond 1 and 2	River Tobol	road+Kulikol	Kulikol-Taldykol	Taldykol-Urkash-Babatkol	Tenis	Babatkol	Babatkol-Urkash	Babatkol	Urkash-KulikolN	Kulikol-Taldykol
Scientific name	**Red List**	**25-09-16**	**25-09-16**	**26-09-16**	**26-09-16**	**27-09-16**	**28-09-16**	**28-09-16**	**28-09-16**	**29-09-16**	**29-09-16**	**30-09-16**	**01-10-16**
Arenaria interpres	LC						4	4				4	
Calidris alba	LC						2	2					
Calidris alpina	LC	25	25			2	100	100				120	20
Calidris canutus	LC											1	
Calidris ferruginea	NT						2AKo	2					
Calidris minuta	LC	8	8				40	40				15	
Calidris temminckii	LC					4	3	3					
Gallinago gallinago	LC									15	10	1	2
Limosa lapponica	NT	5	5				2	2				1	
Limosa limosa	NT	40	35				6	6				3	
Lymnocryptes minimus	LC									1	1		
Numenius arquata	NT						1		1	1	1		
Philomachus pugnax	LC	5	5				20	20				7	
Scolopax rusticola	LC												
Tringa erythropus	LC	25	25				2	2					
Tringa glareola	LC											1AKo?	
Tringa nebularia	LC											2	
Tringa ochropus	LC												
Tringa stagnatilis	LC											1	
Chlidonias niger	LC					1ad6juv	6						
Hydrocoloeus minutus	LC											4	
Hydroprogne caspia	LC	1											
Larus cachinnans	LC	30	5	xx			2	1					
Larus cachinnans (barabensis)	LC	50	5	xx		50	300	200	50	xx	xx	200	300
Larus canus	LC	500	100	xx	50	1000	1000	600	100	100	50	100	200
Larus fuscus	LC	1			1					1	1	3	1juv
Larus ichthyaetus	LC	3	1			1							
Larus marinus	LC	8"1'		1									
Larus ridibundus	LC	300	50	xx		100	500	200	100	250	250	200	30
Larus sp.	LC												

Kostanay West		Taldykol	Taldykol-Bliskopa	Bliskopa	Bliskopa-Ayke-Karashatau	Bliskopa	Karashatau ponds in village	Shelkar Karashatau	Karas-hatau-Sulukol	Shelkar Karashatau	Karashatau ponds in village	Sulukol	Sulukol-Taldykol
Scientific name	**Red List**	**02-10-16**	**03-10-16**	**03-10-16**	**04-10-16**	**04-10-16**	**04-10-16**	**04-10-16**	**05-10-16**	**05-10-16**	**05-10-16**	**05-10-16**	**06-10-16**
Anas acuta	LC	300	200	30	65				50			40	40
Anas clypeata	LC	50	10	5	15				25		2	20	15
Anas crecca	LC	100	115	50	150				85			70	120
Anas penelope	LC	200	80	20	100				50			50	50
Anas platyrhynchos	LC	300	350	150	2400				4300			70	400
Anas querquedula	LC	1			1		1		1		1		
Anas strepera	LC	40	5		20	10	10		5			5	5
Anser indicus	LC												
Aythya ferina	VU	120	30		7								45
Aythya fuligula	LC	30	4										
Aythya marila	LC												
Branta bernicula	LC												
Bucephala clangula	LC												1
Cygnus columbianus	LC												
Cygnus olor	LC	9	5		21	16		5	12			2	20
Cygnus sp.	LC	20	10		10	2ad4juv							1
Mergellus albellus	LC												
Netta rufina	LC	18	9		51		51		45		45		2
Oxyura leucocephala	EN												
Gavia arctica	LC												
Phalacrocorax carbo	LC	2	2						8				
Ardea alba	LC	10	3		1								
Ardea cinerea	LC	2											
Botaurus stellaris	LC	1	8	8	5			5	1				1
Egretta/Ardea sp.	LC								8				2
Ixobrychus minutus	LC												
Podiceps auritus	VU												
Podiceps cristatus	LC	1							1			1	
Podiceps grisegena	LC												1
Podiceps nigricollis	LC												
Podiceps sp.	LC												

Kostanay West		Taldykol	Taldykol-Bliskopa	Bliskopa	Bliskopa-Ayke-Karashatau	Bliskopa	Karashatau ponds in village	Shelkar Karashatau	Karas-hatau-Sulukol	Shelkar Karashatau	Karashatau ponds in village	Sulukol	Sulukol-Taldykol
Scientific name	**Red List**	**02-10-16**	**03-10-16**	**03-10-16**	**04-10-16**	**04-10-16**	**04-10-16**	**04-10-16**	**05-10-16**	**05-10-16**	**05-10-16**	**05-10-16**	**06-10-16**
Accipiter nisus	LC	10	5	2	10	1			5	1			2
Accipter gentilis	LC												
Aquila clanga	VU	1juv											
Aquila heliaca	VU	2ad1juv	8	1	3				1	1			1
Aquila nipalensis	EN		1										
Buteo buteo	LC												
Buteo lagopus	LC	3			2								
Buteo rufinus	LC				5(1black)				2				1
Circus aeruginosus	LC	10	15		10	1			5			2	10
Circus cyaneus	LC	3	6	3	13	1			6				9
Circus macrourus	NT	10	9		3				10	2		1	10
Circus pygargus	LC	1											
Circus sp.	LC												
Haliaeetus albicilla	LC	2	4						1	1			1
Pandion haliaetus	LC												
Falco columbarius	LC	3	2		6				8			1	3
Falco naumanni	LC				1m, 1juv/f								
Falco peregrinus	LC												
Falco sp.	LC												
Falco tinnunculus	LC	10	5	1	15				8			2	5
Falco vespertinus	NT												
Fulica atra	LC	5							4		1	3	6
Porzana porzana	LC												
Rallus aquaticus	LC		1	1	2	2							1
Grus grus	LC	500	3000	950	208			8	400				850
Tetrax tetrax	NT		360	4	150			3				6	
Recurvirostra avosetta	LC				9		9		5		5		
Charadrius hiaticula	LC												
Pluvialis apricaria	LC												
Pluvialis squatarola	LC				1		1		2		1		1

Kostanay West		Taldykol	Taldykol-Bliskopa	Bliskopa	Bliskopa-Ayke-Karashatau	Bliskopa	Karashatau ponds in village	Shelkar Karashatau	Karas-hatau-Sulukol	Shelkar Karashatau	Karashatau ponds in village	Sulukol	Sulukol-Taldykol
Scientific name	**Red List**	**02-10-16**	**03-10-16**	**03-10-16**	**04-10-16**	**04-10-16**	**04-10-16**	**04-10-16**	**05-10-16**	**05-10-16**	**05-10-16**	**05-10-16**	**06-10-16**
Vanellus vanellus	NT	5	1		30		15		15			8	25
Arenaria interpres	LC				3		3						
Calidris alba	LC												
Calidris alpina	LC		4	4	30		30		20		20		v
Calidris canutus	LC												
Calidris ferruginea	NT												
Calidris minuta	LC				5		5		3		3		
Calidris temminckii	LC												
Gallinago gallinago	LC	1							3	2		1	1
Limosa lapponica	NT				3		3		4		4		
Limosa limosa	NT				8		8		5		5		
Lymnocryptes minimus	LC								1			1	
Numenius arquata	NT												
Philomachus pugnax	LC				1		1		4		4		
Scolopax rusticola	LC	1											
Tringa erythropus	LC												
Tringa glareola	LC								1			1	1
Tringa nebularia	LC				2		2		2			2	
Tringa ochropus	LC				1								
Tringa stagnatilis	LC				1		1		1		1		
Chlidonias niger	LC												
Hydrocoloeus minutus	LC												
Hydroprogne caspia	LC												
Larus cachinnans	LC												
Larus cachinnans (barabensis)	LC	200	200	5	120				200				200
Larus canus	LC	100	125	20	500				300	200		20	300
Larus fuscus	LC												1
Larus ichthyaetus	LC												
Larus marinus	LC												
Larus ridibundus	LC	500	115	10	200				300	250		50	70
Larus sp.	LC												

Kostanay West		Sulukol	Taldykol	Taldykol	Taldykol	Taldykol-Kulikol	Taldykol-Kulikol	Kulikol-Urkash	Tenis	Urkash-Dieyvka	Tenis	Zharsor	Dieyvka	Dieyvka-Kostanay
Scientific name	**RedList**	**06-10-16**	**07-10-16**	**08-10-16**	**09-10-16**	**10-10-16**	**11-10-16**	**12-10-16**	**12-10-16**	**13-10-16**	**13-10-16**	**13-10-16**	**13-10-16**	**14-10-16**
Anas acuta	LC	30	200	xx	100		7	2000	2000	2100	2000		100	x
Anas clypeata	LC	15	35	10				100	100	150	100		50	xx
Anas crecca	LC	50	100		120			1000	1000	150	100		50	x
Anas penelope	LC	50	20	100	50	20		600	600	330	300		30	x
Anas platyrhynchos	LC	70	500	440	xx			2000	2000	2200	2000	100	100	xx
Anas querquedula	LC						3							
Anas strepera	LC	5	15		100			1000	1000	250	200		50	
Anser indicus	LC													
Aythya ferina	VU		40	270		9		800		920	800	6osp	60	xx
Aythya fuligula	LC		6	150				300	300	480	300	30	50	xx
Aythya marila	LC					1		2	2	25			25	xx
Branta bernicula	LC													
Bucephala clangula	LC	1		2				15	15	6	2		4	
Cygnus columbianus	LC			1				243	243	50	50			
Cygnus olor	LC	10	15	15	5	10	10	120	120	40	30		8	2
Cygnus sp.	LC	4	100	1	8	30	v	2500	2500	1500	1500	10	5	35
Mergellus albellus	LC		1	1	7			3	3	80			80	35
Netta rufina	LC	2	20	22	3			25	25	7	5		2	
Oxyura leucocephala	EN							141	141	40			40	
Gavia arctica	LC													
Phalacrocorax carbo	LC									40	40		40	
Ardea alba	LC			1				10	1					
Ardea cinerea	LC						9	10	1					
Botaurus stellaris	LC	1		3		10	8	1	1					
Egretta/Ardea sp.	LC	2				1								
Ixobrychus minutus	LC													
Podiceps auritus	VU													
Podiceps cristatus	LC					1		19	19	150	15		135	400
Podiceps grisegena	LC	1									70		70	
Podiceps nigricollis	LC									70				
Podiceps sp.	LC							20	20					
Accipiter nisus	LC	1	5	5	5	5	5	3	1					

Kostanay West		Sulukol	Taldykol	Taldykol	Taldykol	Taldykol-Kulikol	Taldykol-Kulikol	Kulikol-Urkash	Tenis	Urkash-Dieyvka	Tenis	Zharsor	Dieyvka	Dieyvka-Kostanay
Scientific name	**RedList**	**06-10-16**	**07-10-16**	**08-10-16**	**09-10-16**	**10-10-16**	**11-10-16**	**12-10-16**	**12-10-16**	**13-10-16**	**13-10-16**	**13-10-16**	**13-10-16**	**14-10-16**
Accipter gentilis	LC													
Aquila clanga	VU		1juv											
Aquila heliaca	VU				1			1ad						2
Aquila nipalensis	EN													
Buteo buteo	LC													
Buteo lagopus	LC		1		2		1	10	2	2	1		1	
Buteo rufinus	LC		1											
Circus aeruginosus	LC	3						2	1	1	1			
Circus cyaneus	LC	2	5	2	1	1	2	4	1	2	1		1	
Circus macrourus	NT	2	5	2		1		2	1	1			1	
Circus pygargus	LC													
Circus sp.	LC			1										
Haliaeetus albicilla	LC	1	3	4		1	2	10	2	4	2		2	
Pandion haliaetus	LC													
Falco columbarius	LC	1	1	5	1	5	1	2	1	1			1	
Falco naumanni	LC													
Falco peregrinus	LC									1	1			
Falco sp.	LC													
Falco tinnunculus	LC	2	2					2	1	1			1	
Falco vespertinus	NT													
Fulica atra	LC	6	3					30	30	6	5		1	
Porzana porzana	LC													
Rallus aquaticus	LC	1												
Grus grus	LC	5	500											
Tetrax tetrax	NT		2											
Recurvirostra avosetta	LC							7	7					
Charadrius hiaticula	LC									1	1			
Pluvialis apricaria	LC													
Pluvialis squatarola	LC	1	1					3	3	5	5			
Vanellus vanellus	NT	15	4	2	2					8	3		5	
Arenaria interpres	LC													
Calidris alba	LC			2										

Kostanay West		Sulukol	Taldykol	Taldykol	Taldykol	Taldykol-Kulikol	Taldykol-Kulikol	Kulikol-Urkash	Tenis	Urkash-Dieyvka	Tenis	Zharsor	Dieyvka	Dieyvka-Kostanay
Scientific name	**RedList**	**06-10-16**	**07-10-16**	**08-10-16**	**09-10-16**	**10-10-16**	**11-10-16**	**12-10-16**	**12-10-16**	**13-10-16**	**13-10-16**	**13-10-16**	**13-10-16**	**14-10-16**
Calidris alpina	LC	v		20	v			150	150	100	100			
Calidris canutus	LC													
Calidris ferruginea	NT													
Calidris minuta	LC							3	3	1	1			
Calidris temminckii	LC													
Gallinago gallinago	LC	1		1										
Limosa lapponica	NT													
Limosa limosa	NT													
Lymnocryptes minimus	LC													
Numenius arquata	NT													
Philomachus pugnax	LC							1	1					
Scolopax rusticola	LC													
Tringa erythropus	LC													
Tringa glareola	LC	1												
Tringa nebularia	LC													
Tringa ochropus	LC													
Tringa stagnatilis	LC													
Chlidonias niger	LC													
Hydrocoloeus minutus	LC													
Hydroprogne caspia	LC													
Larus cachinnans	LC													
Larus cachinnans (barabensis)	LC		100	xx	xx	xx		150	100	150	100		50	xx
Larus canus	LC	25	100	xx	xx	xx		250	200	200	200			xx
Larus fuscus	LC		1					1	1					
Larus ichthyaetus	LC													
Larus marinus	LC													
Larus ridibundus	LC	20	50	xx	xx	xx		40	40	85	60		25	xx
Larus sp.	LC									1150		100	1050	xxx

North Kazakhstan		Akzhan	Sarayoban	Retchnoe	Lebyazhe	Zhaman Zarkol	Shoshkaly	Zhaksysharkol	Bolshoy Kak	Aksuat	Maliy Kak	Zhaltyr	nr Balikty
Scientific name	**Red List**	**26-09-16**	**27-09-16**	**28-09-16**	**29-09-16**	**29-09-16**	**29-09-16**	**29-09-16**	**01-10-16**	**01-10-16**	**02-10-16**	**02-10-16**	**04-10-16**
Anas acuta	LC											25	
Anas clypeata	LC			Present									
Anas crecca	LC		2	Present								1	
Anas platyrhynchos	LC			12									3
Anas querquedula	LC			12									
Anas sp.	LC						2			56		15	
Anas strepera	LC			15								2	
Aythya ferina	VU			15									
Aythya fuligula	LC			2								17	
Bucephala clangula	LC			1				6				16	
Cygnus columbianus	LC										245		
Cygnus cygnus	LC	28	195	11				8			152	28	7
Cygnus olor	LC								8	66		32	
Mergellus albellus	LC						2						
Mergus serrator	LC												
Netta rufina	LC											3	
Tadorna ferruginea	LC						2						
Gavia arctica	LC	1						1					
Pelecanus onocrotalus	LC	5											
Phalacrocorax carbo	LC	13	127			24			12				23
Ardea alba	LC						24						1
Ardea cinerea	LC												
Botaurus stellaris	LC					1							
Podiceps cristatus	LC			2				7			2		
Accipiter nisus	LC		1	1			1						
Aquila clanga	VU	1		1									
Aquila heliaca	VU												
Buteo lagopus	LC		1						1		1		
Circus aeruginosus	LC	1		2			1				1		1
Circus cyaneus	LC	1	1				1	1					1
Circus macrourus	NT	1		1									
Haliaeetus albicilla	LC		2					1		3		1	3

North Kazakhstan		Akzhan	Sarayoban	Retchnoe	Lebyazhe	Zhaman Zarkol	Shoshkaly	Zhaksysharkol	Bolshoy Kak	Aksuat	Maliy Kak	Zhaltyr	nr Balikty
Scientific name	**Red List**	**26-09-16**	**27-09-16**	**28-09-16**	**29-09-16**	**29-09-16**	**29-09-16**	**29-09-16**	**01-10-16**	**01-10-16**	**02-10-16**	**02-10-16**	**04-10-16**
Pandion haliaetus	LC		1										
Falco peregrinus	LC											1	
Falco tinnunculus	LC												
Fulica atra	LC		16	3								15	
Porzana porzana	LC												
Grus grus	LC	111	48	562	11		4	181	128	1	63		
Pluvialis squatarola	LC						1			1	2	13	
Vanellus vanellus	NT	3	1							24		13	
Arenaria interpres	LC										6		
Gallinago gallinago	LC											35	
Lymnocryptes minimus	LC											1	
Numenius arquata	NT						5			6			
Tringa erythropus	LC									1			
Larus cachinnans	LC												
Larus canus	LC		22	12						45			
Larus ichthyaetus	LC									1			
Larus ridibundus	LC	4											

North Kazakhstan		Uzynkol	Kumdykol	nr Kumdykol	Karasor	Terenkol	nr Shagly Teniz	Shagly Teniz	Tayinsha	Solenoe	Sukhoe (Kamyshlovo)	Kamyshlovo	Polovinnoe
Scientific name	**Red List**	**04-10-16**	**05-10-16**	**06-10-16**	**07-10-16**	**07-10-16**	**07-10-16**	**08-10-16**	**08-10-16**	**09-10-16**	**10-10-16**	**11-10-16**	**11-10-16**
Anas acuta	LC												
Anas clypeata	LC								Present				
Anas crecca	LC					X			Present				
Anas platyrhynchos	LC					X			Present				7
Anas querquedula	LC												
Anas sp.	LC	1			2	1	hundreds				25		
Anas strepera	LC								12				
Aythya ferina	VU												
Aythya fuligula	LC												
Bucephala clangula	LC								1				
Cygnus columbianus	LC		2				1	12					
Cygnus cygnus	LC	8	19			1				1	15	32	6
Cygnus olor	LC							28	9	185	178		
Mergellus albellus	LC					6							
Mergus serrator	LC								3				
Netta rufina	LC					7			5				
Tadorna ferruginea	LC												
Gavia arctica	LC												
Pelecanus onocrotalus	LC												
Phalacrocorax carbo	LC				18				25				
Ardea alba	LC							8					
Ardea cinerea	LC						1						
Botaurus stellaris	LC						3						
Podiceps cristatus	LC								12			7	2
Accipiter nisus	LC												
Aquila clanga	VU												
Aquila heliaca	VU	1											
Buteo lagopus	LC		3										
Circus aeruginosus	LC						3						
Circus cyaneus	LC					1	4	3	3				
Circus macrourus	NT												

North Kazakhstan		Uzynkol	Kumdykol	nr Kumdykol	Karasor	Terenkol	nr Shagly Teniz	Shagly Teniz	Tayinsha	Solenoe	Sukhoe (Kamyshlovo)	Kamyshlovo	Polovinnoe
Scientific name	**Red List**	**04-10-16**	**05-10-16**	**06-10-16**	**07-10-16**	**07-10-16**	**07-10-16**	**08-10-16**	**08-10-16**	**09-10-16**	**10-10-16**	**11-10-16**	**11-10-16**
Haliaeetus albicilla	LC	7			1				3		2		1
Pandion haliaetus	LC					Present							
Falco peregrinus	LC		1										2
Falco tinnunculus	LC												
Fulica atra	LC					Present			6				Present
Porzana porzana	LC												
Grus grus	LC			11									
Pluvialis squatarola	LC												
Vanellus vanellus	NT								5				
Arenaria interpres	LC												
Gallinago gallinago	LC												
Lymnocryptes minimus	LC												
Numenius arquata	NT												
Tringa erythropus	LC												
Larus cachinnans	LC								1				
Larus canus	LC					1						5	2
Larus ichthyaetus	LC								3			5	
Larus ridibundus	LC												

Appendix 4 *Sources of GIS information used in the analyses*

Country and province boundaries

Basic country shapefiles and admin areas downloaded from
http://www.diva-gis.org/gdata

Roads and inland water

Roads, inland water, elevation downloaded from same source as above, for inland water they have used "Digital Chart of the World":
http://www.diva-gis.org/gdata

World water bodies

World Water bodies available from ESRI
https://www.arcgis.com/home/item.html?id=e750071279bf450cbd510454a80f2e63

World linear water bodies

World Linear Water available from ESRI
http://www.arcgis.com/home/item.html?id=273980c20bc74f94ac96c7892ec15aff

Lakes of the former Soviet Union downloaded from USGS, meta-data at:
http://pubs.usgs.gov/of/2001/ofr-01-104/fsucoal/metadata/faq/lakes.htm#what

World Forest Cover

Forest cover (Percentage 0-100) for the year 2000. Results from time-series analysis of Landsat images characterizing forest extent and change. Reference 2000 and 2014 imagery are median observations from a set of quality assessment-passed growing season observations. Results from time-series analysis of Landsat images in characterizing global forest extent and change from 2000 through 2014. For additional information about these results, please see the associated journal article (Hansen et al., Science 2013). Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

World Cropland

Agricultural activities have dramatically altered our planet's land surface. To understand the extent and spatial distribution of these changes, we have developed a new global data set of croplands and pastures circa 2000 by combining agricultural inventory data and satellite-derived land cover data. The agricultural inventory data, with much greater spatial detail than previously available, is used to train a land cover classification data set obtained by merging two different satellite-derived products (Boston University's MODIS-derived land cover product and the GLC2000 data set). Our data are presented at 5 min (_10 km) spatial resolution in longitude by longitude, have greater accuracy than previously available, and for the first time include statistical confidence intervals on the estimates. According to the data, there were 15.0 (90% confidence range of 12.2–17.1) million km^2 of cropland (12% of the Earth's ice-free land surface) and 28.0 (90% confidence range of 23.6–30.0) million km^2 of pasture (22%) in the year 2000.

Appendix 5 *Estimating geese numbers at Taldykol and Kulikol lakes*

The Kostanay West team made repeated counts at Taldykol/Kulikol because of the importance of these lakes, and in total they obtained 17 separate counts of species composition on 12 separate days from 26 September to 11 October 2016. More than one count took place on several days, either through the team surveying different areas of the lakes or through counts in the morning of returning birds and then separate counts in the afternoon (of returning/departing birds). Counts mostly consisted of direct observations of all birds. However, random sampling (of every fifth bird in flocks) was undertaken on 4 days when very large numbers of flying birds made it impossible to estimate species composition of them all.

A maximum count of 348,150 birds was recorded between 19:00-19:45 on 6 October 2016 and Risto/Samuli consider this the best estimate of the maximum number of birds at both lakes (the lakes are only 2.5 km apart and geese were regularly seen moving between each lake). This count of 348,150 was a mixed species flock of *Anser*/*Branta*/*Tadorna* species. All population estimates depend on this total.

The proportion of LWfG varies a lot over the 17 count occasions (from 0.1% to 41% of the total) and these extremes produce implausibly low or implausibly high population estimates. Estimating a weighted average of LWfG proportions across all 17 count occasions is one potential approach. However, this is complicated by what appears to be a general drop off in the proportion of LWfG present at the sites (high proportions in early counts and fewer in later counts due to an increase in overall bird numbers and/or departures of LWfG) (see **Figure A1**). In addition, while the overall average across all 17 counts provides reasonable estimates for LWfG (overall proportions of 7.4%, with 95% confidence intervals 6.0 – 8.7%), this approach does not work when other species are considered. This is particularly so for RbG where the same approach produces unrealistically high proportions (33% RbG, 95% CI 22-44%) which produces a total estimate of around 117,600 RbG which is more double the global population estimate of this species (56,000 birds) at just these two lakes and is clearly unrealistic. The proportions of RbG counted are also highly variable (see **Figure A1**) and likely to be a result of different patterns of timing in the departure and arrival of this species at lakes (see **Annex 1** and **Box 5**).

In the end, we chose to estimate species composition from counts of birds taken at the same observation point and on the same afternoon (between 15:15 and 19:00) as the maximum count of 348,150 birds. This doesn't utilize all of the available information from the other days of sampling, however it provides very similar estimates of the proportion of LWfG to the figure above and it provides plausible estimates of RbG numbers. Proportions on this afternoon are taken from four periods of sampling every fifth bird as well as additional counts of a further 13,135 birds where a total 1,552 birds were identified to species level. A weighted mean and 95% confidence intervals were then calculated for each species. Observations on species composition made in the same afternoon as the maximum dusk count of 348,150 birds should also accurately reflect the species present, as there will have been no further influxes (or departures) of birds at this time.

This produced the following proportions and population estimates:

LWfG, mean = 6.6% (95% CI 5.3 – 7.9%) and 23,205 birds (95% CI 18,750 – 27,650)

RbG, mean = 5.0% (95% CI 0.4 – 9.5%) and 17,550 birds (95% CI 1,550 – 33,550)

The mean proportion and confidence intervals of LWfG in the flock on this day overlap with the mean and confidence intervals for this species from all 17 count occasions (see the graph below – the single

error bar is on the count on the 6 October which is when the maximum flock size was observed). This provides some confidence that there really were around 23,000 LWfG at these two lakes. For RbG there is less confidence in the results as the average proportion on 6 October is less than the average across all 17 counts (see graph). However, using a single count method is still preferred as the total population estimate of ~17,400 birds seems more realistic, and when the number is added to all other RbG observations we get a total estimate of around 40,000 birds – which is in line with previous surveys and the total global population.

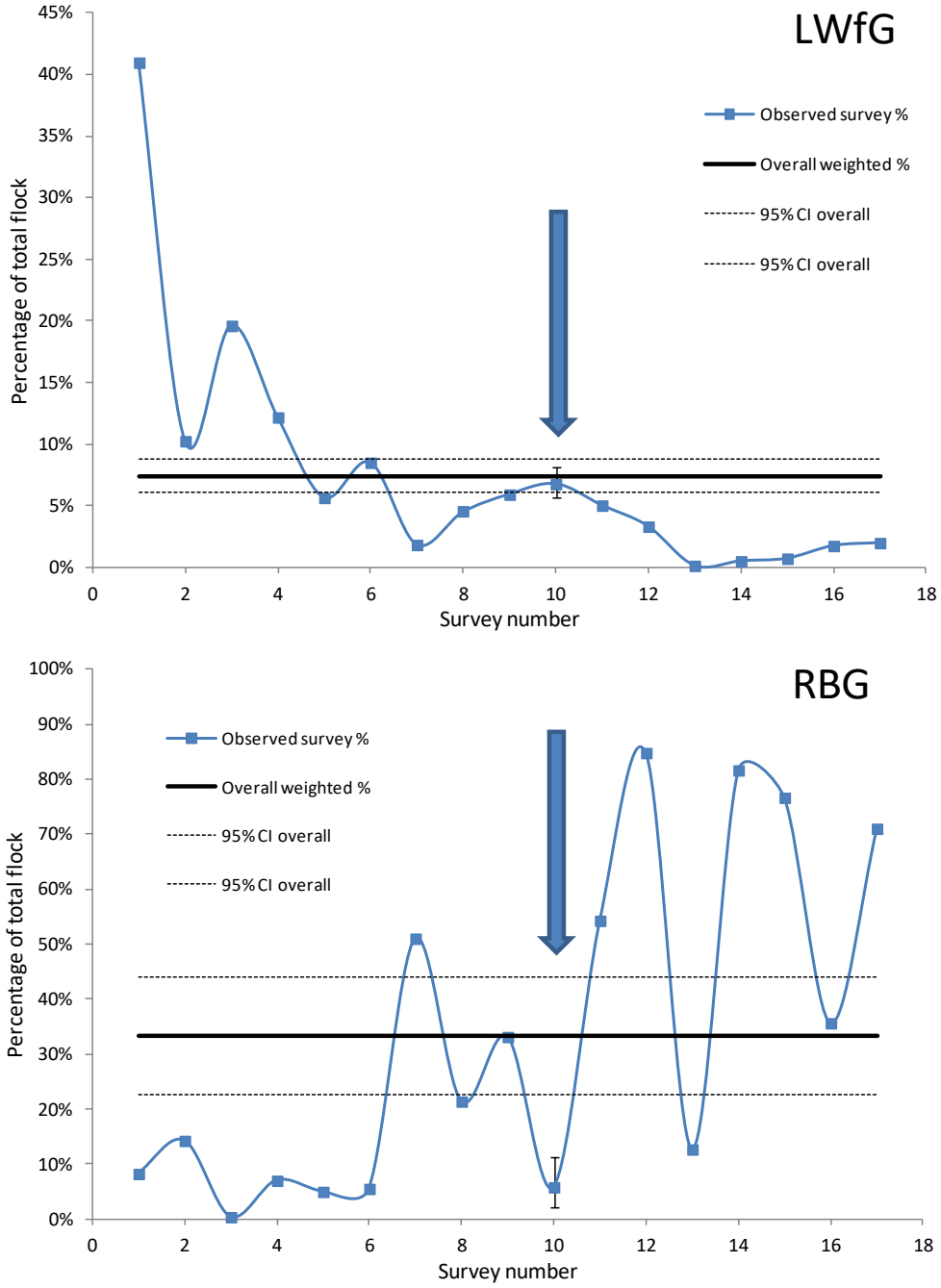


Figure A1 The observed proportions of Lesser White-fronted Geese (upper figure) and Red-breasted Geese (lower) in counts of identified birds at Taldykol and Kulikol Lakes over 17 count occasions. Blue squares and smoothed blue lines indicate the observed proportion on each survey occasion; the solid black lines and dashed lines are the overall weighted mean and 95% confidence intervals. The maximum observed flock of 348,150 birds was on the same day as survey 10 (blue arrows). Error bars on survey 10 are the 95% confidence intervals for this count.

Appendix 6 ***Modified field monitoring instructions for Lesser White-fronted Goose***

The first general monitoring instruction to facilitate common methods for surveys of Lesser White-fronted Geese was published by the Fennoscandian LWfG Conservation project (Tolvanen *et al*. 1999). This included not only recommendations for identification and sampling methods but also instructions for measuring behaviour of birds in the field.

An updated version was produced within 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" in 2012 (LIFE10 NAT/GR/000638) and was subsequently made available in electronic form (http://piskulka.net/docs/MonitInstrucsLWfG2013.pdf) as well as in the form of a shorter field guide in several languages (https://wwf.fi/mediabank/2341.pdf). The 2012 monitoring instructions were also adopted by the AEWA Lesser White-fronted Goose International Working Group at its 2nd meeting in Greece in November 2012 and thus serve as the general guidance for monitoring the species within the Western Palearctic.

Following the modelling exercises and survey results in the present report, several suggestions to improve the reliability of the counts are added in red font below:

Field monitoring instructions for Lesser White-fronted Goose

These instructions are made for Lesser White-fronted Goose (*Anser erythropus*, LWfG) surveys in staging and wintering areas. In these areas the LWfG are often mixed with large numbers of other goose species, usually with the (Greater) White-fronted Goose (*A. albifrons*).

The most important data to be collected during LWfG field monitoring are:

- Count (or estimate) of the number of LWfG (and other geese) present
- Age structure
- Colour rings or neck bands
- Locations of the feeding and roosting sites as well as habitat types and conservation status of these sites – relevant mainly for new sites for which this data is not yet available
- Hunting pressure

Results of the field work should be reported using these titles (2-6).

1. General instructions

- The identification of LWfG (i.e. separating it reliably from the White-fronted Goose) is very difficult, and requires good observation conditions and very good field identification skills. Keep this in mind and report as LWfG only individuals that are definitely identified by a skillful observer. Uncertainly identified white-fronted geese are always reported separately as *Anser albifrons/erythropus.*

- Always use a note book, and note everything down in the same note book in order not to lose data. Use abbreviations for making faster notes:

English name	Scientific name	Abbreviation
Lesser White-fronted Goose	*Anser erythropus*	Aery
White-fronted Goose	*A. albifrons*	Aalb
unidentified white-fronted goose	*A albifrons/erythropus*	Aa/e
Greylag Goose	*A. anser*	Aans
unidentified Anser goose	*Anser* sp.	Ans
Red-breasted Goose	*Branta ruficollis*	Bruf
unidentified goose	*Anser* sp. / *Branta* sp.	AB

Age	Abbreviation
adult bird	ad
juvenile bird	juv
2nd calendar year bird	2cy

Directions	Abbreviation
north, east, south, west	N, E, S, W
north-east, south-east, south-west, etc.	NE, SE, SW, etc.
north-north-east, east-north-east, etc.	NNE, ENE, etc.

- When working in areas not already identified as permanent staging / wintering sites of LWfG, always locate your observation point — if possible, using a GPS – and mark it on a map. When using GPS, don't rely on the GPS's memory, but always also write down the co-ordinates in your note book.

- For each observation of LWfG, note down exact date and time. For flying flocks, always note down the exact time (in the accuracy of minute) and the direction, using a compass.

- For every field day, note down all the sites checked / the route of the survey (also including sites checked to be empty of geese). When marking observations on working copies of maps, note down the same symbol (number) of the observation on the map and in your note book.

2. Number of LWfG and other accompanying geese

2.1 Direct counts

This method is preferred, and should be used always when possible.

When observing pure flocks of LWfG or LWfG in relatively small mixed flocks of geese, accurately count the number of individuals. Even when mixed in a flock of White-fronted or other geese, the LWfG tend to flock in their own group.

Try to identify all individuals by species and the LWfG by age at the same time. Scan the whole flock systematically from one end to the other individual by individual. Carefully wait until each individual turns its head up, to be positively identified (and aged). However, keep in mind that:

- LWfG are much lower than White-fronted Geese and surprisingly easily hidden in the vegetation / behind other geese even when the White-fronted Geese appear to be easily visible

- also juveniles need to be individually and definitely identified by species

Therefore, counting a flock of geese and identifying all individuals requires time and patience. Finding a LWfG in a flock of hundreds of White-fronted Geese may require several repeated careful “scans” of the whole flock by telescope even in good observation conditions, and this may easily take more than half an hour.

In areas where LWfG are already known to occur only as vagrants or in single individuals (e.g. sites with large concentrations of White-fronted Geese on the Black Sea coast in Bulgaria and Romania, and on the North Sea coast), it is more efficient to concentrate in scanning the flocks in order to find the LWfG and not to spend time in sampling as described below in 2.2.

2.2 Estimation of total numbers for each goose species in large flocks

However, sometimes - especially along the migration route of the main populations of LWfG, when a very large number (thousands or tens of thousands) of geese and possibly hundreds or even thousands of LWfG are present - counting and identifying each individual is simply not possible. In these kind of conditions, the method to estimate the number of each species is:

1. to count the total number of geese present
2. to estimate species composition by random sampling

Always clarify in the report, which method has been used!

2.2.1 Counting the total number of geese

The best way to count the total number of geese is to count them using spotting scopes and binoculars when taking off from a roost. Departure from the roost normally starts much before sunrise, so you already need to be ready and in position for the count in the dark before the dawn. Counting a large roost requires at least three people, one of them keeping book. When counting the total number of geese during the morning flight it is normally useless even to try to estimate the species composition due to the poor light conditions and the large number of geese.

The general method of counting large flocks of birds is to first count 10 individuals accurately, then use this “measuring flock“ to estimate a bigger “measuring flock“ of 100 individuals (= 10 x 10), and then estimate the size of the whole flock in groups of hundreds. Take into account, that some parts of the flocks are more dense. Reliable estimation of flocks of thousands of geese requires experience, and repeated “calibration of the measuring flock“.

2.2.2 Estimating the species composition by random sampling

Flocks on the ground: When observing large goose flocks on the ground (and there’s not enough time to identify all individuals), take **random samples of birds in the flock through counting random birds.** The easiest way to do this is to observe every fourth, fifth or ninth bird and **it is recommended to identify and record every fifth bird**. Taking random samples in this way will produce more precise estimates of the species composition than counting in groups of fixed size (i.e. flocks of 30 birds as undertaken previously), and overcomes the issue of LWfG being more likely to flock in groups of their own species. When identifying birds in a flock, patiently identify every fifth bird, don’t just pick the most easily visible birds! To give a precise estimate of the proportion of LWfG in a flock **a minimum of 20-25% of the flock should be counted** (i.e. every fifth or fourth bird, respectively). Counting a much higher proportion of the flock (i.e. 50% or 60%) will not greatly improve the precision of the estimate: this time is better spent on other components of the survey or moving to the next site. Such sampling

is very intensive and requires good concentration, and it is recommended to sample in this way for 10-15 minute periods and then have a 5-10 minute break before sampling again.

Flying flocks: Especially along the migration route of the main populations of LWfG (e.g. in Kazakhstan in autumn), the easiest way to estimate the proportion of each species (and at the same time the age structure) is to take **random samples** of flying flocks when the geese are returning from feeding sites to the roosting site to drink (and often again departing to the feeding areas) during mid-day and the afternoon. Again, the **samples have to be randomly selected, and it is again recommended to count and identify every fifth bird, evenly covering the whole goose population present**. It is recommended - and we want to test the efficiency of this - to have **one observer taking photographs of the flocks and then identifying the species composition from screening images** in the afternoon/evening. Good photographic equipment and a telephoto lens will be required to undertake this, as well as good light conditions. These photographs should verify the accuracy of observers counts of flying flocks.

Practical advice for sampling:

- Try to find the most frequently used flyway from the feeding grounds to the roost (or from the roost to the feeding grounds), and choose an observation point next to the flyway.
- Always use a telescope when taking samples.
- Take **samples of every fifth individual** and work your way through the whole flock as far as possible.
- **Sampling requires intense concentration** and it is best to do this in 10-15 minute blocks of time and then have a 5-10 minute break before continuing.
- **Randomly choose the flock** that you are sampling (e.g. when finished with one flock, decide in advance to take the next sample after 2 minutes on the left side, the first flock in sight at that moment).
- Include **only individuals that you have seen properly in the samples**; **if you can't identify all of the** individuals then record this in your records classifying them as far as possible (i.e. "unidentified white-fronted goose", "unidentified Anser goose").
- Remember that separating juvenile Lesser White-fronts / White-fronts is tricky!
- **Record samples in 30 min** (or shorter) **periods**, and **keep the original samples separate** to calculate statistics from the data.
- It is important to take samples **evenly during the whole return** (or departure) **flight** to get non-biased data.
- **Save all the original sample data** to count the statistical precision of the estimate (standard deviation and variance) later.

Processing the sample data: The number of LWfG can be calculated from the total number of geese in the following way:

$Aery_{tot} = (Aery_{sam} / AB_{sam}) * AB_{tot}$

where:

$Aery_{tot}$ = the estimated total number of LWfG
$Aery_{sam}$ = number of LWfG in the samples
AB_{sam}= number of all geese (incl. LWfG) in the samples
AB_{tot}= number of all geese in the area (see 2.2.1)

3. Estimating age structure

When it is possible to count and identify all the LWfG in the flock individually (see 2.1), ageing is done at the same time. Try to identify the different broods of LWfG and note down the broods separately.

When estimating the number of each species by sampling (see 2.2), the age ratio of LWfG can be derived from the sample data: note down the age of the LWfG in the samples.

The age classes of LWfG that can safely be identified in the field are:

Autumn (until end of December)

- **ad** (=+1cy =, older than first calendar-year)
- **1cy** (= "juvenile"; without belly patches and blaze)

Spring (from beginning of January)

- **ad** (=+2cy, older than second calendar-year),
- **2cy** (juvenile coverts, weak or no belly patches, usually incomplete blaze)

Sexing of (adult) LWfG is usually possible only when comparing paired birds. In direct comparison, the forehead of the female is not as steep as the male's and the blaze is usually smaller than in the male.

4. Recording colour rings, neck bands and satellite transmitters

Colour rings provide very valuable data on the population and life history of the LWfG, therefore special attention has to be paid to looking for and reading the codes of the possible colour rings.

LWfG may have:

- ordinary metal leg ring
- colour leg rings (one, two or three colours)
- coloured plastic neck collars with a code
- satellite transmitters

The colours of the rings may bleach over the years, and some of the colour rings may also be lost.

Of each ringed LWfG observed, always check both legs, carefully read the colour codes (recorded **from the top down**) and note down in the following way:

- metal ring on the right leg, white + orange colour ring on the left leg: MR, WOL
- red + uncertain colour (e.g. because of mud) ring on the right leg, metal ring on the left leg: R?R, ML
- metal ring on the right leg, definitely no ring on the right leg: MR, –L
- also note down for each individual LWfG, if it definitely has no rings (often this is not possible, because the legs are hidden in the vegetation)

Use the following codes (international standard, http://www.btoipmr.f9.co.uk/cm/cm_codes.htm):

R = Red
W = White
O = Orange
Y = Yellow
G = Dark Green
N = Black
P = Pale Blue
? = uncertain colour
M = Scheme metal ring
– = no rings

R (in the end) = right
L (in the end) = left

The colour rings can be documented by photographing and/or recording them on video. However, **never rely on the photographic documents only**, but always note down the authentic sightings of the colour rings in your note book. When observing the same ringed individual again in the following days, remember to note it down every day. Report always also incompletely read codes, or individuals that certainly are wearing rings (even if you cannot read the colour code).

Photo. Adult (male) LWfG with metal ring on the right leg and orange-red colour ring on the left leg (MR, ORL). © János Tar.

5. Mapping the feeding and roosting sites of LWfG

Collecting these data is relevant mainly for new sites for which this no data is yet available. The roosting places are practically always in water or on the shoreline.

5.1 Description of roosts

- Draw the roost on a map, and if possible locate the site with a GPS.
- Determine roost type (fresh water lake / salt lake /coastal lagoon /bay of the sea /fishpond etc.)
- Describe vegetation types surrounding the roost
- Take photos

- Describe potential threats for the geese at the site, and potential threats for the natural conditions of the site
- Describe the conservation status and hunting regulations of the site
- Describe the distance from the roost to the nearest settlement

5.2 Description of feeding sites

- Draw the feeding site on a map, and if possible locate the site with a GPS.
- Determine the habitat type: agricultural field (winter wheat / maize etc.), natural grassline, coastal meadow etc.
- If possible, determine the vegetation in more detail by taking samples of / photographing the most abundant plant species.
- Take photos
- If possible (without disturbing the geese) collect droppings of LWfG for later diet studies.
- Determine the distance between the feeding site and the roost
- Describe potential threats for the geese at the site, and potential threats for the natural conditions of the site
- Describe the conservation status and hunting regulations of the site
- Describe the distance from the feeding site to the nearest settlement

6. Estimating hunting pressure

Hunting and poaching is the main threat for the LWfG, therefore it is essential to estimate the hunting pressure on geese at the staging and wintering sites.

- **When in the field, count the frequency of gunshots** (note the number of shots heard / 15 minutes) and, if possible, estimate at least roughly the locations of the hunters.
- **Interviews authorities** responsible for hunting and hunters. Also make your own estimate of the number of geese shot during a day in the area based on your own observations.
- Study the birds shot by hunters (if possible), and note down the number of geese by species and age. Keep each hunter's bag separate in your notes.
- Photograph all the shot LWfG, especially the heads and bellies.
- **Mark hunters on a map**. Especially study their position in relation to borders of nature reserves and in relation to the goose flocks.

Recent observations of LWfG:

www.piskulka.net

Further information:

wwf.fi/lwfg

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