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*A family of Lesser White-Fronted Geese (2 adults + 3 goslings)
wintering in Drana marshes, January 1997. © Didier Vangeluwe*

Life-Nature program “Restoration and Conservation Management
of the Drana Lagoon in the Evros Delta (Greece)”

THE DRANA MARSHES (EVROS DELTA, GREECE), A QUESTION OF SURVIVAL FOR THE EUROPEAN POPULATION OF *ANSER ERYTHROPUS*.

WITH DATA ON THE OCCURRENCE AND ECOLOGY OF THE RED-BREASTED GOOSE *BRANTA*
RUFICOLLIS

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INTRODUCTION AND OBJECTIVES

The Lesser White-fronted Goose *Anser erythropus* is the most vulnerable goose species in the World and one of the most threatened bird in Europe. It is listed on Annex I of the European Directive on the Conservation of Wild Birds (79/409/EEC) and "endangered" in the *Red data book* of Greece (Handrinos, 1992). It nests in the arctic wooded tundra from Norway to Far Eastern Russia. The breeding range has contracted dramatically during the last century. It is now fragmented into three more or less distinct populations (Fennoscandia, Northern Russia to the West of the Taymir peninsula and from the Taymir peninsula eastwards to the Chukosk peninsula). The most recent estimate of the World population is 22.000 to 27.000 individuals (mid-winter). The population is severely declining as shown by recent extinction in Sweden and Finland and a current estimate of 20-30 pairs in Norway compared to 10.000 individuals given for Fennoscandia during the first half of the 20th century (Aarvak, *in litt.*, Cramp *et al.*, 1997, Jones, 2005, Lorentsen *et al.*, 1999, Norderhaug & Norderhaug, 1984)

The Evros Delta was almost untouched until the end of World War II. It has since suffered severe reclamation programs undertaken in the framework of the reconstruction initiative of the European continent. Despite that, it is still, with the Camargue, the Ebro Delta, and the Po Delta one of the main natural areas along the Mediterranean Sea where fresh- and seawater merge in an exceptional mosaic of habitats still covering a large surface. It is listed as a Natura 2000 site (according to the Habitat Directive, 92/43/EEC), a Special Protected Area (according to the Birds Directive), a Ramsar site and comprises a "Wildlife Refuge" (i.e. permanent non-hunting zone) under the Greek Law.

In Greece, Lesser White-fronted Geese have been seen in "large flocks" wintering in Macedonia and Thrace with shot birds frequently proposed for sale in the market of Thessaloniki in the beginning of the 20th century (Harrison, 1918, Kattinger, 1934). Despite the increase of observation pressure since the 1950's, the numbers observed are small (only one record with more than 1000 ind.) and restricted in surface with the Evros Delta concentrating most of the data (Handrinos & Akriotis, 1997). For the period 1950-1990 63% of the encounters and 94% of the individuals were recorded from the Evros Delta (Handrinos & Goutner, 1990).

Specific surveys to re-evaluate the population status and search for undetected numbers were organised in 1988 (Goutner *et al.* 1988) and 1997-1999 (Kazantzidis & Nazirides, 1999). Both have confirmed the decline.

In 2001, a program aiming to restore the Drana Lagoon, a key habitat of the Evros Delta, was launched with European Union support (LIFE program LIFE00/NAT/GR/7198, GR1110001). Among the expected outputs was an improvement of the conservation status of the rare goose by wardening the area and an enhancement of the quality and surface of natural habitats used for roosting and grazing.

Two objectives were followed. First, to evaluate the effect of Drana Lagoon restoration on wintering Lesser White-fronted Geese in order to determine which further actions could improve their survival and eventually increase the capacity of the area. Second, to collect ecological data on the Lesser White-fronted Geese wintering in Greece in order to participate in the global effort aiming to understand why

the species is so declining. Could their appartenance to a particular breeding population be traced? Which are the demographic parameters?

The Lesser White-fronted Goose is not the only goose species wintering in the Evros Delta. Two other arctic species occur: the Red-breasted Goose *Branta ruficollis*, also a threatened species, and the White-fronted Goose *Anser albifrons* whom conservation status is globally favourable but nevertheless of very local occurrence in Greece. Considering the fact that all species are associated during the wintertime most investigations were conducted for every species.

ABUNDANCE

Surveys were conducted during the winter 2002-2003, 2003-2004 and 2004-2005. Additional data collected using identical methodology during a survey made in February 1997 were included in the analyses.

Systematic punctual complete counts of Lesser White-fronted Goose are almost impossible to achieve when the species winters together with large flocks of White-fronted Geese, which is the case in the Evros Delta. The similarity of the two species and the frequently poor observation conditions (distance, weather) make the probability of detecting most or all individuals very low. To sample mixed flocks observed under good conditions in order to extrapolate the result to the whole wintering population is equally not suitable. Lesser White-fronted Geese may occur in such a low proportion compared to White-fronts that the chance is too high of underestimating the rare species as demonstrated in a study conducted in an attempt to resolve a similar problem of look-alike between the extremely rare and critically-endangered Slender-billed Curlew *Numenius tenuirostris* observed on passage or during winter among large flocks of Eurasian Curlews *Numenius arquata* (Ledant & Lafontaine, 1999).

The numbers given in table 1. are therefore an estimation resulting from surveys taking place for at least 6 consecutive days almost fully devoted to studying wintering geese. Inter-annual variation for Lesser White-fronts must be used with caution to determine population trend, the variance of the estimation being possibly larger than the difference itself.

Table 1. Estimation during specific surveys of the abundance of Lesser White-fronted Goose *Anser erythropus*, White-fronted Goose *Anser albifrons* and Red-breasted Goose *Branta ruficollis* wintering in the Evros Delta.

| | <i>Anser erythropus</i> | <i>Anser albifrons</i> | <i>Branta ruficollis</i> |
|---------------------|-------------------------|------------------------|--------------------------|
| 01/02/97 – 06/02/97 | 19 – 23 | 7.000 | 1.200 |
| 26/12/02 – 06/01/03 | 17 – 19 | 11.000 | 1.000 |
| 26/12/03 – 03/01/04 | 52 | 3.500 | 50 |
| 28/12/04 – 08/01/04 | 40 – 45 | 1.200 | 12 |
| 21/02/05 – 02/03/05 | 44 – 50 | 3.200 | 700 |

It is noteworthy that fewest Lesser White-fronted Geese were counted when the total number of wintering geese was high (winter 1996-1997 and 2002-2003). It is highly likely to be a methodological consequence of the look-alike problematic Lesser White-fronts being more difficult to detect among large groups of similar White-fronts. This hypothesis may be corroborated by considering the time elapsed between the beginning of the survey and the first observation of a Lesser White-fronted Goose. In the winter 2003-2004 survey (total geese: 3.600), the rare species was first detected after 9 days. In comparison, the first Lesser White-fronts were observed the first day of the survey having begun the 28/12/2004 (total geese: 1.250).

According to this it may be considered that the number of Lesser White-fronted Geese wintering in the Evros Delta was of the order of magnitude of 50 individuals during the winter 2003-2004 and 2004-2005.

Date of arrival and departure

Concerning the phenology of wintering, we have no direct information regarding arrival and departure dates. We know that White-fronts arrive in November in the Evros Delta and leave in mid-March. It is well known that additional numbers of White-fronts frequently arrive later in the Evros Delta, pushed south from Dobrodgea (Romania and Bulgaria) by harsh weather (Handrinos & Afriotis, 1997, pers. obs. in Thrace and Dobrodgea). No direct ringing evidence exists of this cold-weather movement but it is corroborated by two phenomena. First, the consistency between departures south in the Black Sea wintering grounds when cold spells prevail, observation of flocks migrating or in stopover along the Greek upper course of the Evros stream (Orestiada area) and arrival in the Evros Delta. Second, the fact that flocks of geese arriving in such condition included very large numbers of Red-breasted Geese *Branta ruficollis* necessarily coming from Black Sea shores where most of the world population winters (Vangeluwe & Stassin, 1991, Vangeluwe, 1992). This massive arrival of Red-breasted Geese was clearly documented during winter 2004-2005 where the numbers counted for that species were multiplied by 58 between two surveys when numbers of White-fronted Geese were multiplied by 2,6. It seems that such movement from the Black Sea do not include significant numbers of Lesser White-fronted Geese as indicated by the insignificant increase observed for that species between above-mentioned surveys. Most of the Lesser White-fronted Geese wintering in the Evros delta would therefore arrive in November with the "regular" wintering flock of White-fronts.

BREEDING ORIGIN

In order to evaluate the significance in terms of conservation of the population of Lesser White-fronted Geese wintering in the Evros Delta it was essential to attempt to determine from which breeding sub-population they are related.

A search of the literature produced two cases of birds ringed in or close to breeding grounds. One Lesser White-fronted Goose shot in Macedonia on 7 February 1956 was ringed the previous summer in Swedish Lapland (Handrinos, 1991). More recently, an unpaired male caught on 27 July 1995 at a moulting site in Norwegian Finmark and equipped with a satellite transmitter was recorded to spend the winter 1995-1996 in the Evros Delta (Lorentsen *et al.*, 1998).

The time and resources available in the framework of the current program did not allow the capture, ringing and possible satellite tagging of some of the Lesser White-fronts wintering in the Evros Delta. Much effort was thus invested in the search for colour-marked individuals. Indeed in a general effort to delineate migration routes of the different sub-populations, a few dozen Lesser White-fronts were ringed on Norwegian, Finnish and Russian breeding grounds using marks visible at a distance: combination of colour rings or engraved colour neck-collars (<http://www.cr-birding.be>).

During the last day of the winter 2003-2004 survey a colour-ringed Lesser White-fronted Goose was observed and ring combination read in Drana Marshes. It was ringed as a second calendar-year male on 27/05/2002 at the Valdak Marshes, a pre-breeding and post-moulting stop-over site in Norwegian Finmark (all data concerning colour-ringed Lesser White-fronted Geese were communicated by T. Aarvak & I. Oien, Norwegian Ornithological Society NOF). Valdak (70°09'N, 24°54'E) is situated in the Porsangen Fjord very close to the North Cape and at a distance of 2350 km from the Evros Delta. No other colour-ringed individual was detected that winter but only a very few among the 52 Lesser White-fronts observed could have legs checked for the presence of rings since they were grazing in a dense flock of White-fronted Geese. This observation together with the number of individuals observed leads us to think that most of the critically-endangered Fennoscandian population of the Lesser White-fronted Goose was indeed wintering in the Evros Delta (Vangeluwe, 2004).

During the winter 2004-2005 surveys the flock of circa 40 Lesser White-fronts could be more carefully and intensively checked for colour rings probably because the number of wintering White-fronts was lower compared to the previous winter. The same colour-ringed individual was observed again but seven others were additionally seen. Six of them were also ringed at Valdak (table 2.). The origin of the last one is doubtful. It was possibly originating from central northern Siberia (Taymir) but a Norwegian origin could not be ruled out. It is better to leave it as unallocated for the moment.

Table 2. Ringing and observation dates for colour-ringed Lesser White-fronted Geese *Anser erythropus* observed in the Evros Delta during winter 2003-2004 and 2004-2005. All were ringed at Valdak, Norway by T. Aarvak and I. Oien, from the Norwegian Ornithological Society NOF. One individual with origin still to be confirmed is not included.

| Ring | Date of ringing | January 2004 | January 2005 | February 2005 |
|---------------|-----------------|--------------|--------------|---------------|
| OSLO/CA18546 | 25/05/2000 | | | 21, 24 |
| OSLO/CA31455 | 27/05/2002 | | 1, 5, 7 | 21, 24 |
| OSLO/CA31456 | 27/05/2002 | 3 | 1, 4, 7 | 21, 24 |
| MOSK/CS000002 | 01/06/2003 | | 1, 4, 7 | 21, 24 |
| MOSK/CS000004 | 28/05/2004 | | 7 | 21, 22, 24 |
| MOSK/CS000005 | 28/05/2004 | | 4, 7 | 21, 24 |
| MOSK/CS000006 | 28/05/2004 | | 1, 4, 7 | 21, 24 |

Lesser White-fronts were recorded almost every day in the course of both surveys conducted during winter 2004-2005 and observation conditions were regularly good. It is thus considered that very few if any additional colour-ringed individuals were missed. It is noteworthy that all marked individuals were always observed in the same coherent flock. No one of the isolated individuals or pairs with legs having been checked was observed ringed.

Altogether, 44 Lesser White-fronted Geese were colour-ringed at Valdak during the period 1995-2004. The proportion of each annual cohort is given in table 3. Among the circa 50 Lesser White-fronted Geese wintering in the Evros Delta in 2004-2005 at least 14% were previously ringed in Norway including a very large proportion of the individuals ringed during the last two years. All that gives a very strong indication that most if not all Lesser White-fronted Geese wintering in the Evros Delta belong to the Fenoscandian sub-population.

Table 3. Number of Lesser White-fronted Geese *Anser erythropus* colour-ringed per year at Valdak, Norway and proportion of each cohort observed in the Evros Delta, Greece during the winter 2004-2005.

| Year | Number colour-ringed | Observed in the Evros Delta during winter 2004-2005 |
|------|----------------------|---|
| 1995 | 5 | |
| 1996 | 0 | |
| 1997 | 6 | |
| 1998 | 3 | |
| 1999 | 0 | |
| 2000 | 14 | 7,1% |
| 2001 | 0 | |
| 2002 | 10 | 20% |
| 2003 | 2 | 50% |
| 2004 | 4 | 75% |

On 14/05/2005 among the first three Lesser White-fronted Geese observed at Valdak this spring by Tomas Aarvak and Ingar Oien were two of the colour-ringed Lesser White-fronted Geese observed in the Evros Delta in January and February 2005. The colour-ringed Lesser White-front observed in the Evros Delta during both winter 2003-2004 and 2004-2005 was observed this spring migration in Estonia, Finland to finally reach Valdak on 16/05/05.

Using the data gathered from colour-ring readings and satellite transmitter locations, the migration route of Lesser White-fronted Geese wintering in the Evros Delta is presented in figure 1.



Figure 1. Migration route for Lesser White-fronted Geese *Anser erythropus* wintering in the Evros Delta, Greece. From Lorentsen *et al.*, 1998 and Aarvak pers. com.

DEMOGRAPHIC PARAMETERS

The collection of demographic parameters is the basis of survival/mortality investigation essential to understanding the numeric evolution of a population. Such calculation will not be undertaken here the set of data being too limited. Demographic data for the Lesser White-fronted Goose were rarely published and probably never for that concerning individuals wintering in Greece.

Demographic parameters also have the advantage of providing the first clues on population trend and to give results independent of the observation effort as soon as a reasonable proportion of the population concerned is sampled. Inter-annual and inter-specific comparison is thus here fully relevant.

As for abundance, data for associated wintering geese species are also given (Table 4).

Table 4. Sample size (n individuals for demographic parameters recorded during specific surveys for Lesser White-fronted Goose *Anser erythropus*, White-fronted Goose *Anser albifrons* and Red-breasted Goose *Branta ruficollis* wintering in the Evros Delta, Greece.

| | <i>Anser erythropus</i> | | <i>Anser albifrons</i> | | <i>Branta ruficollis</i> | |
|---------------------|-------------------------|------------|------------------------|------------|--------------------------|------------|
| | Age ratio | Brood size | age ratio | brood size | age ratio | brood size |
| 01/02/97 – 06/02/97 | 6 | 1 | 1814 | 26 | | |
| 26/12/02 – 06/01/03 | 17 | 2 | 4498 | 110 | 317 | 11 |
| 26/12/03 – 03/01/04 | 52 | 4 | 588 | 24 | | |
| 28/12/04 – 08/01/05 | 39 | 3 | 769 | 62 | 11 | 2 |
| 21/02/05 – 02/03/05 | 40 | 3 | 2108 | 25 | 565 | |

According to the limited and interrupted sample available for the Red-breasted Goose, the parameters for this species are given separately and not discussed (table 5).

Table 5. Demographic parameters for Red-breasted Goose *Branta ruficollis* wintering in the Evros Delta, Greece.

| | <i>Branta ruficollis</i> | |
|---------------------|--------------------------|------------|
| | age ratio | brood size |
| 26/12/02 – 06/01/03 | 52,1 | 2,5 |
| 26/12/03 – 03/01/04 | | 3 |
| 28/12/04 – 08/01/05 | 45,5 | 2,5 |
| 21/02/05 – 02/03/05 | 47,8 | |

Data collected during the late February-early March 2005 survey were not analysed. At this period the brood cohesion in arctic geese has already begun to brake down (Van Impe, 1978).

age ratio

The evolution of the number of juveniles among Lesser White-fronted Geese wintering in the Evros Delta shows a very negative trend that could be interpreted as a component of the decline of the species. Not enough data are available for the moment to assess the phenomena but it appears evident that such a low proportion of juveniles is a worrying observation in the dynamic of the species. No similarity is observed with the data collected for White-fronted Geese giving the indication that the phenomenon seems to be linked to the species and not to the area.

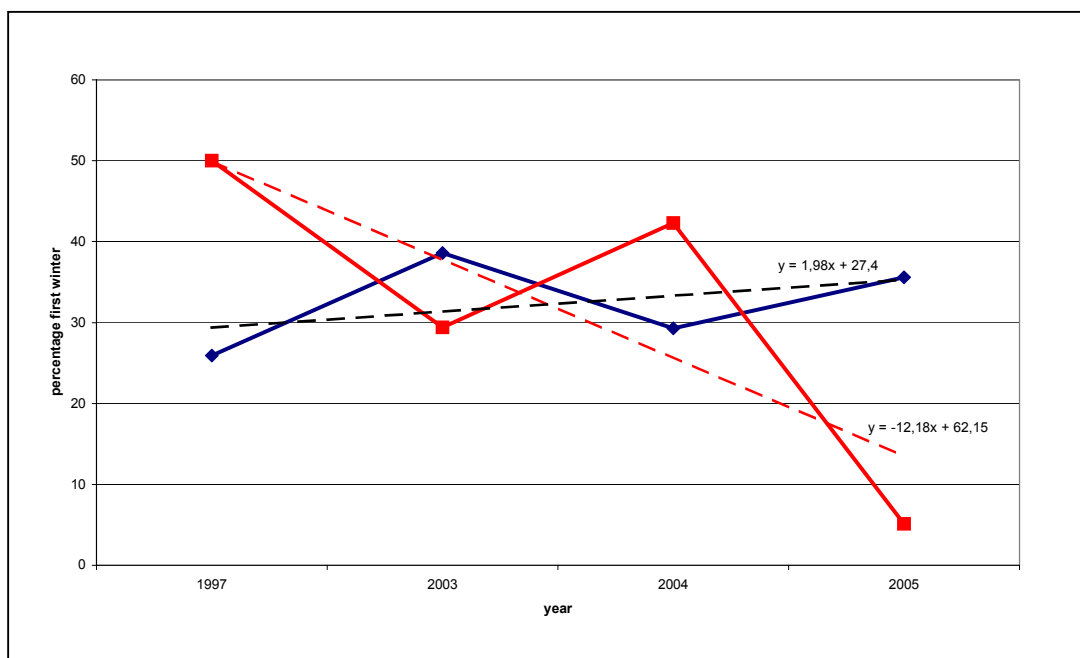


Figure 2. Evolution of the age ratio recorded in the Evros Delta during mid-winter specific surveys for Lesser White-fronted Goose *Anser erythropus* (red line) and White-fronted Goose *Anser albifrons* (blue line).

brood size

The mean brood size shows a declining trend. The sample is nevertheless very limited but the results are consistent with the proportion of young and with data collected in Hungary (Sterbetz, 1985). Here also, no similarity is observed with the data collected for White-fronted Geese giving the indication that the phenomenon is linked to the species and not to the area.

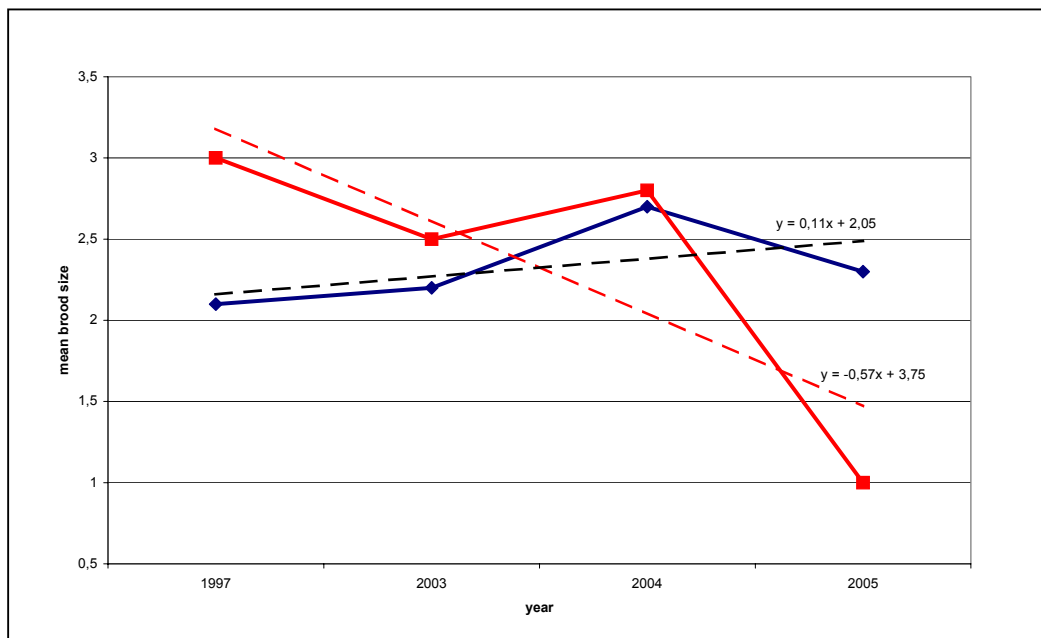


Figure 3. Evolution of the brood size recorded in the Evros Delta during mid-winter specific surveys for Lesser White-fronted Goose *Anser erythropus* (red line) and White-fronted Goose *Anser albifrons* (blue line).

DISTRIBUTION AND SITE SELECTION

The study area in the Evros Delta was systematically searched for geese during the surveys. This area was defined as the zone where wintering geese are known to generally occur (G. Handrinos & A. Athanasiadis, pers. comm.; pers. obs.) and has a surface of 69,7 km².

The position of every flock was reported on a map using a grid system (square of 350 m x 460 m; 0,16 km²) or directly located by GPS or/and topographic elements. The following parameters were noted for every flock: species composition, behaviour (feeding, roosting), habitat (natural, agricultural, more detailed when possible) and demographic data according to the species.

An electronic database was organised in order to allow analyse with a geographic information system (ArcGIS 9.1, ArcInfo).

Distribution

The geographical distribution of the three arctic goose species in the Evros Delta is first presented using a basic system of presence/absence grid mapping (figures 4 to 6.).

Altogether, wintering geese were located on 44 squares of the 440 comprised in the study area. Lesser White-fronted Geese were seen on 15 (35% of the squares where wintering geese were observed), White-fronted Geese were seen on 43 (98% of the squares where wintering geese were observed) and Red-breasted Geese were seen on 10 (22% of the squares where wintering geese were observed).



Figure 4. Distribution of the Lesser White-fronted Goose *Anser erythropus* in the Evros Delta, Greece. All data from specific surveys winter 1996-1997, 2002-2003, 2003-2004 and 2004-2005. Squares have a surface of 0,16 km².



Figure 5. Distribution of the White-fronted Goose *Anser albifrons* in the Evros Delta, Greece. All data from specific surveys winter 1996-1997, 2002-2003, 2003-2004 and 2004-2005. Squares have a surface of 0,16 km².

This atlas type of presentation does not relativise the distribution according to the numbers of individuals counted in every flock. Nor does it allow the relativisation of the results according to the observation effort, the number of visits having not been identical for every square of the grid.

A second approach to the analysis of the distribution uses a deterministic interpolator technique aiming to predict the true surfaces for distribution: the local polynomial. The deterministic interpolation method creates surfaces from measured points. Local techniques calculate predictions from the measured points within neighbourhoods, which are smaller spatial areas within the larger study area. This calculation was made possible by using the geostatistical analyst extension from ArcGIS 9.1 (ArcInfo). In order to relativise the observation effort, only maximum counts per species per site were selected for calculation. Data are presented on figures 7 to 9.



Figure 6. Distribution of the Red-breasted Goose *Branta ruficollis* in the Evros Delta, Greece. All data from specific surveys winter 1996-1997, 2002-2003, 2003-2004 and 2004-2005. Squares have a surface of 0,16 km².

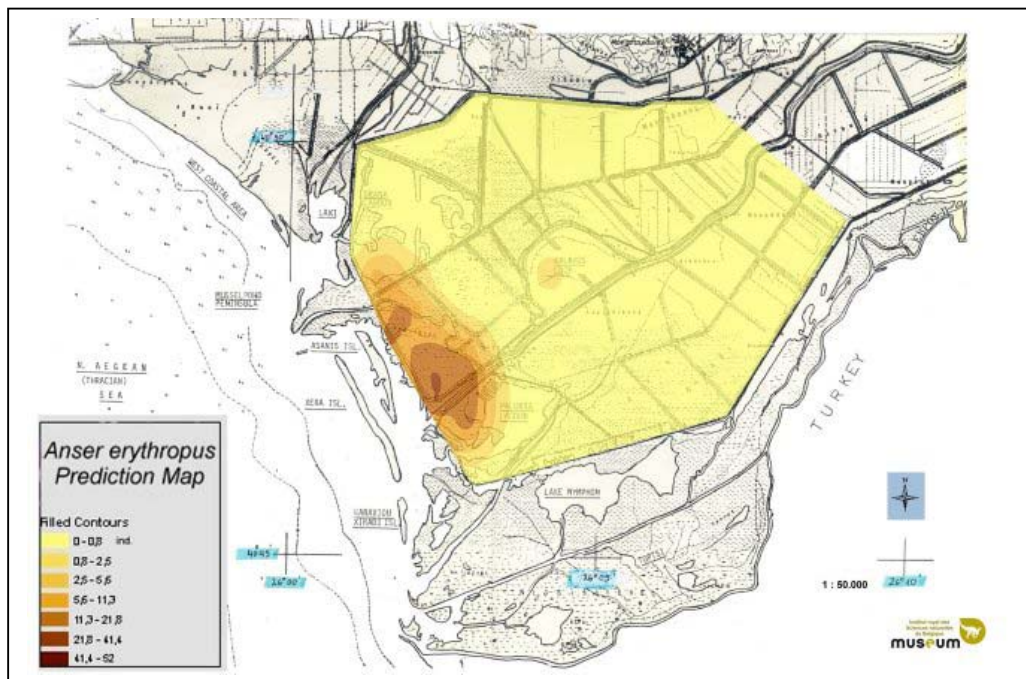


Figure 7. Prediction of the distribution of the Lesser White-fronted Goose *Anser erythropus* in the Evros Delta, Greece using local polynomial interpolation. Only maximum counts from specific surveys winter 1996-1997, 2002-2003, 2003-2004 and 2004-2005.

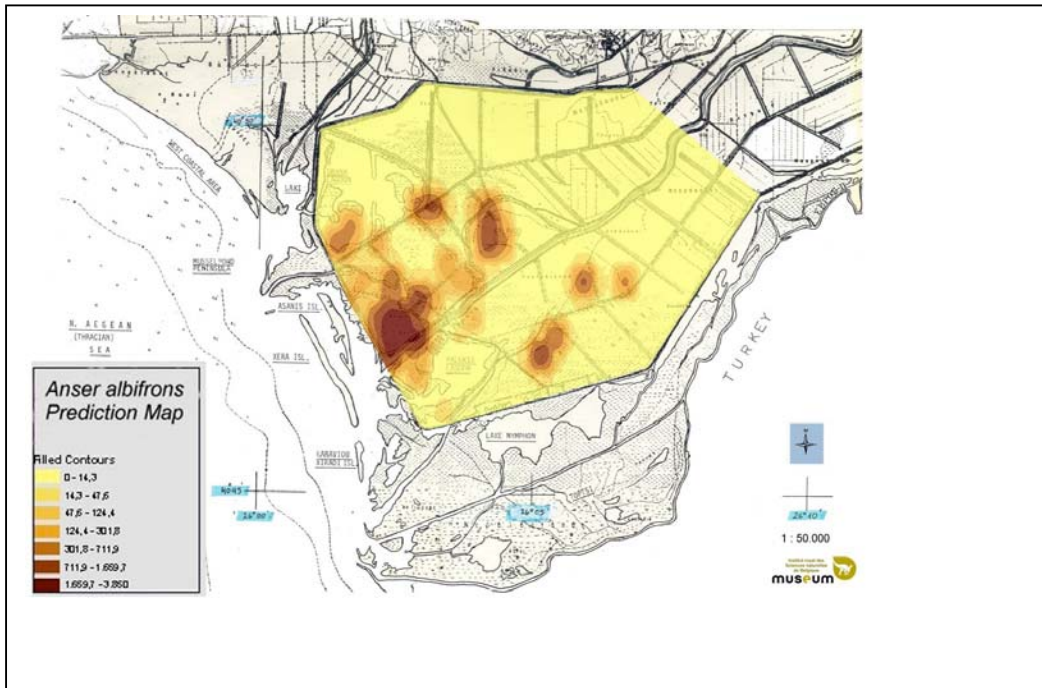


Figure 8. Prediction of the distribution of the White-fronted Goose *Anser albifrons* in the Evros Delta, Greece using local polynomial interpolation. Only maximum counts from specific surveys winter 1996-1997, 2002-2003, 2003-2004 and 2004-2005.

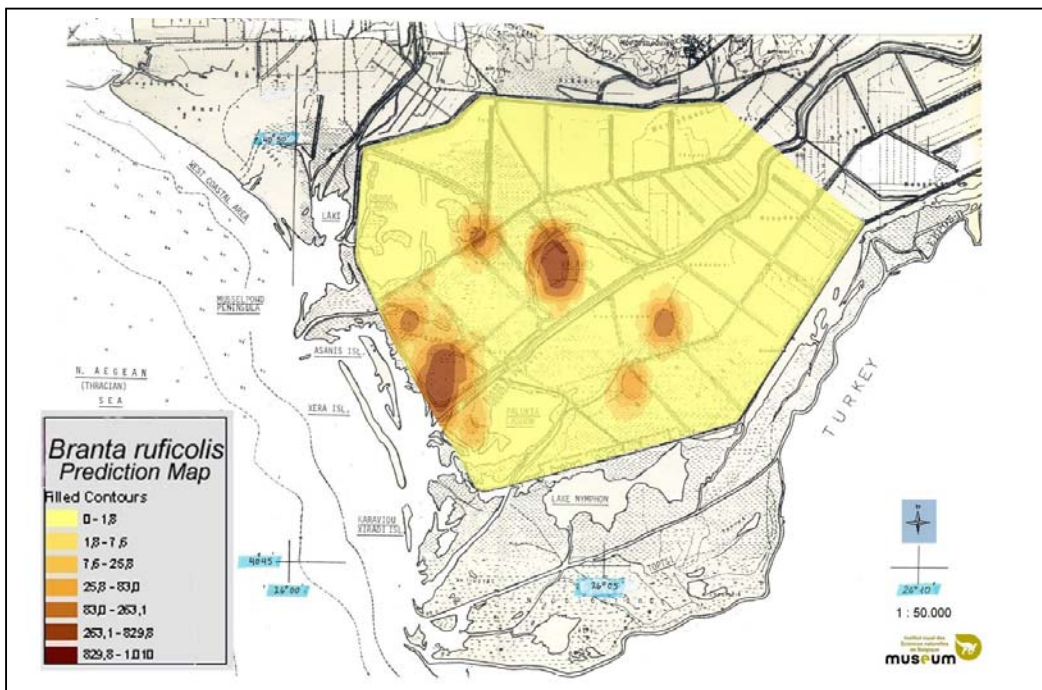


Figure 9. Prediction of the distribution of the Red-breasted Goose *Branta ruficollis* in the Evros Delta, Greece using local polynomial interpolation. Only maximum counts from specific surveys winter 1996-1997, 2002-2003, 2003-2004 and 2004-2005.

Predictions of the distribution for the White-fronted Goose and the Red-breasted Goose are essentially similar. Maximal predicted density is observed in Drana marshes, in Kalavos loop and just east of the large tamarix belt extending in the centre of the eastern part of the Delta. The prediction is minimal north and east of these areas.

The distribution pattern interpolated for the Lesser White-fronted Goose is markedly different with almost all prediction area situated in Drana marshes, close from the Aegean Sea. A secondary nucleus occurs in Kalavos loop.

Feeding site selection

The factors tested in order to study in what extent they affect the feeding distribution of the Lesser White-fronted Goose wintering in the Evros Delta were habitat type (natural vs agricultural) and hunting disturbance (in or outside hunting zone; in or outside hunting period). The hunting period for waterfowl extends at present from the 15 September to 10 February.

The following method was used to determine the site choice by the geese. The parameters observed on the sites at which we had observed geese feeding were compared with those from a regular representative sample of 102 points dispersed within the area scanned. These points were taken as the intersection of a grid squares included within the study area.

The extent of the natural habitats in the study area is presented on figure 10; the limits of the non-hunting zone inside the study area is depicted on figure 11.

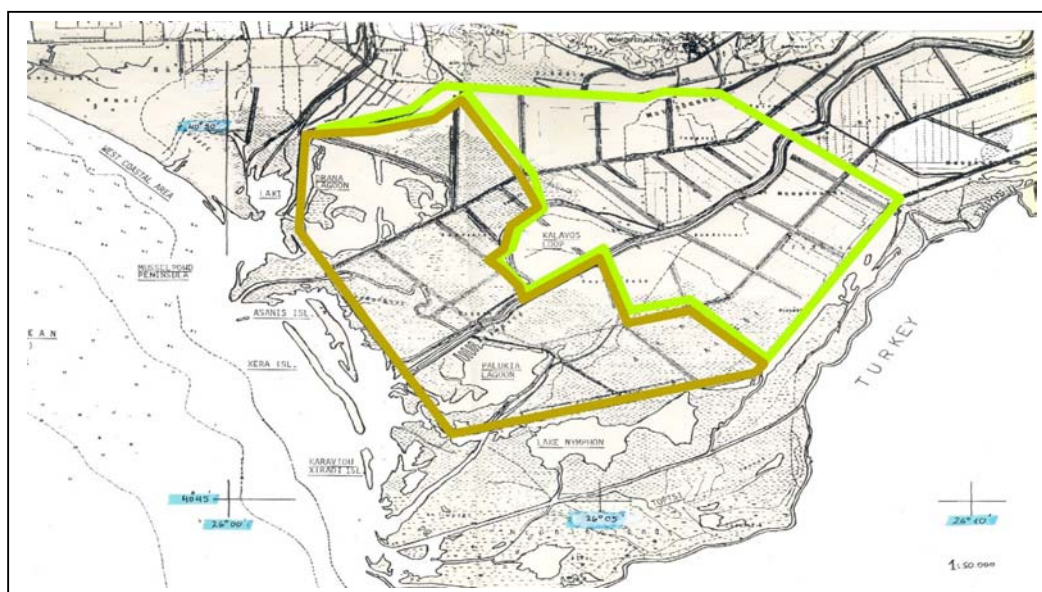


Figure 10. Delineation of zones of natural habitat (dark green) and agricultural land (light green) inside the study area.

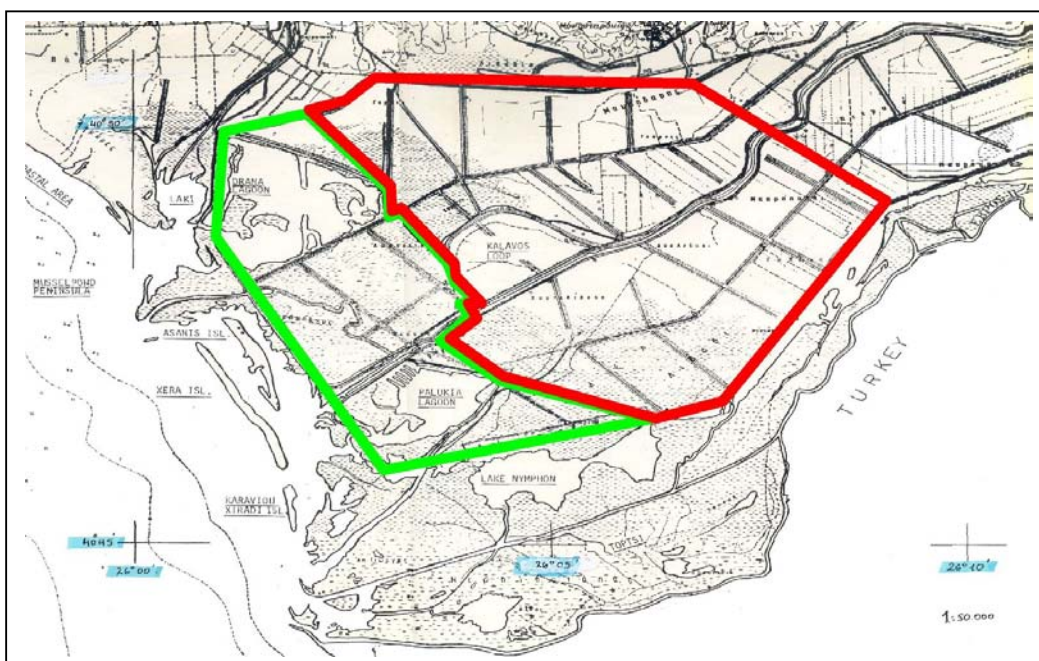


Figure 11. Delineation of zones of non-hunting (green) and hunting (red) inside the study area.

Feeding site selection parameters were also studied for White-fronted Goose and Red-breasted Goose to allow comparison.

Lesser White-fronted Geese were recorded feeding on a total of 14 squares, 92,3% were in natural habitat and 7,7% on agricultural land compared to respectively 47,9% and 52,1% for the sampled grid squares intersections. The Lesser White-fronted Goose feeding preference for natural habitat as compared with agricultural land is highly significant ($X^2 = 11,3$; 1 df; $p < 0,001$). Both White-fronted Goose and Red-breasted Goose show no preference for one type of habitat (respectively $X^2 = 2,14$; 1 df; $p = 0,143$ and $p = 0,750$).

During the hunting period, 100% of the Lesser White-fronted Geese were observed feeding in the protected area. The hunting zone represents 67,6% of the study area compared to 32,4% for the non-hunting zone. The Lesser White-fronted Geese select very favourably area where no hunting occurs ($X^2 = 16,55$; 1 df; $p < 0,001$). Same result is obtained for the White-fronted Goose ($X^2 = 33,04$; 1 df; $p < 0,001$) and the Red-breasted Goose ($X^2 = 12,69$; 1 df; $p < 0,001$).

To understand if the selection of a feeding site was only dependant of the disturbance due to hunting or to the type of habitat, the distribution of geese recorded during the survey organised during 28/12/04 – 08/01/04 (hunting period) and the survey organised during 21/02/05 – 02/03/05 (closed hunting) was compared. After the closing of the hunting season, Lesser White-fronted Geese were recorded feeding on 1 square lying in the hunting zone compared to 4 situated in the non-hunting zone. It indicates that the species continues to select feeding sites on natural habitat ($p < 0,001$) even if disturbance has stopped. It is even more strong if we consider that only one Lesser White-fronted Goose was observed on the square lying in the hunting zone. Both White-fronted Goose and Red-breasted Goose do not seem to prefer one habitat compared to the other.

HABITATS AND PLANTS POTENTIALLY GRAZED

As shows in the previous chapter, natural habitats seems to be positively selected by Lesser White-fronted Geese wintering in the Evros Delta.

Being among the larger herbivorous birds geese have an inefficient digestive system: only circa 20% of the vegetation ingested is finally digested (Owen, 1972). To be able to ingest large quantities of food and to select a relatively nutritious diet is therefore extremely important.

The quality and surface of feeding grounds is therefore essential for their survival, often having the function of a bottleneck in their dynamic.

Few precise data are available on Lesser White-fronted Geese feeding habits outside the breeding season. Most were moreover recorded on staging areas or in (today) marginal wintering grounds (Markkola et al., 2003, Sterbetz, 1990, Tar, 2001, 2004).

As a first attempt to investigate this key aspect, habitats used by Lesser White-fronted Geese in the Evros Delta were identified and described according to the *Classification of Palaearctic habitats* using CORINE Habitat typology system (Devillers *et al.*, 1991, Devillers and Devillers-Terschueren, 1996). The list of habitat types of community interest according the Habitat Directive (92/43/EEC) is based on this system.

The following list gives only qualitative information, relative selection of the different habitats is not available at this stage. Habitats whose conservation requires the designation of special areas of conservation under the terms of the Habitat Directive are marked by an asterisk. Those listed as “priority habitats” by the same Directive are marked with 2 asterisks.

- 12.2 Semi-enclosed coasts
- 13.21 Coastal plain estuaries
- 14 Mud flats and sand flats
- 15.113* Mediterranean glasswort swards
- 15.51* Mediterranean tall rush saltmarshes

Juncion maritimi p.

Beds of *Juncus maritimus* or *J. acutus* of periodically inundated depressions, with *Carex extensa*, *Iris spuria*, *Gladiolus communis*, *Aster tripolium*, *Sonchus maritimus*, *S. crassifolius*.

- 15.52* Mediterranean short rush, sedge, barley and clover

Trifolion maritimi, *Juncion maritimi p.*

Humid meadows of low vegetation dominated by *Juncus gerardii*, *Carex divisa*, *C. extensa*, *Hordeum marinum* or *Trifolium spp.* and *Lotus spp.* Of the edges of brackish lagoons.

- 15.53* Mediterranean halo-psammophile meadows

Plantaginion crassifoliae

Drier, dense formation of sandy soils at the foot of dunes, or between dunes and lagoons, with *Plantago crassifolia*, *Schoenus nigricans*, *Juncus acutus*, *J. littoralis*, *Spartina versicolor*, all of which may dominate and form physiognomically distinct, sometimes almost monospecific, facies.

- 15.55* Mediterranean saltmarsh grass swards

Puccinellion festuciformis

Dense formations of *Puccinellion festuciformis* and *Aeluropus littoralis* along Mediterranean coasts and coastal lagoons.

- 15.571 15.571* Mediterranean saltmarsh couch stands

(15.57) *Agropyro-Artemision coerlescentis* i. a.

Formations of *Elymus* or *Artemisia* fringing Mediterranean saline wetlands.

15.611 Creeping glasswort mats

Arthrocnemion perennis : *Puccinellio festuciformis*-*Arthrocnemetum perennis*, *Halimione portulacoides*-*Sarcocornietum alpini*

Prostrate *Arthrocnemum perenne* carpets of wettest areas of coastal marshes.

15.612 Shrubby glasswort thickets

Arthrocnemion fruticosi : *Puccinellio festuciformis*-*Arthrocnemetum fruticosi*, *Cistancho lutea*-*Arthrocnemum fruticosi* .

Formations of robust *Arthrocnemum fruticosum*, capable of forming extensive low, dense thickets.

15.616 Mediterranean sea-purslane-woody glasswort scrubs

Halimione portulacoides-rich facies within Mediterranean *Arthrocnemum* communities

15.617 Mediterranean *Halocnemum* scrub

Halocnemion strobilaceae

Rare and local formations dominated by the tall, often sparse, clumps of *Halocnemum strobilaceum*, usually associated with *Arthrocnemum glaucum*, sometimes with *A. fruticosum*.

15.813** Aegean sea-lavender communities

(15.81) *Limonium*-rich facies of the saltsteppes

21.1** Sea connected lagoons

34 Steppes and dry calcareous grasslands

53.17 Halophile clubrush beds

Scirpion maritimi

Formations of *Scirpus tabernaemontani*, *S. maritimus*, *S. triquetus*, *S. litoralis*, *S. unguis* mostly characteristic of brackish or saline waters to 1,5 m deep

82.11 Field crops

87.1 Fallow fields

87.2 Ruderal communities

It is well known that arctic geese are able to select particular plant species among large vegetal communities. Therefore in complement to feeding habitat listing, potential plants grazed by arctic geese were identified. Plants were sampled in both feeding zones where Lesser White-fronted Geese were most frequently recorded feeding. Samples were stored in an herbarium. Both pictures taken in the field and samples were used for identification that was conducted by the Botanical Laboratory of the Free University Brussels (Prof. M. Tanghe). Useful and additional information was found in the catalogue of plants collected (1971-1976) by Prof. Babalonas in the Evros Delta (Babalonas, 1980, 1981).

| | |
|-----------------|--------------------------------|
| Caryophyllaceae | (<i>Spergularia</i> sp) |
| Compositae | <i>Artemisia sanbonicum</i> |
| | <i>Matricaria mantina</i> |
| | <i>Matricaria recutita</i> |
| | <i>Picris echioides</i> |
| Chenopodiaceae | <i>Arthrocnemum fruticosum</i> |
| | <i>Arthrocnemum perenne</i> |
| | <i>Halimione portulacoides</i> |
| | <i>Halocnemum strobilaceum</i> |
| | <i>Salicornia europea</i> |

| | |
|----------------|---|
| Cruciferae | <i>Capsella burso-pastoris</i> |
| Cyperaceae | <i>Carex divisa</i> |
| Gramineae | <i>Aeluropus litoralis</i> |
| | <i>Agropyrum litorale</i> |
| | <i>Alopecurus myosuroides</i> |
| | <i>Bromus mollis</i> |
| | <i>Hordeum maritimum</i> |
| | <i>Phleum sp</i> |
| | ((<i>Phleum arenarium</i>)) |
| | <i>Lepturus (pholiurus) incurvatus</i> |
| | <i>Lepturus (pholiurus) cylindricus</i> |
| | <i>Poa sp</i> |
| | (<i>Poa annua</i>) |
| | <i>Poa bulbosa</i> |
| | (<i>Polypogon monspeliense</i>) |
| | (<i>Puccinellia maritima</i>) |
| | <i>Puccinellia sp</i> |
| | <i>Vulpia sp</i> |
| | <i>Vulpia (myuros)</i> |
| Juncaceae | <i>Juncus gerardii</i> |
| Plantaginaceae | <i>Plantago coronopus</i> |
| Plumbaginaceae | <i>Limonium sp</i> |
| Polygonaceae | <i>Polygonum equisetiforme</i> |
| | <i>Rumex acetosella</i> |

DISCUSSION AND PROPOSALS

The observation among the Lesser White-fronted Geese wintering in the Evros Delta of a great proportion of individuals ringed in or close to the Norwegian breeding grounds indicates that the Delta hosts most if not nearly all of the highly-threatened Fennoscandian sub-population of this globally endangered species. It is corroborated by the fact that the number of Lesser White-fronted Geese recorded in the Evros Delta during the last two winters (circa 50 ind.) is similar to the latest estimation given for the European population (20-30 pairs). The fact that most of the Lesser White-fronts recorded were observed in a coherent flock of circa 40 ind. further supports that they have a common origin.

No precise data exists but Fennoscandian Lesser White-fronted Geese are probably spending continuously the period November-March, thus between 4 and 5 months, in the Evros Delta. It is a very important part of their annual cycle and gives a high responsibility to Greece in the conservation of this sub-population.

For the first time demographic parameters in winter are made available for this sub-population. The set of data is not enough for statistically significant results to be obtained but both the proportion of young and the brood size show a declining trend. Such a decline was not observed for the two others arctic goose species wintering in the Evros Delta. Further surveys will hopefully allow the study of inter-seasonal survival for marked birds and their offspring. It would lead to an essential result: where (and further, which) are the factors that are limiting the population. Recent calculations (e.g. Lampila, 2001) make winter survival as the key of the current dynamic of the species.

Factors affecting the distribution and particularly the feeding site selection of the Lesser White-fronted Geese wintering in the study zone were approached for the first time. A deterministic mathematical model was applied to predict the distribution from the maxima counted. It results that the prediction is for all species very high on natural habitats. It makes the Evros Delta a very special place not only the only one that hosts significant numbers of arctic geese along the shores of the Mediterranean Sea every winter but also one of the very last for all Europe where arctic geese are feeding predominantly on natural habitats.

Inside the Delta a difference of distribution pattern between Lesser White-fronted Geese on one side and White-fronted and Red-breasted Geese on the other was found. The Lesser White-fronted Geese had essentially selected sites in saltmarshes and saltmeadows near the sea and this choice was not related to the disturbance linked with hunting. The two other species had also mainly selected natural habitats during the hunting season but when it was closed they shifted to agricultural land (winter wheat, ploughed land) showing at this stage no marked preference for either habitat type.

The typology of the different natural habitats used for feeding indicates that several require special conservation measures according to the Habitat Directive and thus have an intrinsic conservation value irrespective of their use by *Anser erythropus*. At this stage, it was not possible to study the relative preference shown by the geese for the different types of natural habitats recorded. The relative selection of the different plant species was also not undertaken now. It would be very useful to investigate both in the near future.

These first conclusions regarding the fact that Lesser White-fronted Geese are selecting favourably feeding sites consisting of natural habitats could be crucial in understanding the decline of the species. During the last decades, nearly all Palaearctic goose populations are stable or increasing (Madsen, 1996) and nearly all are winter feeding essentially on agricultural land. Nevertheless, beside the Lesser White-fronted Goose three species were/are of conservation concern: the Brent Goose (*Branta bernicla*) and the Red-breasted Goose and we could add the Ross Goose (*Anser rossii*) in the New World. Interestingly, all four species have a very short bill. The decline of the Brent goose is well documented: it was mainly feeding on *Zostera* beds. A disease depleting the *Zostera* beds had provoked the crash of the Brent population unless they shifted to grassland and agricultural land. Red-breasted Geese were abundant in winter on salt steppes in Azerbaijan with for example more than 60.000 ind. counted in one locality during winter 1956-1957. But during the sixties the steppe was cultivated and the world population was estimated around 15.000 geese. In the early nineties, more than 75.000 were observed on winter wheat in Romania and Bulgaria having shifted wintering area and feeding sites type.

Were short billed geese naturally very specialised in a particular vegetation type and thus more vulnerable than others geese to the disappearance of saltmeadows and salt steppes? It could explain why these geese were declining while their sister species have not suffered conservation problems. That needs to be confirmed by more precise comparative studies on feeding habitat and plant selection.

If our data are still scanty concerning the exact typology of natural habitat and plants selected by the arctic geese wintering in the Evros Delta we have the strong indication that the quality of the habitats where the geese are feeding is continuously deteriorating for the last 60 years. The main cause was the reclamation program undertaken in the early fifties (figure 12). The restoration of the natural ecology of Drana lagoon was the first essential step in an effort to reverse the trend. It is hoped that the hyper-saline to saline part of the ecosystem will fully function again. It had most probably an influence on feeding site selection for arctic geese. It will have a definitive positive influence by giving a safe and permanent roosting place in case of frost.



Figure 12. Drana lagoon and Drana marshes, Evros Delta in 1945 (left) and 1976 (right) after reclamation program. The red circle indicates the connection to the sea that was restored in the framework of the Life program.

It would be essential to next continue the strategy and undertake the restoration of the Drana Marshes precisely the area favoured by the Lesser White-fronted Goose. The principle would be to rebuild a gradient of salinity by reconstructing the passage of freshwater through the area from Paliomaritsa to the former outlet of Musselpond Peninsula. The reconstructed system will include a network of specific sluices in order to strictly control the intrusion of sea water in the area.

A new problem seems related to the tremendous increase of grazing by cattle. Current grazing must be urgently completely stopped in the Drana Marshes. Then the activity must be fully monitored to see the level of grazing that may eventually be accepted. For that experimental grazing under the strict control of the Management Body may be undertaken. If it is concluded that a grazing activity may be beneficial for the geese, it is suggested that the Management Body contract an herder to graze the area under the complete supervision of the Management Body, or that grazing by introduced wild and semi-wild ungulates be considered (Bunzel-Drüke *et al.*, 1999, Devillers, 2003). Grazing in a protected area frequented by such threatened species may be a tool for nature management but not an independent private activity.

Hunting is an activity known to have an important influence on the survival of geese in general and the selection of feeding grounds in particular. Hunting for all species of geese was closed in Greece during the period 1998-2003. The objective of this measure was then to protect the Lesser White-fronted Goose from accidental killing. The rare and protected species and the White-fronted Goose are hard to tell apart with a telescope and even more difficult to identify when preparing to shoot an individual flying over. Although Lesser White-fronted and Red-breasted Geese remain strictly protected hunting for White-fronted Geese was reopened for unclear reasons from winter 2003-2004 for a period extending from 15 September until 10 February. This period is not in accordance with the Bird Directive of the European Union and will most probably bring the Greek State to the European Court.

The risk exists thus currently that one of the 50 Lesser White-fronted Geese will be confused with a White-front Goose and accidentally shot down. It would obviously be ideal to close again any hunting for geese in the Evros Delta at least. If a consensus on the subject is not and hunting for White-fronted Geese continues to be allowed it is absolutely necessary that the influence of the practise on geese is fully documented by specific studies and by the full control and study of the daily hunting bag.

But the main influence of hunting on geese is not the direct killing but the disturbance caused by the presence of hunters together with regular shots. It is also confirmed in the Evros Delta where we have found that the distribution of all species of arctic geese is strongly influenced both by the hunting zone and the hunting period. An essential measure would be to extend the boundaries of the non-hunting zone to give more safe feeding grounds to the geese. The area comprised in the Kalavos loop is contiguous to the actual non-hunting zone and is visited by thousands of geese after the hunting season is closed. That occurrence makes it a priority parcel to be protected (figure 13).

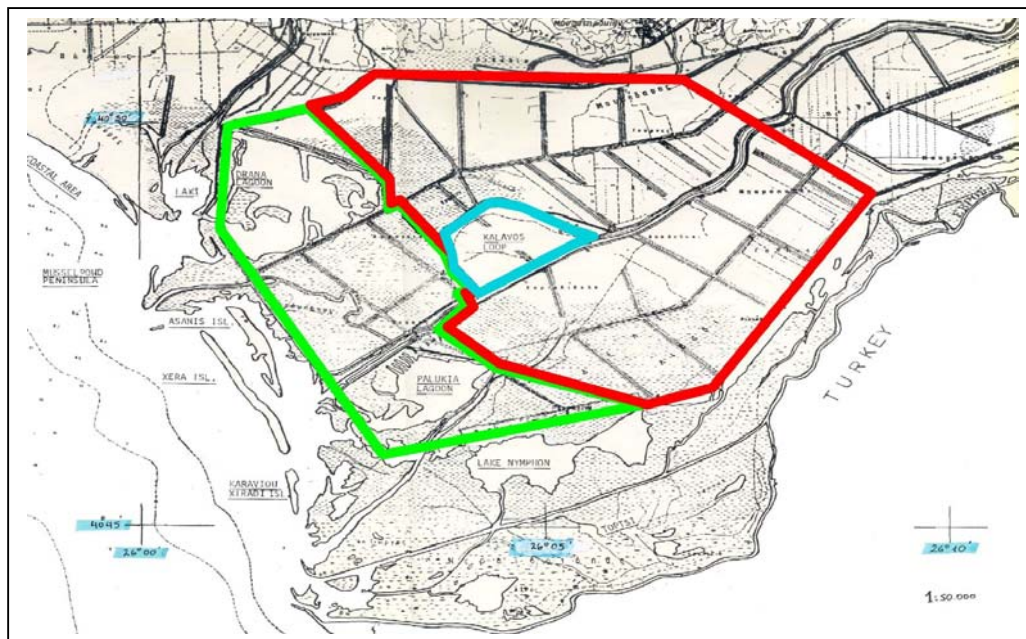


Figure 13. Current extent of the non-hunting zone (green) and hunting zone (red) with new area proposed for non-hunting (blue). Only limits concerning the study area are shown.

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