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Literature Review of the Research Project :

"Evaluation of bird species populations, in the Ramsar Wetland of the Lakes Koronia & Volvi in Northern Greece"

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1. Introduction

Subject of the present study will be the evaluation of the bird species populations recorded during the past 20 years in the Ramsar Wetland of the Lakes Koronia and Volvi, in Northern Greece. Several factors (human activities, agricultural uses, water resources, industry and pollution, biocides, fish species populations, protection measures) usually affecting the bird species (Berthold 1993), will be analysed and correlated with the documented variance of their populations.

The review of the existing literature will present the general profile of the Wetland of the Lakes Koronia and Volvi, give a detailed description of its characteristics and explain why it is an important area for bird species. The Wetlands' location, geomorphological characteristics, human activities, land use, pollution problems caused by industrial sewage and current protection status, are subject of the present literature review, which also focuses on the significance of wetlands in promoting and maintaining global biodiversity, the importance of bird species as indicators of biodiversity and the factors contributing to the decline in bird species populations during the last decades.

2. Wetlands

An official definition for the term **wetland** is provided by the Ramsar Treaty: *"…wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres." "may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands".*

On scientific terms, a wetland is an area covered by shallow waters either on a seasonal or permanent basis. At the same time wetlands feature a wet substratum that is permanent all through the year. Rivers, their estuaries and deltas are also classified as wetlands. The same is true for lakes, lagoons, springs and river/lake/shore sides, artificial ponds, salt-marshes, swamps and peatland areas.

The official name for the Ramsar Treaty (1971) is "*The Convention on Wetlands of International Importance especially as Waterfowl Habitat*", or *Ramsar Convention*, in short. Since 1971 the Ramsar Convention has gained world recognition and functions as point of reference for entities around the world concerned about the protection of the environment. Greece ratified the Ramsar Convention in 1974, while up to 1995 more than 90 countries had also signed the Convention. The countries that join the Ramsar Convention endorse the principle that wetlands represent irreplaceable natural resources of high economic, cultural and scientific value, as well as recreation areas. In this light the signatories should strive to preserve wetlands in their jurisdiction by taking national and international action. Wetlands represent complex ecosystems manifesting a wide range of aquatic or marine life (e.g. plants, insects, fish, amphibians, reptiles, fowl and mammals). These species are highly dependent as much on each other as on the environment.

Wetlands, those which have not yet been degraded by Man, support a wonderful world of living organisms that form complex food webs. A notable wetland feature is the plethora of waterfowl which reproduce, nest, feed, and rest in wetland habitats. Several of these bird species are migratory and are protected by international conventions (e.g. Ramsar, Bonn) and EEC Directives (e.g. 79/409/EEC on wild birds, 92/43/EEC on Habitats).

Wetlands have multiple values for man because :

· their high biological diversity is essential to the breeding of superior yielding plants and farm animals, to advances in science and to the security of many industries that use living resources.

· they provide drinking and irrigation water, enrich underground waters, protect against floods, improve water quality and reduce damage from frost and heat stress.

· they support fish and game and provide rich grazing land for farm animals.

· they offer opportunities for recreation, ecological tourism, education, and research

· they are linked with the history, myths, and traditions.

(Sources: Adamantiadou & Katsikas 1997; "Greek Wetlands", 1994; www.ramsar.org; www.mfa.gr; www.minenv.gr)

3. Wetlands in Greece

Greece is a country of exceptional geomorphology: approximately 70% of its total area is dominated by mountains, while the coastlines of Greece measure thousands of kilometres including those of hundreds of islands and numerous peninsulas. This multivariable geomorphology has considerable effects on the climate of the country that ranges from desert-like conditions in the south-east to continental wet and frosty conditions dominating the Rodopi range.

The mosaic of micro-climatic conditions in Greece is also reflected in the diversification of flora, fauna and particular ecosystems of the country. The **wetlands** of Greece sum up the environmental and climatic conditions particular to the country. More than 400 bird species have been observed, while some of them run the risk of extinction on a world scale (www.mfa.gr; www.minenv.gr).

(Adopted from: David Gosney, 1994. Finding Birds in Greece.)

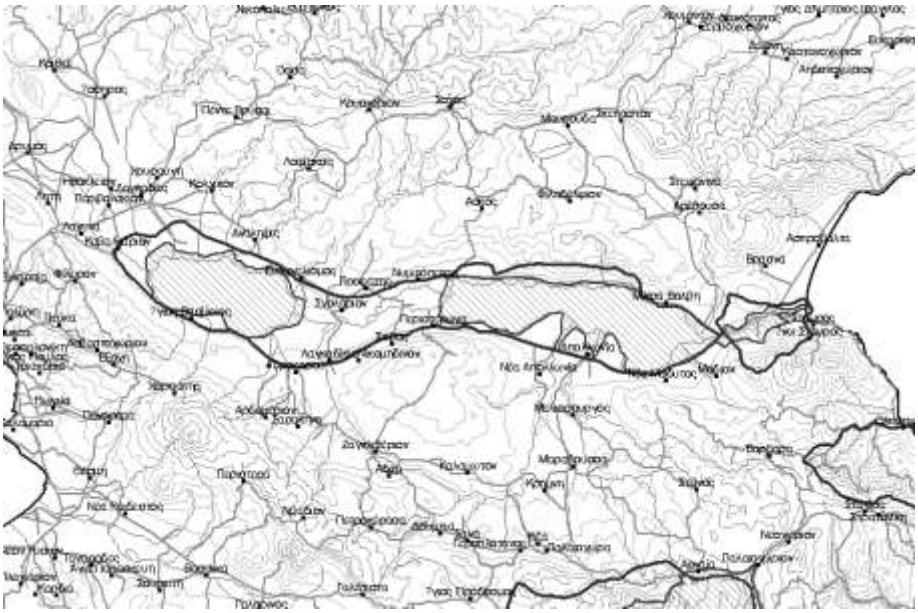
Since 1920 Greece has lost over 60% of its wetlands owing to the draining/drying effects, either natural or artificial. These effects were partly brought about in an effort to increase arable land and supply of irrigation waters, check disastrous flood effects and control malaria. Currently, the wetlands of Greece are further degraded owing to housing the tourism development (Handrinos 1992, Gerakis & Koutrakis 1996, Zalidis & Mantzavelas 1994, Psilovikos 1990 & 1992).

In 1990 the Ministry for the Environment, Urban Planning and Public Works and the European Commission, assigned the Goulandris Museum of Natural History with the task to organize an Institute devoted exclusively to the conservation of wetlands in Greece. The following year (1991) the Greek Center for Biotopes – Wetlands was inaugurated in the city of Thessaloniki. Following an inventory, this Institute established that Greece features over 400 large and small wetlands covering a total area of 2 million square metres. During the last few years the significance of wetlands has been recognized by the general public while there is also a general consensus for the need to take action for the conservation, management and wise use of wetlands (Greek Wetlands, Goulandris Natural History Museum 1994).

4. The Ramsar Wetland of the Lakes Koronia and Volvi

Lake Koronia and Lake Volvi are situated in Northern Greece, at the central part of Makedonia, 30-50 km from Thessaloniki (Coordinates: 40°41'N 023°20'E), occupying an area of 16,388 ha, are among the five largest in Greece (Volvi is 2nd and Koronia is 4th). The area is protected by the Ramsar Convention and was recently designated as a Natural Wetland Park (Government of the Hellenic Republic, Decision 6919, 5th March 2004).

Intense tectonic activity and fracturing was the forming force of Mygdonia basin, since the Palaiogene (1.8 million years ago) (Knight & Karavokyris 1999). Lake Koronia is shallow, eutrophic and almost deplete of oxygen during the summer; on the other hand, lake Volvi is much deeper, meso-eutrophic with more oxygen during the summer (Vassilakis et al., 1994; Adamantiadou & Katsikas 1997; Zacharias et al, 2002).



Map of the area around the Lakes Koronia and Volvi (1:300.000) (Source: Hellenic Ornithological Society)

Biological/Ecological notes: The area has long been important for bird species (**IBA**), but it became even more important as a bird habitat after 1957 when the two small lakes of Mavrouda and Lantza to the north of Volvi were drained. Most of the IBA is designated as a Special Protection Area (SPA) under the EU Birds Directive, covering 15,671ha, including Lakes Volvi and Koronia and Rendina Gorge. Lakes Volvi and Koronia are also designated as a Ramsar wetland of international importance (16,388ha) (www.birdlife.org.uk).

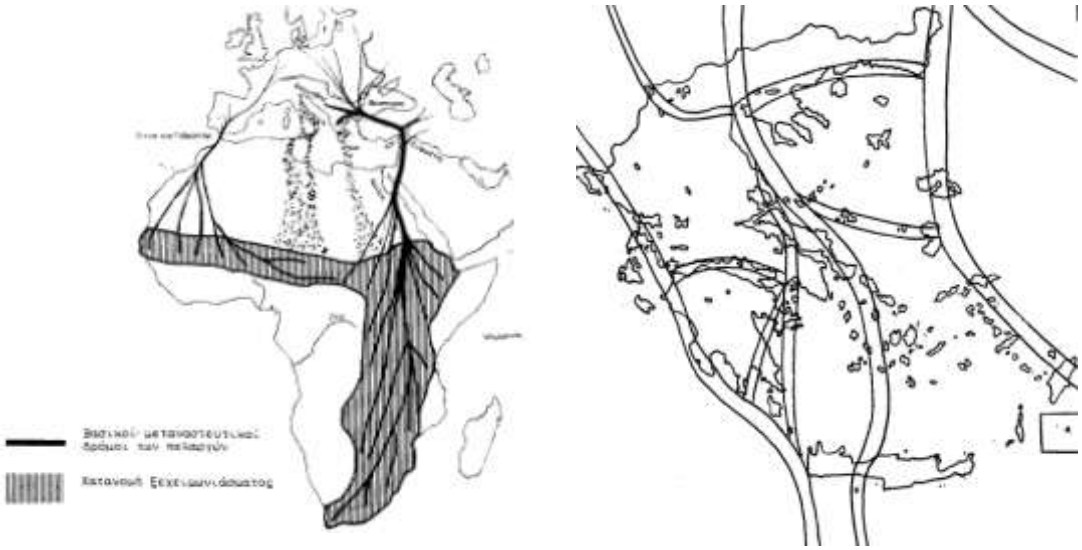
There are two Protected Monuments of Nature: the first is a centuries-old Plane in "St Paul Step" near Apollonia and in Sholari, between the two lakes, two veteran plane trees supporting large colonies of grey heron (Vassilakis et al., 1994; Adamantiadou & Katsikas 1997; Archer, 2003). The area boasts of two significant forests: the Rentina (flanking the Rechios river) and the Apollonia forest next to Lake Volvi.

The lakes and their wider area possess a high biological diversity at both the species and habitat level. Eight hundred different plant species are present in the habitats surrounding the wetland. Among those 340 different aquatic plant species, 13 of which are considered rare (Adamantiadou & Katsikas 1997). 248 bird species (Kazantzidis 1998), 14 reptiles, 34 mammals, 5 amphibian species (Adamantiadou & Katsikas 1997) and 22 fish species (Kokkinakis et al, 2000) at the site. The fish species *Alosa macedonica* and

Chalcalburnus chalcoides macedonicus are endemic. The **amphibians** *Bufo viridis, Hyla arborea* and *Rana balcanica*, the **reptiles** *Agama stellio, Lacerta trilineata, Lacerta viridis* and *Natrix tessellata*, and the **mammals** *Myotis blythi* and *Myotis* are protected by international conventions and are found at the site. The otter *Lutra lutra* formerly occurred but there is currently no evidence for its continued presence.

Two hundred forty eight (**248**) **bird species** (about 58% of Greece's species), have been observed at the site and at least 40 breed in the area and 62 are protected under EU legislation. It is a hot spot for migrating birds, an ideal wintering station and breeding haven for many birds. The Rentina straits are the crossing of snake-eagle and golden-eagle (Adamantiadou & Katsikas 1997; Kazantzidis 1998; Nasopoulou & Banti 2003; Archer 2003).

Breeding waterbird species include *Nycticorax nycticorax, Ardea purpurea, Ixobrychus minutus, Egretta garzetta Tadorna ferruginea, Accipiter brevipes, Buteo rufinus, Aquila pomarina, Circus aeruginosus, Hieraaetus pennatus* and *Coracias garrulus.* Also present are *Ciconia ciconia* - whose breeding population in the area is among the largest in Greece, and *Ardea cinerea* that is breeds in two colonies of approximately 70-80 nests (Handrinos & Akriotis 1997; Kazantzidis 1998). Although winter waterbird counts within the IBA are carried out annually, there are no regular surveys of breeding birds. Consequently, limited data is available on only a few key species, notably breeding grey herons. The status of the breeding populations of different species is therefore largely unknown, and the relative importance of the IBA in a Greek and EU context cannot currently be assessed (Archer, 2003).



The Wetland of the Lakes of Koronia & Volvi is is located across the migration route of many migratory birds. (Figures adopted from: P.Latsoudis, Migration, for the Hellenic Ornithological Society, 2003).

The IBA is of international importance for wintering and passage waterbirds, regularly supporting over 20,000 birds. Some important **wintering** waterfowl species are *Aythya ferina* with a mean number of 1,352 individuals in the preceding 12 years, *Tadorna tadorna*, *Anas platyrhynchos* and *Fulica atra*. At winter, we can see the Great Crested Grebe *Podiceps cristatus* (11,000), Black-necked Grebe *Podiceps nigricollis* (100+), Pochard *Aythya ferina* (30,000), Coot *Fulica atra* (20,000) and, at times, the White-headed Duck *Oxyura leucocephala.* In recent years large populations of *Phoenicopterus ruber* (11750 birds in October 2000 – the largest recording of this species in Greece ever) appear at Lake Koronia resting or feeding during their migration. The Apollonia forest hosts both *Ciconia ciconia* and *C. nigra*, and at Redina Gorge, to the east, *Circaetus gallicus, Aquila Chrysaetos, Bubo bubo* and rarely *Neophron percnopterus* have been observed. Moreover, the Wetland is a very important feeding site for the White Pelican *Pelecanus onocrotalus* (maximum 550 birds) at summer and for the Dalmatian Pelican *Pelecanus crispus* (50+ birds) during migration (Vassilakis et al., 1994; Kazantzidis 1998; Nasopoulou, 1999; Nasopoulou & Banti 2003; Archer 2003).

Lake Koronia used to be one of the most important wintering sites for waterfowl in Greece. Notable wintering species were *Podiceps cristatus* with a mean number of 1,924 individuals before 1995 and the globally threatened species *Pelecanus crispus* and *Phalacrocorax pygmeus*. Breeding species included the Little Bittern *Ixobrychus minutus* (30 pairs), the Night Heron *Nycticorax nycticorax*, the Little Egret *Egretta*

garzetta, the Grey Heron *Ardea cinerea* (90 pairs), the Purple Heron *Ardea purpurea*, the White Stork *Ciconia ciconia* (50 pairs), the Ruddy Shelduck *Tadorna ferruginea*, the Levant Sparrowhawk *Accipiter brevipes*, the Long-legged Buzzard *Buteo rufinus*, the Lesser Spotted Eagle *Aquila pomarina* (1 pair), the Marsh Harrier *Circus aeruginosus* (3 pairs), the Booted Eagle *Hieraaetus pennatus*, the Little Crake *Porzana parva*, the Roller *Coracias garrulus*, and the Lesser Grey Shrike *Lanius minor* (Handrinos & Akriotis 1997).

In August **1995**, however, the drop of surface level, together with incidence of industrial pollution, lead to massive mortality of fish and waterfowl. Since then, the lake remained practically dead. (Knight & Karavokyris 1999; Nasopoulou & Banti 2003; Blionis, 2004). In September **2004**, the second major massive wildlife kill outbreak in Koronia lake took place. More than 30.000 of birds were killed. Thirty nine species were affected (more than 200 individuals of *Pelecanus crispus*, and individuals of *Platalea leucorodia* and *Egretta alba*, among other bird species). The event occurred in coincidence with a bloom of the haptophyte ***Prymnesium parvum*** (Moustaka-Gouni et al, 2004). ***Clostridium botulinum*** (type C) neuroparalyzing toxin has also been isolated and related with the birds' mortality (Hunters Federation of Macedonia and Thrace, Press Newsletter 17/9/2004 and personal communication). Investigations are underway to elucidate the cause(s) of this ecological catastrophe in Lake Koronia.

Hydrological / Physical notes: In the lowland coastal zone the **soils** are alluvial, fine-grained, and of considerable depth and high fertility. Acid brown forest soils predominate in the wider area.

Lake Koronia freezes in winter, is eutrophic and highly turbid, with a shortage of oxygen during summer. Lake Volvi, which does not freeze in winter, is poor in nutrients and clear, and is well oxygenated even in the hottest months. Lake Koronia lies at 75 m above sea level, and Lake Volvi lies at 37 m above sea level. During the last 10 years the volume of Lake Koronia has decreased dramatically, due to a decrease in precipitation and to the over-consumption of the lake water, resulting in a complete ecological disaster. The low water level of Lake Koronia severed the natural connection between the lakes. This was artificially restored by a channel constructed in 1980. Koronia is shallow (0.5-1 m), but Volvi is deeper (10 - 24 m). Lake Koronia's surface area was 46 sq km in 1970 (8 m deep), declined to 38 sq km in 1995, to 11 sq km in 2001, was completely drained in summer 2002 and returned to the 1995's levels in 2003 due to increased rainfall (Pitas, 2003; Blionis, 2004). Lake Volvi's surface area is 69 sq km.

The situation of uncontrolled water abstraction in Lake Koronia is clearly not sustainable and is likely to be causing long-term changes to the aquatic ecosystem at this site. It is very noticeable that the lake does not appear to support fish-eating waterbirds, apart from a small number of great crested grebes. This is in stark contrast to Lake Volvi, which supports a healthy population of breeding great crested grebes, obligate piscivores, and other species including great and pygmy cormorant. Lake Koronia would appear to attract significant numbers of black-necked grebe, although clearly they cannot breed at the site. The lowering of the water level poses a major threat for both lakes. This is mainly due to either protracted droughts or to unauthorized pumping of waters for irrigation purposes, with farmland around lake Volvi accounting for approximately 47% of the IBA (Archer, 2003).

The **climate** is mesothermic with a dry period during the hot summer, whereas at the nearby uplands, relatively harsher weather conditions prevail. The air temperature fluctuates; January is the coldest month (mean temperature of 4°C) and July the warmest (mean temperature of 26°C). The mean annual precipitation around the lake is approximately 415 mm (Zalidis at al, 2004).

Socio-economics: The **population** of the area is about 33,000 (Lagadas town: 6,000). **Industries** have started being established in the area of Lagadas since the late 70's, and include: textile dying units, tanneries, manufactures of metallic and stainless items, there are also two large dairy factories. The most water consuming industries are the textile dying units; their effluents contain very high concentrations of salt (NaCl). **Agricultural production** is approximately 140.000 ton. 25% of the farming land is irrigated. The irrigated cultivations include clover (56%), corn (20%), tobacco, vegetables (15%) and fruit. Non-irrigated cultivations include winter wheat and hay (they are the most widespread). There are several greenhouses (mainly with vegetables and flowers). **Stockbreeding** is widespread: bovine (13.000), pig (3.000), sheep (22.000), goat (19.000) and poultry (300.000) (Blionis, 2004; Zalidis et al, 2004).

Human Uses: Both lakes are primarily used for **irrigation** for (mainly) vegetable crops and maize. Some 90% of the lowland in the surrounding catchment is cultivated with cereals, maize, tomato, and tobacco. The areas around the lakes are intensively grazed, especially around Lake Koronia, while around Lake Volvi **grazing** fields are under less pressure (Archer, 2003). Relating the number of grazing animals to the total area of rangelands results in a **stocking density of about 2.42 sheep equivalents / ha**. This is one and a half higher that the grazing capacity estimated to 1 sheep equivalent / ha. Net **fishing** activities occur during the whole year except during the fish-spawning period. Though very important in past decades, the commercial value of the fish production today, is low, and the income from fishing generally supplements other forms of income. Other current land uses in the surrounding catchment are forestry, grazing and manufacturing (Knight & Karavokyris 1999). **Hunting** is prohibited. However there are over 300,000 hunters in Greece, many of whom are unlicensed. Numbers of hunters may be dropping as young people show less interest. Most licensed hunters respect the hunting seasons and protected areas. Targeted hunting of protected species such as golden orioles, shrikes and birds of prey, sometimes to supply taxidermists and killing of fish-eating species, such as white pelicans, and the globally threatened Dalmatian pelican and pygmy cormorant, by fishermen, heavy shooting in wetlands, even during statutory bans in harsh weather (including use of illegal repeating shotguns) and easy access to wetlands through the use of off-road vehicles, cause major concern (www.minenv.gr).

Land cover / use: The study area is covered by a great variety of land cover/use types that produce a rich and diverse landscape. According to the Corine Land Cover classification scheme (level 3), there are 32 different land cover types. These types may be grouped into 6 major land uses, according to the National Statistical Service of Greece:

	Land Use	[%]
–	Forests	16.5
–	Rangelands	46.0
–	Agricultural lands	34.0
–	Bare lands	2.0
–	Urban areas	1.4
–	Water bodies	0.1

Major land use units in the Wetland of Lakes Koronia and Volvi region (www.minenv.gr)

Pollution : Shallow lakes display a number of features that set them apart from the more frequently studied deeper systems. The majority of lakes in Northern Greece are small to moderate in size with a relatively low depth and are considered as sites of high value of the wetland habitat. However, the water quality of these lakes has only been evaluated segmentally and occasionally (Zacharias et al, 2002).

Water quality in Lake Koronia is gradually being degraded by the development of manufacturing units in the catchment area and the lack of sewage treatment (Zacharias et al, 2002; Tsiouris et al, 2001; Skoulikidis et al, 1998; Archer 2003; Petaloti et al, 2004). Agricultural run-off and discharge of effluents from the numerous animal breeding farms and industrial units of the area is detrimentally high, especially runoff into Lake Koronia. 14 plant species have disappeared from Lake Koronia (including all the benthophytes) and two have been lost from Lake Volvi (Knight & Karavokyris 1999; Blionis, 2004).

In a study where, water samples were collected on a monthly basis from lakes Koronia, Volvi, Doirani, Mikri Prespa and Megali Prespa located in N. Greece. Water quality parameters (temperature, dissolved oxygen, pH and conductivity), organic indices (COD, BOD5), and N- and P-species (NO3(-), NO2(-), NH4(+), and PO4(3-), Kieldahl nitrogen and acid-hydrolysable phosphorus) were determined according to standard methods for surface water. The physicochemical parameters determined in the lakes studied revealed a high temporal variation. The trophic state of the lakes ranged from meso- to hypertrophic (Petaloti et al, 2004).

A different study with samples were taken in two seasons, and the average concentration of the elements was calculated. The metals that we most easily extracted in the samples analysed in both lakes are Pb, Cr, Cd, Cu and also Mn in the case of Koronia lake (Fytianos & Lourantou, 2004).

Two field experiments were carried out in the watersheds of two Ramsar wetland areas in Northern Greece, Lakes Koronia and Volvi (area A) and Lakes Mikri and Megali Prespa (area B), to study the effect of application of N fertilizer on wheat yields, the quality of runoff water, and the quality of stream water. Chemical parameters for water did not differ along the selected watercourses in area B, while in area A they were higher in the samples taken near Lake Koronia than in the samples taken upstream, indicating that the watercourses are polluted downstream by non-agricultural sources (Tsiouris et al, 2002).

The haptophyte's *Prymnesium parvum* documented bloom in September 2004 and the presence of *Clostridium botulinum* neuroparalyzing toxin, have been related to a massive bird kill, mentioned before. The physical and chemical conditions of the lake water during that period, where as follows: the water temperature was 20.9 ºC, pH 8.2, transparency 0.18 m Secchi depth, salinity 5.3‰, conductivity 9.2 mS cm^{-1}, the surface water dissolved oxygen concentration 9.9 mg L^{-1} and the above bottom water concentration was 7.9 mg L^{-1}. The phosphate phosphorus concentration was 118.9 μg L^{-1}, the dissolved inorganic nitrogen concentration was 543.6 μg L^{-1} and the N:P atomic ratio was 10.1 (Moustaka-Gouni et al, 2004).

Summary: Wetland of Koronia & Volvi. Threats and importance.

– agricultural expansion	high
– burning of vegetation	high
– forest grazing	medium
– groundwater abstraction	high
– industrialization/urbanization	high
– infrastructure	medium
– natural events	medium

Citation :
BirdLife International 2003 *BirdLife's online World Bird Database: the site for bird conservation.* Version 2.0. Cambridge, UK: www.birdlife.org (accessed 21/1/2005)

Protection: The Wetland, constitutes part of a system of interconnected wetlands protected by:
- The Ramsar Convention (signed by Greece in 1974).
- The "Birds" European Directive (79/409/EC). It is a Special Protection Area.
- The "Habitats" European Directive (92/43/EC). It is a Site of Community Interest and is also included in the European Network "Natura 2000".
- The Barcelona Convention. It is a Special Protected Mediterranean Area.
- The Berne Convention – on the Protection of the Wildlife and the Biotopes in Europe.
- The Bonn Convention – on the Protection of the Migratory Species of the Animal Kingdom.

(Adamantiadou & Katsikas 1997)

Conservation Measures: A Preliminary Management Scheme has been operating since 1997 on the site. Hunting is prohibited in the lakes and a buffer zone up to 200 m from the shore. A number of laws define the fishing regime and protect the riparian vegetation. The Ramsar Management Guidance Procedure was applied at the site. This site was included in the Montreux Record of priority sites for conservation action in 1990. Following a meeting between the Greek government and the Ramsar Bureau in March 1998, an Expert Group was convened to review the conservation status of all Ramsar sites and make recommendations on the possible removal of sites from the Montreux Record. The report of the Expert Group was received in March 1999 and formed the basis of Resolution VII.12.1. As the result of the aforementioned report this site remains listed on the Montreux Record.

The agrienvironmental measures included in European Union regulation 1257/99 encourage agricultural methods designed to protect the environment and maintain the countryside. The option of such environmentally favourable management of farming round a sensitive ecosystem including two lakes is examined. A multi-objective programming model is used to assess the cost of reducing the use of agrochemicals by changing the pattern of cropping alone. The solution shows that a substantial reduction in the use of agrochemicals can be achieved, if the support scheme provided for in this regulation can offset

income loss due to reduced agrochemical use. The proposed aid results in a substantial reduction in the use of fungicides and insecticides, which are the most noxious agrochemicals (Psychoudakis et al, 2002).

Site Management: No single body legally responsible for the direct local conservation of the wetland exists. The Preliminary management Scheme is guided by a Joint Committee presided by a representative of local authorities. As a general point, it is apparent that there is currently no ongoing monitoring programme of anthropogenic activity on or around either of the two lakes (Archer, 2003). Local residents awareness of the value of wetlands, tourism or agriculture development is not satisfactory and needs governmental encouragement, according to a recent survey in protected areas in Northern Greece (Christopoulou & Tsachalidis 2004).

5. Birds in danger worldwide

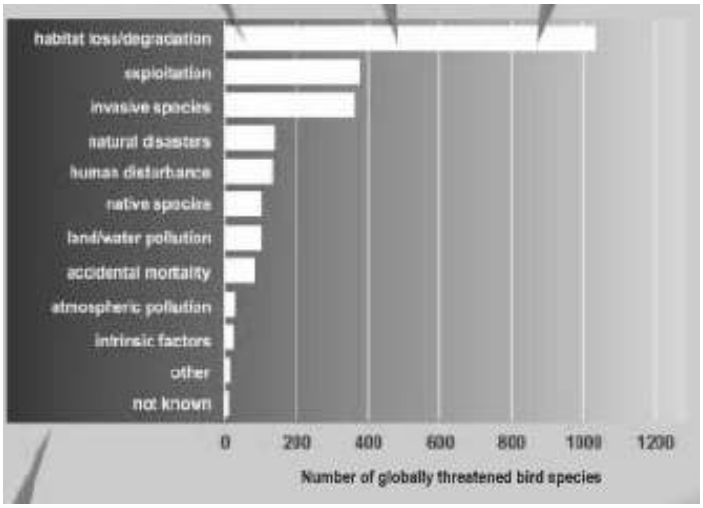
Over 1,000 Globally Threatened Birds (85% of the total) are affected by habitat loss and degradation, indicating that this is the most serious issue impacting biodiversity. Some 540 Globally Threatened Birds (46% of the total) are at particular risk of extinction owing to severe fragmentation of their habitat and isolation in a few locations. Species that were once widespread are affected, as well as those with naturally confined ranges (e.g. on islands or mountains).

Other significant driving forces leading to habitat loss and degradation are the extraction of natural resources and infrastructure development. Over 350 Globaly Threatened Birds (30% of the total) are affected by exploitation for human use, primarily through hunting for food (>200 species) and trapping for the cage-bird trade (>100 species).

Over 350 Globally Threatened Birds (30% of the total), many of which are confined to islands, are impacted by invasive species. In most cases these are introduced predators such as cats, rats and mongooses. Invasive species have been a major factor in most bird extinctions since 1800, so this is a particular concern.

Studies show that global warming is already having measurable effects on habitats, and the ranges and behaviour of some bird species. At present, relatively few Globally Threatened Birds are known to be directly affected by climate change. Most of these are seabirds, where oceanic warming is associated with food shortages. As climate change accelerates owing to atmospheric pollution, it is predicted that it will become a major problem for many species, often exacerbating the impacts of habitat loss and fragmentation.

Artificial habitats such as plantations and man-made wetlands are used by a number of Globally Threatened Birds (>20% of the total). However, they are generally of lesser importance to them, especially when intensively managed. Adjacent natural or semi-natural habitats are also required for feeding and/or breeding and it is often these vital areas which must be safe- guarded to ensure the birds survival (Birdlife International 2002). Globally threatened birds. Indicating Priorities for Action. Cambridge UK).



Bird populations are declining across many regions and habitats of the world. Indeed it has been estimated that, globally, bird populations have declined 20–25% since pre-agricultural times as a result of conversion of natural habitats by humans. Population declines for suites of species that depend on particular habitat types, indicate that these ecosystems are deteriorating globally and require conservation attention.

Factors affecting bird species populations worldwide. Adopted from: Globally Threatened Birds indicating priorities for action. Birdlife Intenational 2004. (www.birdlife.net).

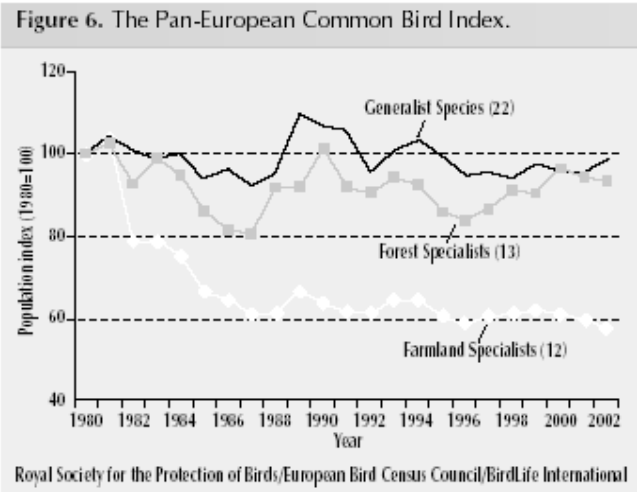
Waterbirds form a diverse guild of over 30 families that are ecologically dependent on wetlands. They occur throughout the world, often in spectacular concentrations, and represent one of the most obvious indicators of the health and diversity of wetland ecosystems. A recent analysis found that 41% of the 1,138 populations for which trends are known are in decline, and only 19% increasing. Reliable trend data are unavailable for 50% of the worlds 2,271 waterbird populations. Nevertheless, data from a well-studied region such as Europe (where estimates are available for 74% of 346 populations) showed a similarly high proportion (39%) of populations in decline (Wetlands International 2002).

6. Birds in Europe

According to the analysis of population trends, species associated with agricultural habitats continue to decline both in the EU and outside. Downward trends in farmland species are significantly correlated with cereal yield, indicating a strong correlation between the intensity of agricultural production and decline in farmland birds (Birdlife International. Birds in the European Union. A status assessment. Papazoglou et al, 2004).

The fact that long distance migrants are declining is alarming, and could be linked to events taking place during their stay on their wintering grounds although at this stage of the analysis it was not possible to determine this. However, it highlights the need for the EU to look beyond its borders when it comes to protecting certain species, as actions on EU territory might not be enough to ensure their Favourable Conservation Status in the long term.

The Royal Society for the Protection of Birds (RSPB), BirdLife International and the European Bird Census Council have developed a biodiversity indicator based on population trends of wild birds. The methods used are harmonised, proven and statistically robust, combining cutting-edge expertise from the Netherlands and the UK.



(Adopted from: State of the world's birds 2004. Indicators for our changing world. Birdlife International. Bennun et al, 2004)

The preliminary index shows that on average, populations of common generalist birds in Europe have remained stable over the last twenty years, although numbers have fluctuated in response to winter conditions (trend 1980–2002 = -2%). Common forest specialists have declined to a small degree (trend 1980–2002 = -7%). Populations of common farmland specialist, in contrast, have declined sharply, especially in the 1980s, and the downward trend continues at a slower rate (trend 1980–2002 = -42%).

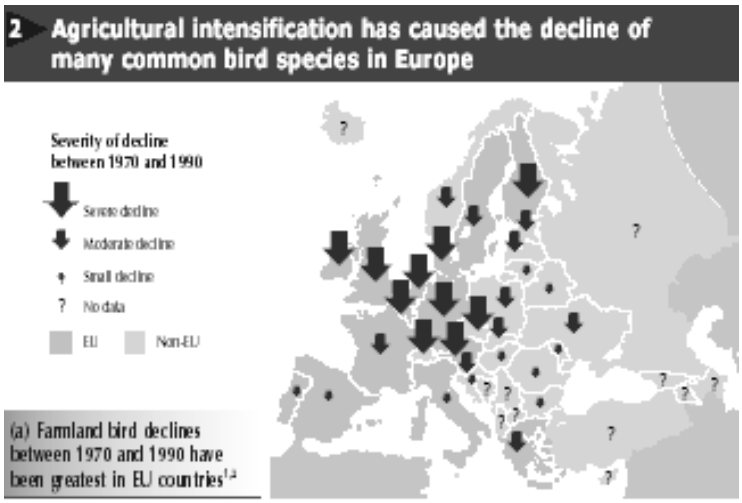
This reflects deterioration in the quality of farmland habitats, affecting both birds and other elements of biodiversity. There is abundant evidence that declines among farmland birds in Europe have been driven by agricultural intensification.

7. Agriculture and wildlife

The conflict between irrigated agriculture and wildlife conservation has reached a critical point on a global scale. World-wide, agricultural policies have intensified farming in many countries, turning farmland into poor-quality habitat for birds and other wildlife. 44% of Europe's land surface is under agricultural

cultivation. Agricultural intensification affects some 42% of declining species and it is the commonest cause reported for these declines. The farmland bird index for Europe has declined by 34% since 1966 (State of the Worlds Birds, 2004; Birdlife International; www.birdlife.org)**.**

Not only has local wildlife suffered, including the extinction of highly insular species, but a ripple effect has impacted migratory birds worldwide. The demand for water to support irrigated agriculture has led to the demise of wetlands and their associated wildlife for decades. In many parts of the world, freshwater ecosystems are already degraded from a range of human activities, including water extraction, pollution and physical alteration.



(Adopted from: State of the world's birds 2004. Indicators for our changing world. Birdlife International. Bennun et al, 2004)

Unsustainable agricultural policies and water and soil resource schemes have drained two thirds of Mediterranean wetlands since 1920. An outstanding example is Karla in Greece, a former internationally important wetland that was drained in 1962 causing environmental, social, and water and soil problems (Zalidis & Gerakis 1999).

Another example is that of the rise of water level in Lake Kerkini, in Northern Greece, at the reservoir during spring (exceeding 5 m) has an impact on the whole system, including several birds, which lose their nesting habitat. Monitoring of the managed habitats showed that most waterbirds used them for resting and roosting. Common terns nested on the rafts, cormorants on the platforms, and Dalmatian pelicans on the man-made island. Under the prevailing hydrologic and weather conditions, islands seem to be the most suitable habitat for pelican nesting. It is concluded that wildlife habitat management should integrate the ecological component, related to the needs of the species and ecosystem, with the social one, expressed by cooperation and involvement of the local community (Pyrovetsi 1997).

8. Birds as indicators for wider biodiversity and environmental objectives

Biodiversity is a complex phenomenon and we need simple indicators, which provide us with information about the main trends in order to take them into account in political decision making.

Birds are ideal indicators of the trends in overall biodiversity because:

- they usually occupy a high trophic level (thus indicating environmental changes occurring at lower trophic levels),
- they live in all ecosystems,
- their taxonomy and identification is well resolved,
- their conspicuous behaviour allow them to be readily censused,
- it is possible to collect large quantities of data in a highly efficient manner using skilled volunteer enthusiasts,
- importantly, birds have great public resonance across European cultures.

Regular monitoring of bird populations can yield trend information for birds. This can then be summarised to produce relatively simple, transparent indicators of ecosystem function and health, and might act as a model to develop indicators for their taxa. Scientific evidence exists to link changes in bird numbers to policy and environmental changes, therefore birds are ideal subject of developing policy relevant indicators. Birds can help to create this constituency for positive change and thus bring about, eventually, a genuinely sustainable world (Bennun et al., 2004).

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