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Population Trend, Phenology and Dispersion of Common Waterfowl Species in Hungary Based on aTen Year Long Time Series of the Hungarian Waterfowl Monitoring

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Abstract – The HUNGARIAN WATERFOWL MONITORING (HWM) takes place at 48 observation units. The current study shows the 25 common waterfowl species, their trend, phenology, and dispersion in Hungary using the data of a ten-year period between the 1996/1997 and 2005/2006 seasons. The six commonest species were: *Anas platyrhynchos, Anser albifrons, Anser fabalis, Anser anser, Anas crecca* and *Fulica atra*. During the ten-year period there were 8 species with about 1000 individuals or less *(Anser erythropus, Mergus albellus, Tachybaptus ruficollis, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Cygnus olor, Mergus merganser)*. We report a heavy increase of *Aythya nyroca, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Anas clypeata, Cygnus olor, Anser albifrons, Podiceps cristatus, Anser anser, Anas strepera* and a slight increase of *Phalacrocorax pygmeus* and *Tachybaptus ruficollis.* A strong decrease can be seen in *Anser erythropus, Aythya fuligula, Anser fabalis, Anas querquedula, Aythya ferina, Anas crecca, Mergus albellus, Anas penelope, Mergus merganser,* a slight decrease in the case of *Anas platyrhynchos* and *Bucephala clangula.* The 25 species were put into six different groups based on their types of phenology: late summer migrating species, species migrating dominantly in autumn, over wintering species, species passing through Hungary dominantly in spring, spring and late summer migrants, species with a stable population. Eco-geographical differences between Transdanubia and the Great Hungarian Plain explain the differences in the dispersion of species: distribution dominance in Transdanubia, dispersion dominance in the Great Hungarian Plain, even distribution. Our conclusions confirmed some of the earlier results, but in some cases we made conclusions different from the earlier suggestions. It is obvious that changing environmental conditions affect the changes in population parameters of waterfowl species.

Hungarian Waterfowl Monitoring (HWM) / common waterfowl species / population trend / penology / dispersion / Hungary

Kivonat – Gyakoribb vízivadfajok állománytrendje, fenológiája és diszperziója Magyarországon a Magyar Vízivad Monitoring 10 éves adatsorainak tükrében. A MAGYAR VÍZIVAD MONITORING megfigyelései 48 megfigyelési egységben folynak. Jelen munka az 1996/1997-2005/2006 között vizsgált 10 év adatai alapján mutatja be 25 rendszeresen előforduló vízivad faj állománydinamikáját, fenológiáját és diszperzióját Magyarországon. A hat leggyakoribb faj az *Anas platyrhynchos, Anser albifrons, Anser fabalis, Anser anser, Anas crecca* és *Fulica atra* volt. 10 év alatt 1000 példány közeli,

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vagy az alatti abszolút maximuma 8 fajnak volt (*Anser erythropus, Mergus albellus, Tachybaptus ruficollis, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Cygnus olor, Mergus merganser*). Vízivad állományaink nagy részénél sikerült állománynövekedést kimutatni; erőteljesen növekedett: *Aythya nyroca, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Anas clypeata, Cygnus olor, Anser albifrons, Podiceps cristatus, Anser anser, Anas strepera.* Enyhén gyarapodott: *Phalacrocorax carbo* és *Tachybaptus ruficollis*. Aggasztó jelenség az *Anser erythropus, Aythya fuligula, Anser fabalis, Anas querquedula, Aythya ferina, Anas crecca, Mergus albellus, Anas penelope, Mergus merganser* erőteljes, az *Anas platyrhynchos* és a *Bucephala clangula* enyhe mértékű állománycsökkenése. A fenológiai jellemzők alapján rendezve, a vizsgált 25 fajt hat csoportba sorolhattuk, amelyek az alábbiak: nyárvégi vonuló fajok, dominánsan ősszel vonuló fajok, áttelelő fajok, dominánsan tavasszal vonuló fajok, nyárvégi és tavaszi vonulók, állandó állományú fajok. A diszperziót tekintve több faj előfordulását befolyásolják a Dunántúl és az Alföld közötti ökogeográfiai különbségek, így létezik: dunántúli diszperziós dominancia, alföldi diszperziós dominancia és egyenletes diszperzió. A korábbi megfigyelések alapján született ismereteinket kutatásaink részben megerősítették, ám sok esetben azoktól eltérő megállapításokat tehettünk. A változó környezeti állapotváltozásokat idézhet elő a vonuló vízivadfajok állományjellemzőiben.

Magyar Vízivad Monitoring (MVvM) / gyakoribb vízivadfajok / állománytrend / fenológia / diszperzió / Magyarország

1 INTRODUCTION

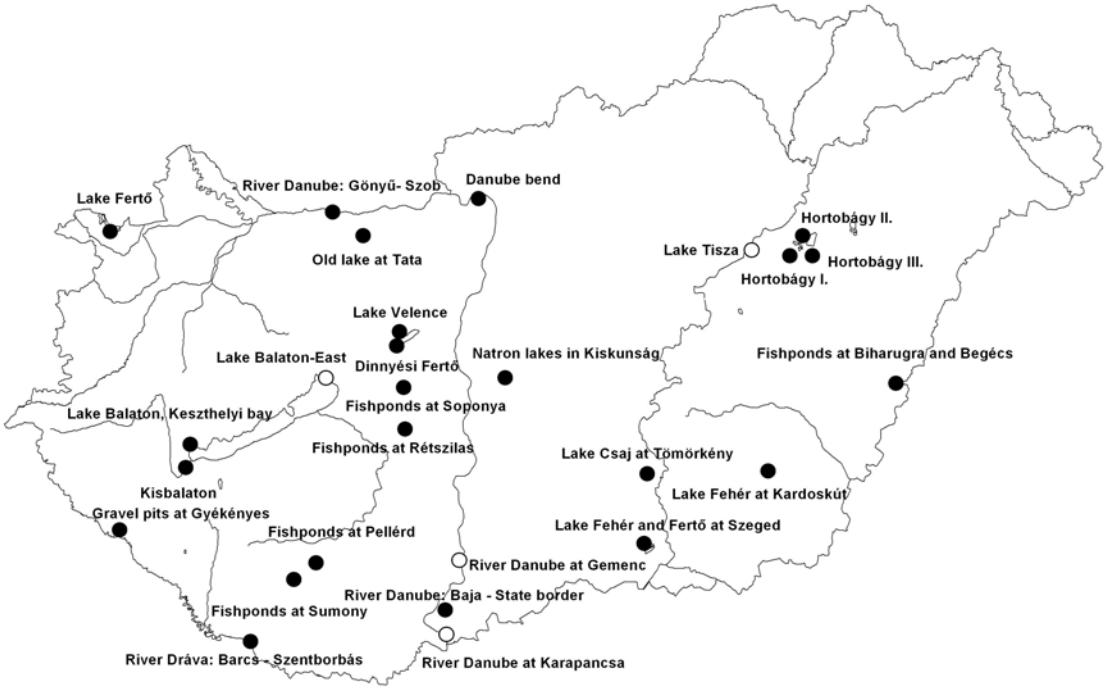
The Hungarian waterfowl information system contributes to fulfilling the requirements of AEWA and, more widely, it serves the purposes of nature protection and sustainable use. It provides necessary information for nature conservation and game management, taking into consideration the unity of the natural systems. An observational sub-system of the Waterfowl Database focuses on the size of the waterfowl population, their current dispersion and the structure of the waterfowl communities. All these refer to the on-going Hungarian Waterfowl Monitoring (Faragó 1998a). The operation of the monitoring provides information on the trend of waterfowl species within individual years and over a period of years, referring to certain sites, regions, and the entire country. It also helps us define the habitat use and selection of certain species within a year and over a period of several years.

2 MATERIAL AND METHODS

The observations of the Hungarian Waterfowl Monitoring (HWM) take place in 23 districts, which are divided into 2 to 6 sub-districts each. It means that HWM takes place in 48 observation units (*Table 1, Map 1*). The censuses were carried out between October, 1996 and March, 1997, in connection with an international census day in each month. Since the 1997/1998 seasons, a nine-month-long period between August and April was used. The observations expanded to the following tax: all species of Anseriformes, Gaviiformes, Podicipediformes, and Pelecaniformes; Great White Egret (*Ardea alba*), Grey Heron (*Ardea cinerea*), Eurasian Coot (*Fulica atra*), Eurasian Crane (*Grus grus*) and White-tailed Eagle (*Haliaaetus albicilla*) totaling **63** species. We have first chosen natatorial birds from this list, but we took into consideration the information needs of fish management, and the Authority for Nature Conservation. That is the reason for including the Grey Heron, the Great White Egret, the Eurasian Crane and the White-tailed Eagle in the survey.

Table 1. Size and geographic coordinates of the observation units of the Hungarian Waterfowl Monitoring (HWM)

	Site	Area ha	Degree of latitude		Degree of longitude	
01	Lake Fertő	1,918	47.6639	47.7389	16.6869	16.8484
02	Danube between Gyönyű and Szob	4,842	47.7279	47.8229	17.8240	18.8414
03	Old Lake at Tata	230	47.6303	47.6499	18.3187	18.3405
04	Lake Velence	2,600	47.1776	47.2383	18.5322	18.6620
05	Dinnyési Fertő	545	47.1378	47.1767	18.5230	18.5639
06	Fishponds at Soponya	520	46.9855	47.0715	18.4197	18.4931
07	Fishponds at Rétszilas	840	46.7950	46.8687	18.5556	18.6009
08	Lake Balaton. Keszthelyi-bay	2,930	46.7062	46.7644	17.2434	17.3177
09.01	Kis-Balaton I.	1,630	46.5899	46.6749	17.1189	17.1738
09.02	Kis-Balaton II.	1,820	46.6127	46.6923	17.1761	17.2379
10	River Dráva between Barcs and Szentborbás	465	45.8623	45.9515	17.4280	17.6501
11	Gravel pits at Gyékényes	170	46.2377	46.2513	16.9718	17.0014
12	Fishponds at Sumony	207	45.9573	45.9745	17.8736	17.8974
13	Fishponds at Pellérd	116	46.0436	46.0525	18.1358	18.1630
14	Danube bend	2,977	47.8219	47.5608	18.8483	19.1358
15	Danube between Baja and state border	2,554	45.9170	46.1875	18.6803	18.9278
16.01	Natron lake Kelemen-szék at Fülöpszállás	430	46.7832	46.8047	19.1678	19.2022
16.02	Natron lake Zab-szék at Szabadszállás	370	46.8126	46.8466	19.1568	19.1813
17.01	Jusztus-Feketerét (marsh)	690	47.5460	47.5777	20.8751	20.9164
17.02	Fishponds at Hortobágy	1,700	47.6040	47.6631	21.0501	21.1140
17.03	Fishponds at Virágoskút	1,500	47.6516	47.7045	21.3235	21.3713
18.01	Fishpond Fényes	258	47.5716	47.5880	21.0019	21.0287
18.02	Fishponds at Csécs and Parajos	554	47.5382	47.5648	20.9984	21.0420
18.03	Fishponds Akadémia and Kungyörgy	248	47.5640	47.5913	21.0631	21.0957
18.04	Pentezug pusza and marshes	4,300	47.4849	47.5879	21.0536	21.1535
18.05	Zámi pusza and marshes	2,880	47.4767	47.5378	20.9843	21.0725
18.06	Borzas	1,600	47.4473	47.4900	21.0377	21.1075
18.07	Nagyiván and Kunmadaras puszta	1,350	47.4883	47.5376	20.9308	20.9944
18.08	Kunkápolnás marshes	4,000	47.4080	47.4959	20.9292	21.0118
19.01	Angyalháza and Szelencés	6,250	47.4403	47.5495	21.0885	21.2076
19.02	Fishponds at Borsós and Malomház	2,230	47.5392	47.5815	21.1336	21.2215
19.03	Borsós. Ökörföld. Görbehát	1,390	47.5395	47.5777	21.2078	21.2886
19.04	Magdolna. Nyírő-lapos. Nyári-járás	3,700	47.5521	47.6152	21.2143	21.3385
19.05	Álomzug. Köselyszeg	4,600	47.4571	47.5443	21.1650	21.2931
19.06	Fishpond at Elep	552	47.5289	47.5589	21.2654	21.2981
20	Lake Fehér at Kardoskút	100	46.4660	46.4762	20.6054	20.6482
21.01	Fishponds at Biharugra	773	46.9370	46.9723	21.6013	21.6423
21.02	Fishponds at Begécs	1,212	46.9074	46.9401	21.5252	21.5979
22	Lake Csaj at Tömörkény	860	46.6044	46.5581	20.0458	20.0950
23.01	Lake Fehér at Szeged	1,506	46.3033	46.3499	20.0666	20.1346
23.02	Szegedi Fertő	628	46.3177	46.3560	20.1367	20.1792
	Total	68,045				



Map 1. Observation units of the Hungarian Waterfowl Monitoring (HWM)

The current study presents information on the **following 25 common waterfowl species**, their trend, phenology, and dispersion in Hungary using the data of a **ten-year-long period between the 1996/1997 and 2005/2006** seasons (Faragó 1998b; 1998c; 1999a; 1999b; 2001a; 2001b; 2002a; Faragó – Gosztonyi, 2002; Faragó, 2002b; 2002c; Faragó – Gosztonyi, 2003a; 2003b; Faragó, 2005a; 2005b; 2006a; 2006b; 2007a; 2007b; 2007c; 2007d):

Mute Swan – *Cygnus olor* (Gmeliin 1789)
Bean Goose – *Anser fabalis* (Latham 1787)
White-fronted Goose – *Anser albifrons* (Scopoli 1769)
Lesser White-fronted Goose – *Anser erythropus* (Linnaeus 1758)
Greylag Goose – *Anser anser* (Linnaeus 1758)
Wigeon – *Anas penelope* Linnaeus 1758
Gadwall – *Anas strepera* Linnaeus 1758
Teal – *Anas crecca* Linnaeus 1758
Mallard – *Anas platyrhynchos* Linnaeus 1758
Pintail – *Anas acuta* Linnaeus 1758
Garganey – *Anas querquedula* Linnaeus 1758
Northern Shoveler – *Anas clypeata* Linnaeus 1758
Red-crested Pochard – *Netta rufina* (Pallas 1773)
Pochard – *Aythya ferina* (Linnaeus 1758)
Ferruginous Duck – *Aythya nyroca* (Güldenstädt 1770)
Tufted Duck – *Aythya fuligula* (Linnaeus 1758)
Common Goldeneye – *Bucephala clangula* (Linnaeus 1758)
Smew – *Mergus albellus* Linnaeus 1758
Goosander – *Mergus merganser* Linnaeus 1758
Little Grebe – *Tachybaptus ruficollis* (Pallas 1764)
Great Crested Grebe – *Podiceps cristatus* (Linnaeus 1758)
Black-necked Grebe – *Podiceps nigricollis* (C.L. Brehm 1831)
Great Cormorant – *Phalacrocorax carbo* (Linnaeus 1758)
Pygmy Cormorant – *Phalacrocorax pygmeus* (Pallas 1773)
Eurasian Coot – *Fulica atra* (Linnaeus 1758)

When investigating the species, we analyzed the following factors:

- Population trends (1) and trends in relation to the examined sites, regions and Hungary in the investigation period. In the current study we show the trends (*Figure 1*) defined on the basis of the annual national **season maximums** (*Table 2*). When qualifying trends, we named the population changes using the method applied by Tucker – Heath (1994). Trend indices characterized the measure of stability of population between 1970 and 1990 with a range of 20%. They showed small changes (increase-decrease) in the 20-49% range, and the larger ones with at least a 50% change. If the direction of the trend was not clear and the change of values exceeded 20%, they classified it as *fluctuating*. While Tucker and Heath (1994) used a twenty-year-long period we studied only a ten-year-long period. Therefore we used the following evaluation:
  - Large decrease at least 25%
  - Small decrease 11-24%
  - **Stable** plus or minus 0-10%
  - Small increase 11-24%
  - Large increase at least 25%
  - **Fluctuating** over 10% but with no clear trend
- Population trend (2) – **phenology**: minimum, average and maximum number of birds in each month (*Figure 2*).
- We are showing maps based on the **dispersion** in each month. In the current study we are showing the maps of peak seasons (month) of certain species (*Map 2*).

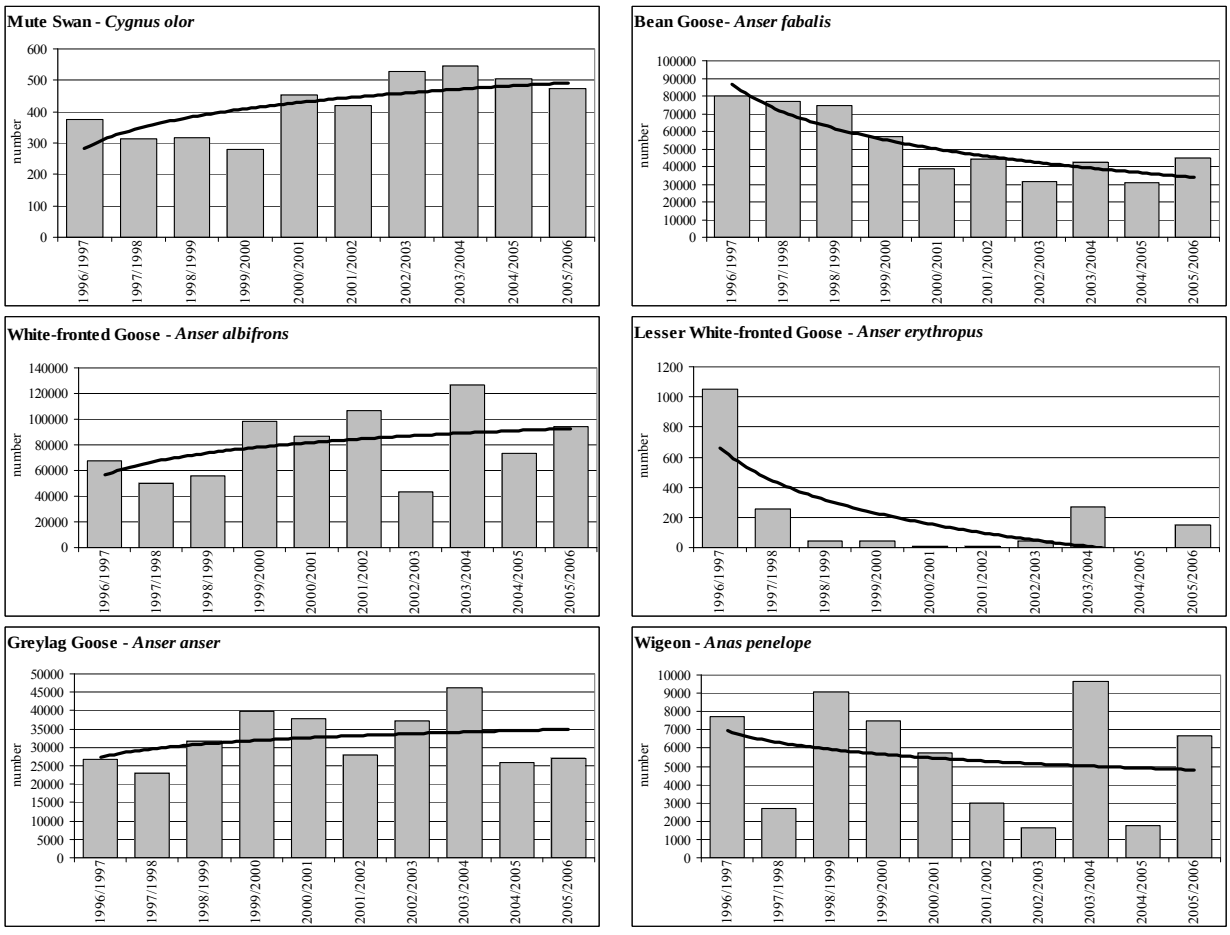


Figure 1: Dynamic and trend calculated on the basis of seasonal maxima in the case of the 25 most frequent waterfowl species

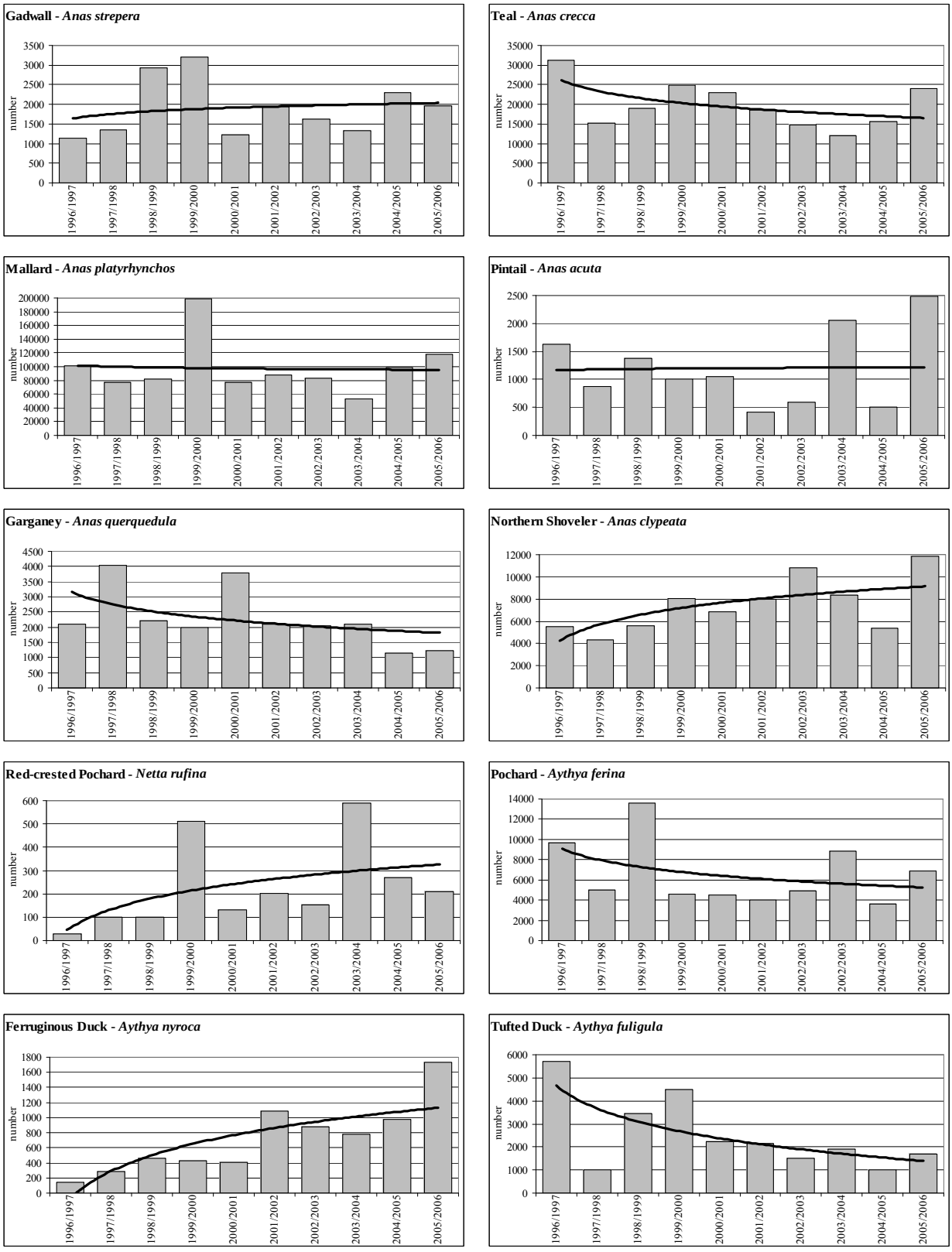


Figure 1 (cont.): Dynamic and trend calculated on the basis of seasonal maxima in the case of the 25 most frequent waterfowl species

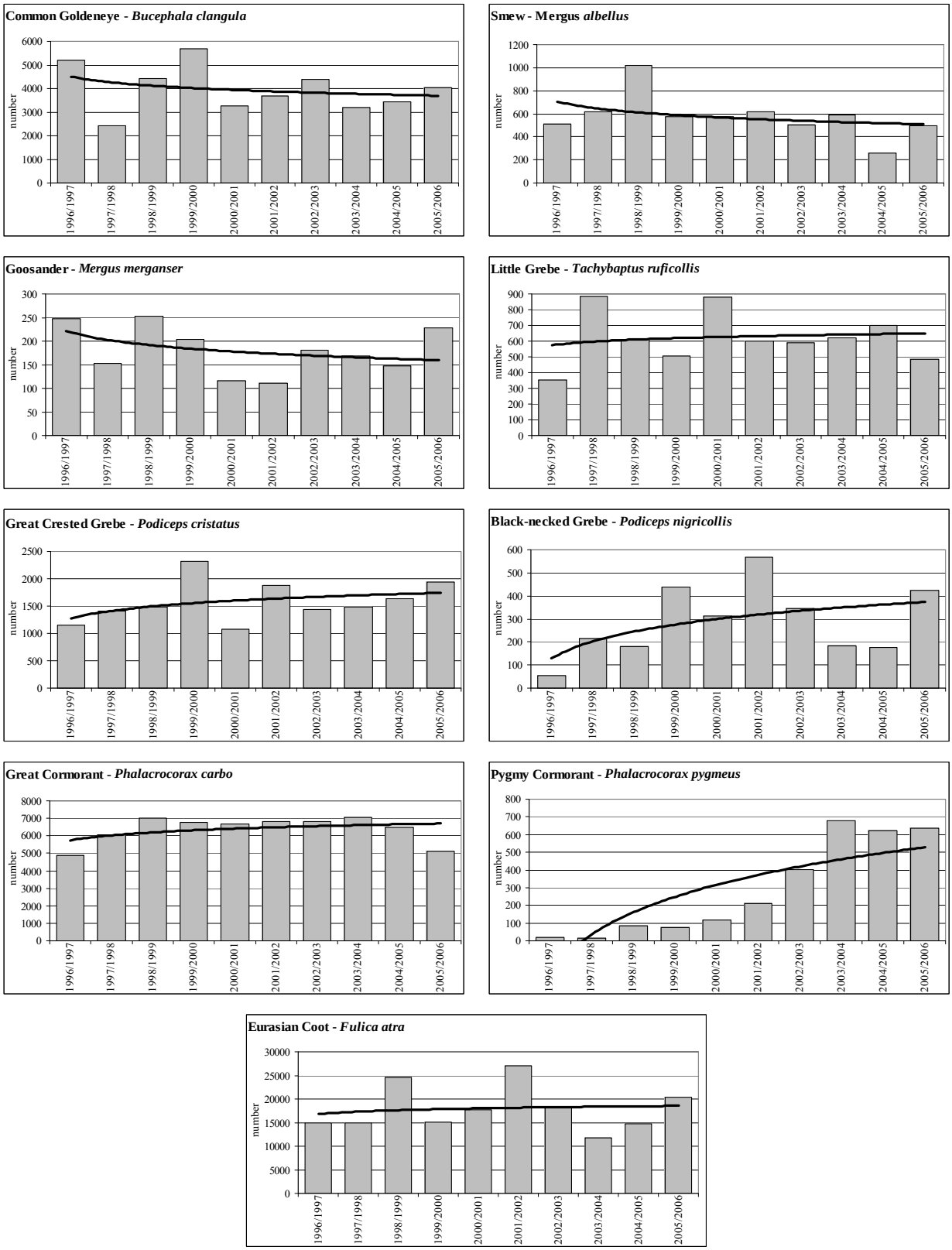


Figure 1 (cont.): Dynamic and trend calculated on the basis of seasonal maxima in the case of the 25 most frequent waterfowl species

Table 2. Seasonal peak values of the 25 most frequent waterfowl species, their 10-year maxima, average values, SD and trends

Species	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03	20003/04	2004/05	2005/06	Max	Average	SD	Trend %
Cygnus olor	374	314	317	278	454	418	529	545	503	474	545	420.6	95.8	75
Anser fabalis	80,247	76,851	74,490	57,099	38,995	44,395	31,589	42,623	30,750	44,756	80,247	52,179.5	18,804.5	-61
Anser albifrons	67,521	49,792	56,048	98,132	86,289	107,011	43,170	126,811	73,668	94,219	126,811	80,266.1	26,934.4	73
Anser erythropus	1,054	256	40	40	6	6	40	270	3	150	1,054	186.5	321.3	-86
Anser anser	26,700	23,020	31,750	39,716	37,766	27,948	37,093	46,184	25,949	26,910	46,184	32,303.6	7,503.5	30
Anas penelope	7,733	2,718	9,063	7,474	5,752	3,003	1,638	9,620	1,743	6,651	9,620	5,539.5	3,035.5	-30
Anas strepera	1,133	1,351	2,934	3,209	1,214	1,945	1,620	1,323	2,299	1,961	3,209	1,898.9	724.1	30
Anas crecca	31,171	15,278	18,986	24,825	23,010	18,604	14,659	12,085	15,521	24,031	31,171	19,817.0	5,864.7	-39
Anas platyrhynchos	100,763	76,573	81,779	198,659	77,702	88,067	83,064	52,583	98,788	117,934	198,659	97,591.2	39,517.8	-14
Anas acuta	1,626	872	1,369	1,007	1,049	407	592	2,059	509	2,483	2,483	1,197.3	686.2	8
Anas querquedula	2,091	4,040	2,220	1,990	3,796	2,108	2,034	2,094	1,139	1,239	4,040	2,275.1	944.5	-44
Anas clypeata	5,524	4,321	5,559	8,086	6,832	7,967	10,831	8,316	5,381	11,829	11,829	7,464.6	2,444.2	113
Netta rufina	29	100	,101	513	130	202	151	589	271	209	589	229.5	183.2	540
Aythya ferina	9,633	4,966	13,580	4,617	4,479	4,020	4,950	8,832	3,642	6,889	13,580	6,560.8	3,200.7	-42
Aythya nyroca	141	,287	459	425	405	1,082	880	776	980	1,735	1,735	717	475.5	1000
Aythya fuligula	5,723	1,023	3,435	4,488	2,212	2,158	1,519	1,904	1,011	1,680	5,723	2,515.3	1,556.4	-68
Bucephala clangula	5,182	2,432	4,429	5,693	3,262	3,692	4,382	3,181	3,433	4,045	5,693	3,973.1	982.0	-18
Mergus albellus	512	616	1,020	578	573	619	506	587	257	497	1,020	576.5	187.9	-31
Mergus merganser	247	153	253	204	116	110	181	168	147	228	253	180.7	51.3	-29
Tachybaptus ruficollis	354	886	612	505	880	598	589	622	700	483	886	622.9	166.3	14
Podiceps cristatus	1,145	1,405	1,481	2,322	1,082	1,879	1,445	1,490	1,629	1,933	2,322	1,581.1	375.8	40
Podiceps nigricollis	54	217	179	437	313	567	345	182	175	424	567	289.3	155.7	192
Phalacrocorax carbo	4,876	6,038	7,029	6,791	6,681	6,794	6,826	7,052	6,497	5,119	7,052	6,370.3	780.6	19
Phalacrocorax pygmeus	18	16	83	75	115	211	402	680	623	638	680	286.1	273.1	940
Fulica atra	14,879	14,941	24,508	15,111	17,662	27,013	18,278	11,737	14,807	20,425	27,013	17,936.1	4,789.9	10

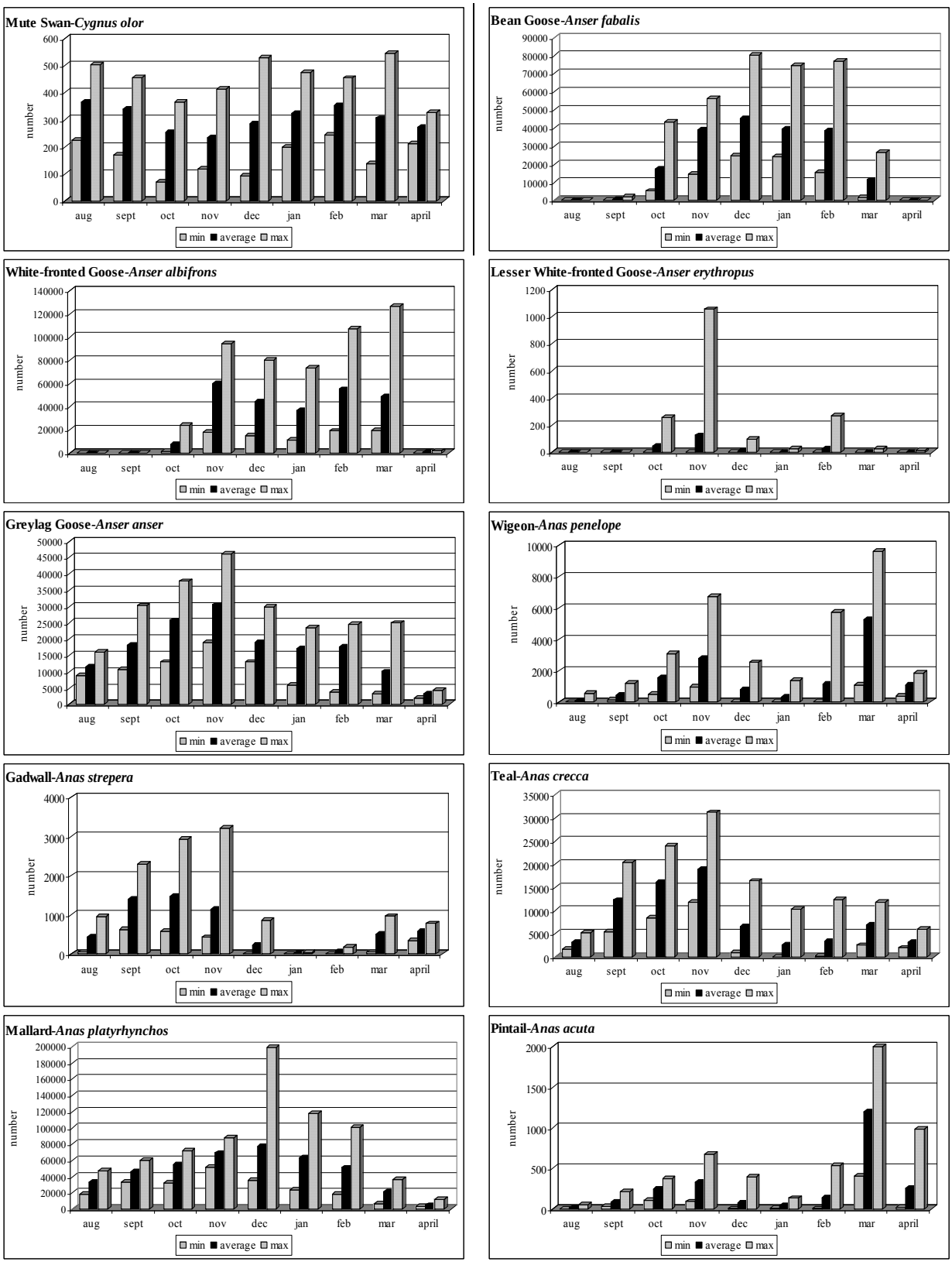


Figure 2. The phenology of the 25 most frequent waterfowl species in Hungary: During the 10-year period the observed minimum, average and maximum number of individuals in each month

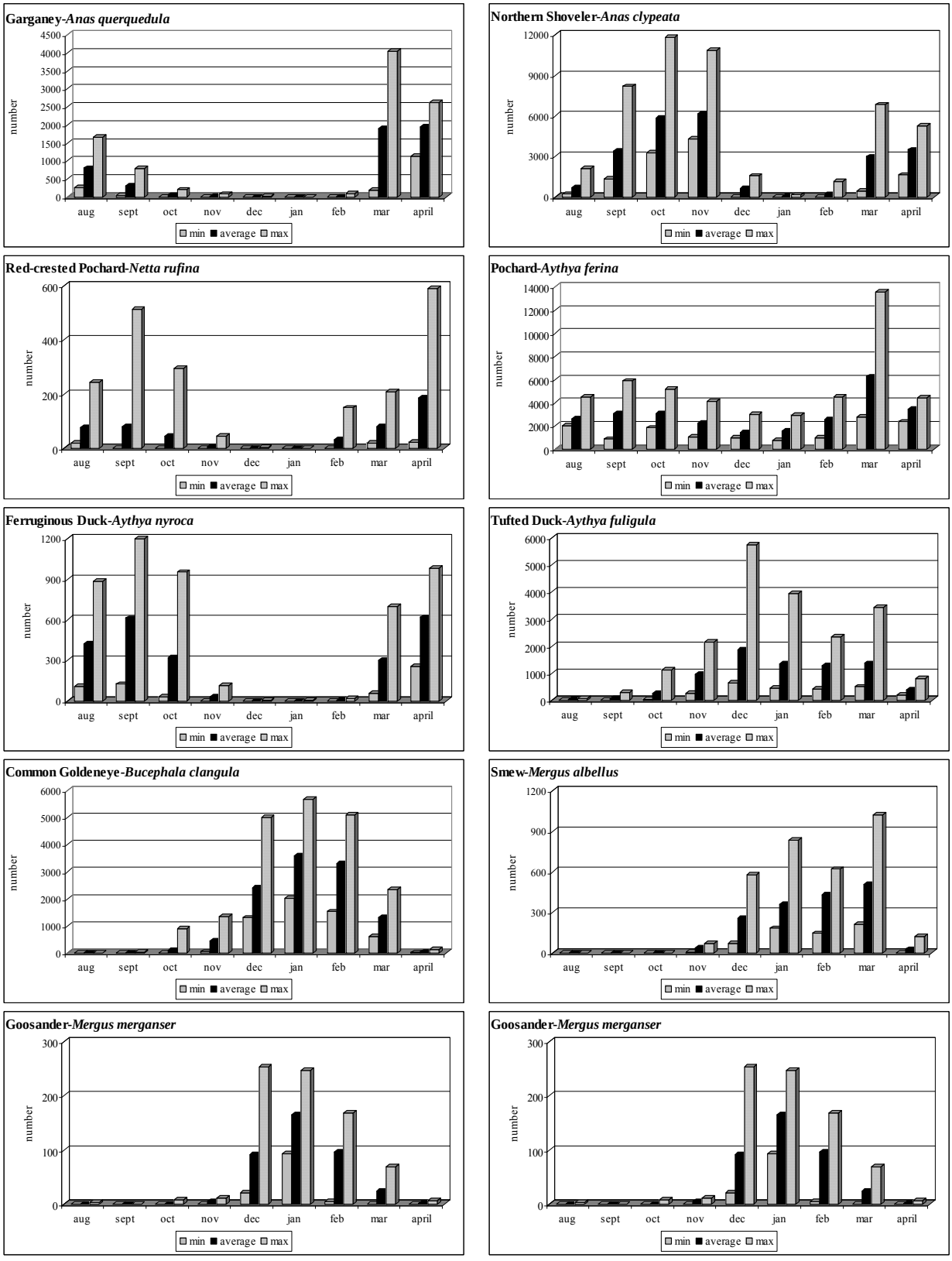


Figure 2 (cont.). The phenology of the 25 most frequent waterfowl species in Hungary: During the 10-year period the observed minimum, average and maximum number of individuals in each month

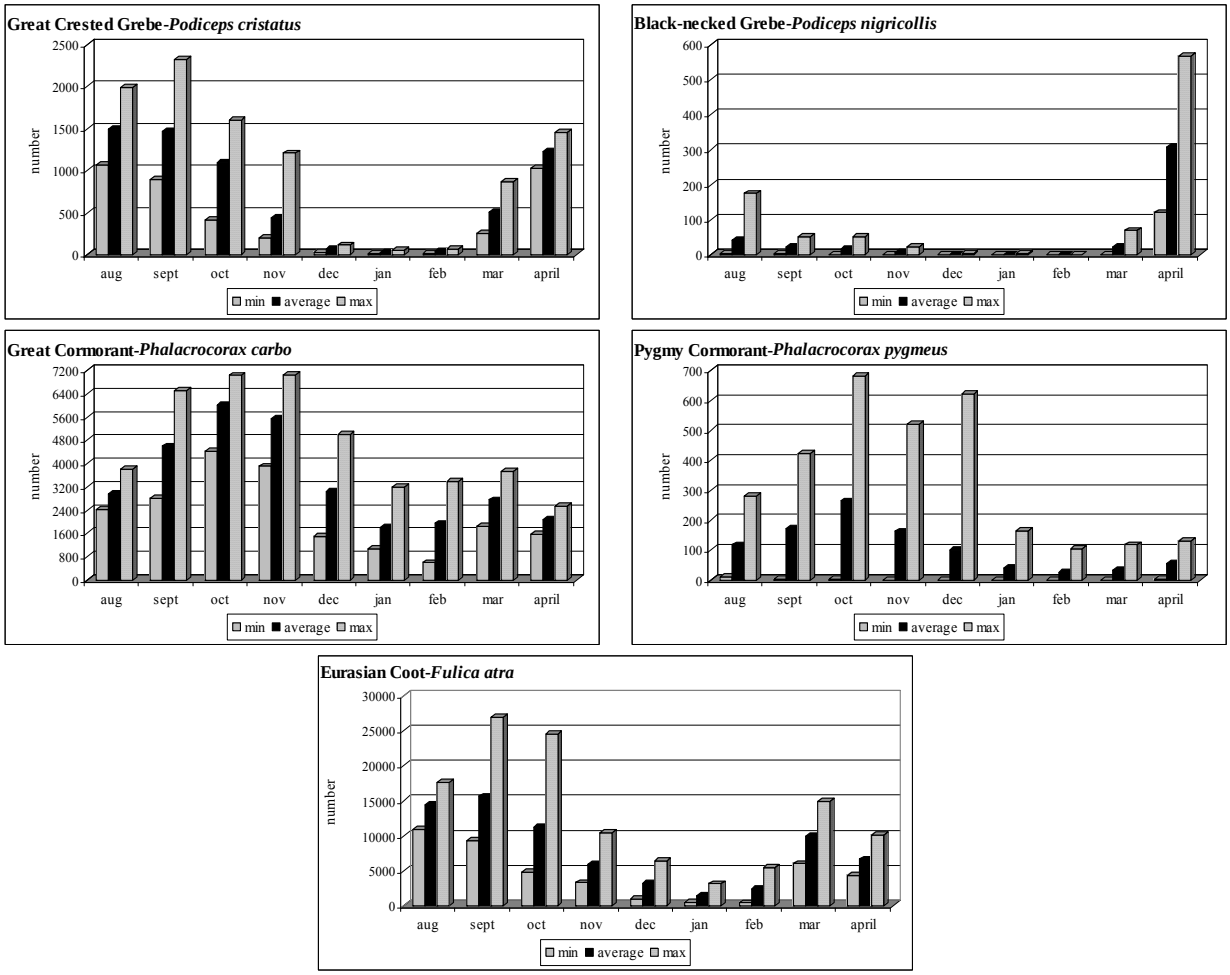
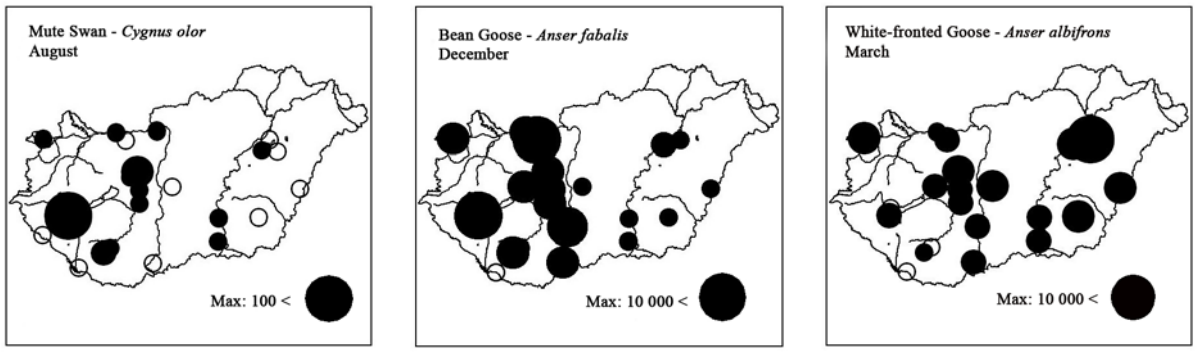
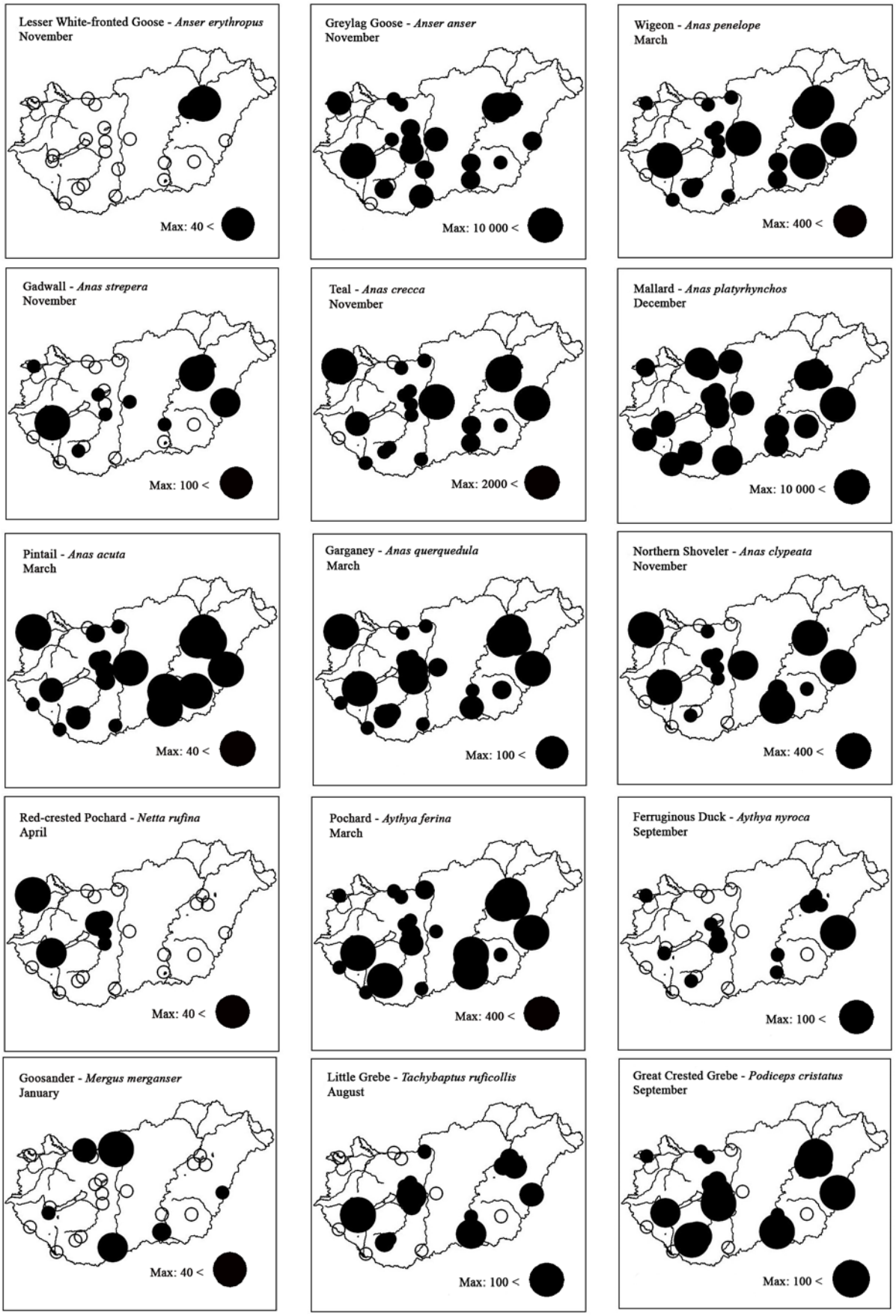


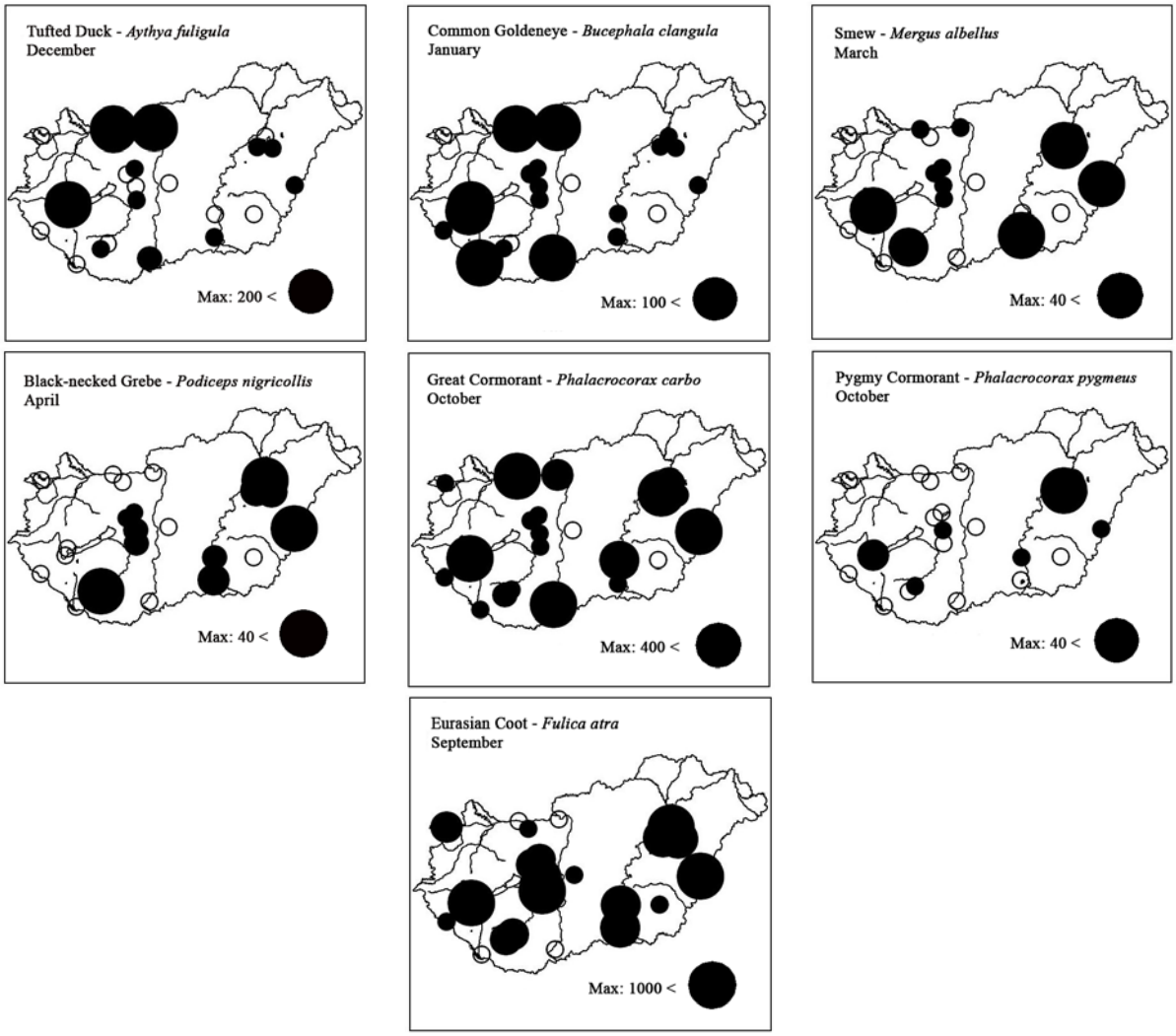
Figure 2 (cont.). The phenology of the 25 most frequent waterfowl species in Hungary: During the 10-year period the observed minimum, average and maximum number of individuals in each month



Map 2. Spatial pattern of the 25 most frequent waterfowl species in their peak month of occurrence



Map 2 (cont.). Spatial pattern of the 25 most frequent waterfowl species in their peak month of occurrence



Map 2 (cont.). Spatial pattern of the 25 most frequent waterfowl species in their peak month of occurrence

3 RESULTS

In an earlier paper we published a detailed regional analysis of all 42 waterfowl species (Faragó, 2008). We defined the phenology of the population of all those waterfowl species migrating through Hungary or overwintering here. We also defined the areal dispersion and its trend (shown on maps) the national, regional and local population trends in this period of examination. We defined the spatial pattern of local population trends (shown on maps) in relation to the season(s) of maximum population (peak period). We gave a comprehensive review for **25 species**. In an additional 17 rare species, no classification was possible because of their small numbers.

We had no or only single records of the following 17 rare vagrant species in the area of the HWM: *Cygnus columbianus, Anser indicus, Branta canadensis, Alopochen aegyptiaca, Anas americana, Anas carolinensis, Anas discors, Marmaronetta angustirostris, Aythya collaris, Aythya affinis, Somateria spectabilis, Polysticta stelleri, Oxyura jamaicensis, Oxyura leucocephala, Gavia immer, Pelecanus onocrotalus, Pelecanus crispus.*

3.1 Analysis by species

Mute Swan – *Cygnus olor* – Migrating species, breeding in small numbers (MME Nomenclator Bizottság, 2008). Within the framework of the HWM its national maximum was **545** individuals (the average of annual maximum was **420.6** individuals). Its phenology had the maximum at late summer and early autumn with a similar maximum in February and at late winter and this was characteristic. In October and November part of the population migrated to the south and its minimum is also in this period. This species is concentrated predominantly in Transdanubia. There were only a few migrating and overwintering observations in the Great Hungarian Plain. We determined a *large increase* in its population trend (+75 %).

Bean Goose – *Anser fabalis* – is a common migrating and overwintering species. Within the framework of the HWM its national maximum was **80,245** individuals, (average: **52 179.5** individuals**).** Its dynamics had a maximum in November/December, which is characteristic. A particular winter minimum (January) and spring maximum (February) can only be shown in certain years. Since Hungary is one of it's overwintering territories (Faragó 1995), after its November (December) peak its quantity continuously decreases until its passage. Departure accelerates in March, and by April only insignificant numbers can be detected. Our investigations supported an earlier finding (Faragó 1995): Bean Goose in Hungary dominantly appears in Transdanubia. Its population trend showed a *large decrease* (–61%).

White-fronted Goose – *Anser albifrons* – is a common as migrating and overwintering species. Within the framework of HWM its national maximum is **126,811** individuals, (average: **80,266.1** individuals). Its phenology had a maximum in autumn (November), a stronger one in February and a weaker one in March, which was very typical for this species. The winter minimum is in January. The remaining April population is only several hundred individuals. The earlier studies had stated (Sterbetz 1967; 1983) and confirmed (Faragó 1995) that the White-fronted Goose mostly appears in the Great Hungarian Plain. Our results have also shown their appearance in a more significant quantity in Transdanubia. Its national population trend showed a *large increase* (+73%).

Lesser White-fronted Goose – *Anser erythropus* – is rare on passage and even rarer as an overwintering species. Within the framework of HWM its absolute national maximum was **1,054** individuals, (average: **186.5** individuals).The top value must be the result of a one-time probably eastern migration, which is not unprecedented in the case of this species. The same phenomenon was shown in Bulgaria in 1991/1992 (Nankinov 1993; Lorentsen *et al*. 1999; Michev – Profirov 2003). It must be known that the European breeding population of this species was under this value in the given period. This is why, regarding the protecting situation of the species, considerable conclusions cannot be drawn. A maximum in November and a weaker one at the end of the winter in February characterize its phenology. The winter minimum is in January. On the basis of our results we achieved similar consequences just as in earlier studies (Sterbetz 1982, 1983): When migrating and overwintering, Lesser White-fronted Geese pay a visit to territories of the Great Hungarian Plain (Tiszántúl); however there are occasional but frequent visits to Transdanubia, too. Its national population trend showed *a large, dramatic decrease* (–86%).

Greylag Goose – *Anser anser* – This waterfowl species of large quantity breeds in increasing population and common migrant (MME Nomenclator Bizottság 2008). Within the framework its national, absolute maximum is **46,187** individuals, (average: **32,303** individuals). A maximum in autumn (November) and a weaker one at the end of winter, in February is characteristic of its phenology. The winter minimum falls in January. According to former enumerations (Sterbetz 1976, 1983) the Greylag Goose paid a visit to areas in the Great Hungarian Plain when migrating and overwintering. Our own examinations (Faragó 1995) demonstrated that up to the 1988/1989 season, a significant part of the observations also came

from the Great Hungarian Plain. Since then, however, we have been witnessing a continuous increasing dominance in Transdanubia. Its national population trend showed a *large increase* (+30%) in the period of the survey.

Wigeon – *Anas penelope* – is a common migrant and non-nesting species. Within the framework of HWM its national, absolute maximum was **9,620** individuals (average: **5,539.5** individuals). An autumn (November) weak maximum, and a stronger spring one in March characterized its phenology. The winter minimum fell to January. According to former knowledge (Bankovics 1990) Wigeons visited the eastern parts of the Great Hungarian Plain. Our own investigations highlighted the role of Transdanubia during autumn migration, and they justified the significance of the Great Hungarian Plain in springtime. Its national population trend showed a *large decrease* (–30 %) in the period of the survey.

Gadwall – *Anas strepera* – rare breeding species and frequent migrant (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum is **3,209** individuals (average: **1,898.9** individuals). Its characteristic phenology has an autumn maximum in October and one weaker, longer lasting spring maximum in March and April. The winter minimum is in January, when it disappears from our wetlands. The former data concerning its regional dispersion were contradictory. Our own investigations showed, besides the presence on the Great Hungarian Plain, their presence in Transdanubia during autumn. Besides their Transdanubian dominance, in certain years we have also recorded their prevalence. Their population trend showed a *large increase* (+30 %) in the examined period.

Teal – *Anas crecca* – This species is rare, occasional breeder in Hungary; but it is a very common migrant, observed in great numbers (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum is **31,171** individuals, (average: **19,817.0** birds). Its phenology has an autumn maximum in November, and a weaker one in March in the spring. The winter minimum is in January. Even in April it is found in great quantities. According to earlier counts (Schmidt 1977, 1982; Bankovics 1990), Teals appeared, during spring and autumn migrations and overwintering, mostly on regions of the Great Hungarian Plain. Our own investigations showed that recently they showed up in large numbers at the wetlands of Transdanubia. The population trend has showed a *large decrease* (–39 %) in the examined period.

Mallard – *Anas platyrhynchos* – is the commonest nesting and migrating waterfowl species in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM, its national, absolute maximum is **198,659** individuals, (average**: 97,591.2** individuals). Its dynamics showed only one December maximum. Although, every year in February there is a slight increase, but its size hardly differs from the January values. In March, after start of nesting, its population diminishes significantly. Earlier data (Schmidt 1975) on Mallards showed that this species visited sites of the Great Hungarian Plain during the autumn migration. In spring their dispersion was steady in the different parts of the country. Our monitoring showed that during the past few years they appeared in a larger number at important wetlands of Transdanubia, as opposed to the years before. As a result it became a lot more evenly distributed, but there were some places with prominent values, in Fishponds at Biharugra and Begécs, Hortobágy, and parts of the river Danube. The national population trend showed a *small decline* (–14 %) in the period of the survey.

Pintail – *Anas acuta* – is a common migrant in Hungary but nests in small numbers (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum is **2,483** individuals (average: **1,197.3** individuals). Its characteristic population dynamics is one modest maximum in autumn, in November, and a stronger maximum in spring, in March. The winter minimum fell to January. According to former data, (Schmidt 1959; 1961) the migration of the Pintail may be connected to the areas of sodic soils of the

Great Hungarian Plain. Our investigations have reconfirmed that earlier findings are still valid nowadays. This species' national population trend indicated *stability* but a strong *fluctuation* (+ 8 %) in the examined period.

Garganey – *Anas querquedula* – is a fairly common nesting and migrating species in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum was **4,040** individuals (average: **2,275.1** individuals). Its population dynamics showed a late summer/early autumn maximum, and a somewhat heavier one in March. The winter minimum fell to December and January. According to earlier surveys (Faragó – Zomerdijk 1997a) Garganey preferred the sites of Transdanubia, both during the autumn and the spring migration. As for our recent investigations, the dominance of the western part of the country during migration is still valid, but during spring they appear at certain wetlands of the Great Hungarian Plain in a larger number than on regions of Transdanubia. Its national population trend showed a *large decrease* (– 44 %) in the period of the survey.

Northern Shoveler – *Anas clypeata* – is a regular nesting species and common migrant in some places in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum is **11,829** individuals (average: **7,464.6** individuals). Its characteristic population dynamics is an autumn, and has a peak in November, and a weaker but longer spring one in March and April. The winter minimum is in January. According to former data (Faragó – Zomerdijk 1997a) the spring migration of the Northern Shoveler may be connected to the Great Hungarian Plain. The autumn migration was steadier, but when a large number of individuals showed up, they were bound always to the regions of the Great Hungarian Plain. Our examinations showed that recently, Northern Shoveler have appeared at certain wetlands of Transdanubia in great quantities, which exceeded their numbers on the plain. This phenomenon can probably be related to the attraction of the habitat restoration of a large area at Kisbalaton and Lake Fertő. The species' population trend showed a *large increase* (+113 %).

Red-crested Pochard – *Netta rufina* – is a rare nesting species, during the past few years its range has expanded eastwards, regular on passage, in some places in Hungary in large numbers (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum was **589** individuals (average**: 229.5** individuals). Its population dynamics is characterized in autumn with a maximum in September and a more definite spring one in April. The winter minimum is in January when it disappears from our wetlands. Up to 1975 there were only 23 observations, and between 1975-1983 there were only 33 observations in Hungary. Later in the course of both the autumn and the spring migration period, it was become commoner in some parts of Transdanubia, where this species was observed in greater quantities. Some individuals were even later observed on the Great Hungarian Plain. Our investigations have recorded its appearance at an increasing number of sites. Its centre of occurrence in terms of migration and nesting has been in Transdanubia since 1983. Its national population trend has shown a *large increase* (+540 %).

Pochard *Aythya ferina* – is a common nesting and migrating species in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum is **13,580** individuals, (average: **6,560.8** individuals). Its population dynamics shows an autumn maximum in September and October and a stronger spring one, in March. The winter minimum falls to December. According to former appraisals (Keve et al. 1959; Schmidt 1959, 1961) during the autumn migration Pochard only appeared in great quantities either at Transdanubia or in the Great Hungarian Plain, but never at the same time in both parts of the country. According to our investigations a modest dominance of the western part of the country was recorded during the wintering period. In other periods they appear in larger numbers at certain wetlands of the Great

Hungarian Plain than those of Transdanubia. Its national population trend has shown a *significant decline* (-42%) during the period of the survey.

Ferruginous Duck – *Aythya nyroca* – is a regular nesting and common migrant in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum was **1,735** individuals (average: **717.0** individuals). Its population dynamics can be characterized by an early maximum in September and a stronger spring one in April. Its winter minimum is in January. According to former records (Keve et al. 1959; SCHMIDT, 1982) the autumn and spring migration of Ferruginous Ducks was connected to Transdanubia, and they became plentiful in the Great Hungarian Plain regions only during their autumn migration. Our observations showed that in recent times during their autumn migration there has been a slight shift in the focal point towards the Great Hungarian Plain and during the spring migration towards Transdanubia. In the course of the investigated period their population trend showed a *large increase* (+1000%!).

Tufted Duck – *Aythya fuligula* – is a scarce breeder, but a common migrant in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum was **5,723** individuals (average: **2,515.3** individuals). Its population dynamics is characterized by a winter maximum in December. According to earlier data (Keve et al. 1959; Schmidt 1959; 1961) the autumn and spring migration of Tufted Ducks can be related to large lakes of Transdanubia. This phenomenon is not attributable to geography, rather to food supply and ecological reasons (the presence of the *Lythoglyphus* and *Dreissena* as food species). Up to 1980, only 3 nests were found in Hungary. Since then both in Transdanubia and sometimes in the Great Hungarian Plain, it has been nesting and spreading continuously (Sterbetz *in* Haraszthy, 1998). Our investigations showed that certain parts of Transdanubia are of particular importance, even in wintertime. Its national population trend showed a *large decrease* (–68 %) during the period of the survey.

Common Goldeneye – *Bucephala clangula* – Only one Hungarian breeding pair is known, but it is a common migrant and winter visitor in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum was **5,693** individuals, (average: **3,973.1** individuals). The first birds arrive in early autumn, but their multitudinous influx is typical during the autumn season. Their winter maximum is in January. The January quantity remains constant in February, but in March their number diminishes considerably. According to the former counts in autumn and spring, the migration of Common Goldeneye mostly took place in Transdanubia. In winter it appeared nearly exclusively in the Transdanubian sites (Lake Balaton, and the river Danube). There were some observations at the Great Hungarian Plain, mostly at Hortobágy and the River Tisza, (Faragó *in* Haraszthy, 1998). In our examinations their large numbers are unchanged in Transdanubia. Its national population trend in the past decade has shown a *small decrease* (–18%).

Smew – *Mergus albellus* – is a common migrant and winter guest in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national, absolute maximum is **1,020** individuals (average: **576.5** individuals). It appears at our wetlands in greater numbers during November. Following this period its numbers grew continuously. There is a characteristic population culmination in spring, in March. According to former data (Bod *in* Haraszthy 1998) Smew appears at Lake Balaton, fishponds and rivers, during the autumn and spring migration. They overwinter on non-freezing wetlands. During the past decade, when migrating in autumn and spring, they appeared on the Great Hungarian Plain, while their wintering concentrated on Kisbalaton, the River Danube and the wetlands of south-east Hungary. Its national population trend showed a *large decline* (– 31 %).

Goosander – *Mergus merganser* – is an occasional nesting species in Hungary, but a common migrant and winter guest (MME Nomenclator Bizottság 2008). Within the framework of HWM its national absolute maximum is **253** individuals, (average: **180.7** individuals). During

November it appears in our wetlands in large numbers. After this its numbers increase continuously. Its population dynamics showed a single winter maximum in January. Following this period it decreases steadily. According to earlier data (Bod *in* Haraszthy 1998) Goosanders appear during their autumn and spring migrations adjacent to our lakes and rivers which are rich in fish. They generally overwinter on our non-freezing wetlands. Our investigations have shown that this species concentrates on the river Danube and in the southeast of Hungary during their autumn and spring migrations and wintering is concentrated on the river Danube and the south-east of Hungary. Its national population trend showed a *large decline* in the past decade (–29 %).

Little Grebe – *Tachybaptus ruficollis* – is a common nesting species in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its absolute national maximum was **886** individuals (average: **622.9** individuals). Its phenology showed a late summer maximum in August, and a weaker spring one in April. The winter minimum falls to February. According to earlier estimations (Schmidt 1959, 1961) the migration of Little Grebes concentrated in Transdanubia, both in autumn and spring. In the course of our monitoring we have showed that their appearance has become equalized in terms of the eastern and western parts of the country. All this has been valid with the hegemony of certain parts of Transdanubia (e.g. Kisbalaton). The species' national population trend showed a *small increase* (+14 %).

Great Crested Grebe – *Podiceps cristatus* – is a common nesting species, migrating, and wintering occasionally (MME Nomenclator Bizottság 2008). Within the framework of HWM its national absolute maximum was **2,322** individuals, (average: **1,581.1** individuals). There is an early autumn population peak in September and a smaller peak in early spring, in April. The winter minimum is in January, but by December there are few individuals, and some birds also appear in February. It starts migrating from its winter territory in March. According to earlier investigations (Keve et al. 1959; Schmidt 1959, 1961), the autumn and spring migration of the Great Crested Grebe is mostly concentrated in Western Hungary, because the species requires big lakes. On the contrary, between 1986 and 1992 these birds stopped on the Great Hungarian Plain during their autumn and spring migrations. Our most recent investigations have proved that they appear on the wetlands of Transdanubia in larger numbers than on the Great Hungarian Plain. Its national population trend has shown a *large increase* (+40%).

Black-necked Grebe – *Podiceps nigricollis* – breeds and migrates in smaller numbers (MME Nomenclator Bizottság 2008). Within the framework of HWM its national absolute maximum was **567** individuals (average: **289.3** individuals). Its population continuously decreases during late summer. Between December and February it does not appear in our wetlands. It begins to return in March. This is the reason for the slight, characteristic population peak in late summer in August, and a somewhat stronger one during spring, in April. According to earlier investigations (Keve et al. 1959; Schmidt 1959; 1961) Black-necked Grebes mostly concentrate in Western Hungary during their autumn and partially spring migration. This is so because they are attracted to large lakes. In certain years the role of the Great Hungarian Plain increased in migration. Our studies have shown that in recent times they have appeared in great quantities in certain wetlands of the Great Hungarian Plain. Its national population trend has shown a *large increase* (+192 %).

Great Cormorant – *Phalacrocorax carbo* – is a common nesting species and increasing both in population and range in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national absolute maximum was **7,052** individuals (average**: 6,370.3** individuals). It has a characteristic autumn population peak and a slightly stronger one in spring (March). After the autumn cooling down, they depart from the frozen lakes to ice-free rivers. In the winter the larger part of the population, including northern visitors, migrate to the south. At the same time some of the nesting and visiting individuals stay in place. The

minimum falls to January. According to the waterfowl census between 1986 and 1992 Great Cormorants mostly visited areas of the Great Hungarian Plain during their autumn migration. In the examined period the dominance of the Plain became more pronounced. In Transdanubia the River Danube, Lake Balaton and the area of Kisbalaton plus certain territories of Baranya County played an important role in their migration. In spring this dispersion changed owing to the predominantly Transdanubian location of nesting places. Because of the latter phenomenon our investigations have shown the increase of the role of Transdanubia. The national population trend showed a *small increase* (+19 %).

Pygmy Cormorant – *Phalacrocorax pygmeus* – is an increasing nesting species and a migrant in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national absolute maximum was **680** individuals (average: **286.1** individuals). Its population dynamics had one autumn maximum in October and one spring maximum in April. It's nesting population leaves continuously until February. In March overwintering species come back from the Mediterranean region or the large European rivers. It has been a regular nesting species in Hungary only since 1988 on the Great Hungarian Plain, before that there were only some occasional observations. Our investigations have shown that apart from the nearly ten-fold increase (+940 %), Pygmy Cormorants also appeared on the wetlands in the regions of Transdanubia, particularly at the Kisbalaton.

Eurasian Coot – *Fulica atra* – is a common nesting, migrating and wintering species in Hungary (MME Nomenclator Bizottság 2008). Within the framework of HWM its national absolute maximum was **27,013** individuals, (average: **17,936.1** individuals). There is a population peak with one strong autumn maximum in September and a weaker spring maximum in March. After its autumn peak, the number of Coots continuously decreases up to the winter minimum in January. Following this its population is gradually increasing up to the above mentioned peak in March. Earlier this species migrated on the Great Hungarian Plain both in autumn and in spring, although Lake Balaton and Kisbalaton also played an important role in its migration. The newest investigations have shown the even distribution of the Eurasian Coot; however, in winter it appears in large numbers on the ice-free wetlands of Transdanubia. Its national population trend showed *stability* and a strong *fluctuation* in the period of the survey.

3.2 Comparative Analysis

In comparative analyses, the first task is to record **species in their largest numbers**, and to make an order for each species**.** These analyses reflect the potential importance of Hungary for migration and overwintering for these species. Mallards had the biggest numbers on the territories of HWM, followed by three species of geese: the White-fronted Goose, the Bean Goose and the Greylag Goose (only latter one is breeding in Hungary). The fifth species—the second commonest duck after Mallard—is the Teal (it is a rare, occasional nesting species). The sixth most abundant waterfowl is the Eurasian Coot.

During the ten-year period there were 8 species with about 1000 individuals or less *(Anser erythropus, Mergus albellus, Tachybaptus ruficollis, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Cygnus olor, Mergus merganser)*. These species appeared regularly but the numbers of individuals were small. Since some of the species are migrants, or their winter population decreased markedly during the ten-year period, the ***average maximum numbers*** of the last eight species showed changes, which put them to the end of the list of the commonest species. *Anser erythropus* became second last on the list. Average values for other species were near the end of the list which had very low annual peaks in the first part of the decade, e. g. *Aythya nyroca*. The average number of individuals recorded is unchanged at the top of the list. The position of the first six species is the same as the rank order of their absolute maximums.

Population changes i.e. ***trends*** over ten years provided the most important information for conservation practice**.** We have listed the following species in different trend categories:

- **Species with a heavily increasing population**: *Aythya nyroca, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Anas clypeata, Cygnus olor, Anser albifrons, Podiceps cristatus, Anser anser, Anas strepera.*
- **Species with an increasing population**: *Phalacrocorax carbo, Tachybaptus ruficollis.*
- **Species with a stable population:** –
- **Species with a fluctuating population:** *Fulica atra*
- **Species with a decreasing population**: *Anas platyrhynchos, Bucephala clangula*
- **Species with a heavily decreasing population**: *Anser erythropus, Aythya fuligula, Anser fabalis, Anas querquedula, Aythya ferina, Anas crecca, Mergus albellus, Anas penelope, Mergus merganser.*

To the real evaluation we have to add that even species showing definite changes showed the significance of fluctuations. The irregular variations of climatic (too cold or too mild winters) might change the speed and size of migration and the number of those birds overwintering. Principles of energetic explain why species migrating from the north to overwinter here in the Carpathian Basin are found in smaller numbers in mild winters than during average winters. When winters are unusually harsh, a larger proportion of these birds migrate to the Mediterranean region. In both cases it is the regional realignment of the populations of the species, but that is detected as a fluctuation in the Pannon region. This uncertainty becomes larger in small populations and for those species in areal expansion (*Netta rufina* e.g.). Those species—e.g. *Netta rufina, Aythya nyroca, Tachybaptus ruficollis* and *Podiceps cristatus*—where the number of breeding birds and nesting success at the end of summer results the population peaks, the fluctuation is caused by climate anomalies, since in dry years, the nesting success is reduced. Populations in August are smaller in dry years than in optimal wetland conditions.

25 species were put into six different groups based on **types of phenology.** These are as follows:

- **Species passing through in late summer:** *Tachybaptus ruficollis, Podiceps cristatus.*
- **Species passing through dominantly in autumn:** *Anser erythropus, Anser anser, Anas strepera, Anas crecca, Anas clypeata, Phalacrocorax carbo, Phalacrocorax pygmeus, Fulica atra.*
- **Wintering species:** *Anser fabalis, Anser albifrons, Anas platyrhynchos, Aythya fuligula, Bucephala clangula, Mergus albellus* and *Mergus merganser.*
- **Species passing through dominantly in spring:** *Anas penelope, Anas acuta, Anas querquedula, Aythya ferina, Podiceps nigricollis.*
- **Species passing through in spring and late summer:** *Netta rufina, Aythya nyroca.*
- **Residents:** *Cygnus olor.*

The ranking of two species needs explanation. Our wetlands, which are generally shallow and when they do not freeze in winter, provide good wintering opportunities for those Mallards *(Anas platyrhynchos)* coming southward from the north. This can lead to over-population. There is a population swap when part of the nesting population of *Cygnus olor* migrates south (to the Balkan) and their places are taken over by individuals of the same species arriving from other parts of Central Europe. They equalize the number of the species throughout the whole season.

Eco-geographical differences between Transdanubia and the Great Hungarian Plain explain the differences in the **dispersion** of species.

Dispersion dominance in Transdanubia: *Cygnus olor, Anser fabalis, Anas strepera, Netta rufina, Aythya fuligula, Bucephala clangula, Mergus merganser, Podiceps cristatus.*

Dispersion dominance in the Great Hungarian Plain: *Anser erythropus, Anas penelope, Anas acuta, Anas querquedula, Aythya ferina, Aythya nyroca, Mergus albellus, Podiceps nigricollis, Phalacrocorax carbo, Phalacrocorax pygmeus.*

Equal distribution: *Anser albifrons, Anas crecca, Anas platyrhynchos, Anas clypeata, Tachybaptus ruficollis, Fulica atra.*

These conclusions are only valid for the periods of maximum populations. In other times, both during migration and wintering, different values were obtained periodically.

4 DISCUSSION

Conclusions of the census on the Hungarian population trend, phenology and dispersion of 25 common waterfowl species reconfirmed some of the earlier results, but in some cases different conclusions were drawn from earlier presumptions. It is evident that changing environmental conditions affect population size, phenology and dispersion of migrating waterfowl species.

These current investigations show the status after the change of the political system in 1989. There was a change of property ownership, a certain decrease of intensive agriculture, and change in land use (Báldi – Faragó 2007), unfavorable impacts caused by global climate change on nesting and migrating species and to their habitats (nesting, roosting, and feeding sites) (Faragó 2005c). At the same time there were positive influences from nature conservation efforts and habitat reconstruction. This created a special wetland system in Hungary (Tardy 2007), and the effort is still continuing. This produces a steady positive impact on the status of our waterfowl species. It helps compensate for the negative effects of climate change in certain regions. Because of the large habitat restoration in Transdanubia, there is now more balance in the dispersion of certain species instead of their earlier dominance on the Great Hungarian Plain. This could be evaluated as a positive development. Some conservation measures were taken in this period: closed season for waterfowl shooting in certain wetlands in Hungary (Faragó 1997), designation of wetlands with international importance (IBA) (Nagy in Heath – Evans 2002) and designation of special protection areas (SPA) for birds and establishment of the entire NATURA 2000 ecological network.

Because of this system of changes we were able to increase the population of most migrating and wintering species. We are glad to report a strong increase in some waterfowl species: *Aythya nyroca, Phalacrocorax pygmeus, Netta rufina, Podiceps nigricollis, Anas clypeata, Cygnus olor, Anser albifrons, Podiceps cristatus, Anser anser, Anas strepera* and a slight increase of *Phalacrocorax pygmeus* and *Tachybaptus ruficollis.*

At the same time it is distressing to witness the decline of some other species. A strong decrease can be seen in *Anser erythropus, Aythya fuligula, Anser fabalis, Anas querquedula, Aythya ferina, Anas crecca, Mergus albellus, Anas penelope, Mergus merganser.* There is a slight decrease in the case of *Anas platyrhynchos* and *Bucephala clangula.*

The globally threatened *Anser erythropus* is the most alarming. The focus of this problem is outside of the Carpathian Basin. We can contribute very little to the solution of the problem (Tar 2001), the key tools are not in our hands. Because of the realignment of wintering sites in mild winters, we are witnessing the population decrease of the following waterfowl species: *Aythya fuligula, Anser fabalis, Anas crecca, Mergus albellus, Anas penelope, Mergus merganser, Bucephala clangula.* On the species level there is not much disturbance, since the populations are stable, it is even increasing in the case of *Mergus merganser* (Wetlands International 2006). Although in the case of *Anas querquedula, Aythya ferina* and *Anas platyrhynchos* we are witnesses of a general population decrease (Wetlands International

2006). The causes are not well understood. The decrease might be explained for Garganey by desertification in their wintering territories in Africa. This is similar to the unfavorable climate effects on nesting areas. Harsh winters, the instability of food sources (e.g. *Dreissena polymorpha*) and some unknown processes, which are affecting breeding areas in Russia all account for the decrease of Pochard. Mallards are decreasing for similar reasons.

Eleven species had a declining trend. Some of these species were hunted in the investigation period: *Anser fabalis, Anas platyrhynchos, Anas querquedula, Aythya ferina, Anas crecca, Bucephala clangula.* In the case of three species—*Anas querquedula, Aythya ferina* and *Anas platyrhynchos*—for a positive change of the unfavorable population trend termination of hunting should take responsibility.

Mallard was the commonest species. Large numbers occur in the Central European Region and in the west Mediterranean region where one million individuals winter. There is no direct danger, so no interference is needed (even though there is a slight uncertainty in the trend).

In 2008 the Hungarian hunting authorities decided to remove Garganey and Pochard from the list of quarry species. We know that this is only a supporting measure and not enough to reverse the negative population trend of the species. To achieve success quickly, we will need protecting measures with an array of different methods of active intervention and a variety of sites as locations of species conservation plans.

Last but not least, the importance of the role of long term monitoring systems must be underlined, which are part of waterfowl research and conservation. Only the HUNGARIAN WATERFOWL MONITORING makes it possible in Hungary to detect changes in the population trends of our waterfowl species. This also applies to phenology and dispersion. We should also draw conclusions for the sake of protection and use (hunting), since this has an effect on our national interest.

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