AQUATIC BIRD ASSEMBLAGES AND THEIR FEEDING PARAMETERS ALONG THE RIVER CONTINUUM IN THE INNER RANGE OF CARPATHIAN BASIN IN HUNGARY

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Abstract

Along the river continuum in Hungary, the aquatic bird assemblages were studied. The population size of aquatic birds in the characteristic areas of headwaters, medium size rivers and large rivers were estimated. The examined aquatic birds were grouped 6 feeding categories. Along the headwaters, aquatic birds were rare. The characteristic insectivorous passeriformes had small populations along these running waters. Along the medium sized rivers, the small fish and insect eater kingfisher became more characteristic. In higher-order rivers and their flooded areas provided not only very good resting and feeding place but the nesting assemblages were also very rich. The feeding of organic materials by piscivorous birds, diving ducks, dabbling ducks and herbivorous geese were also calculated. The role in the eutrophication of black-headed gull was also studied.

Key-words: aquatic bird, river continuum, population size, feeding, excrement

Introduction

The impact of birdson the aquatic ecosystem is much higher and more complicated than we have believed until now. This effect depends on three main factors: what animals eat, how the digestive system of animal works and where birds excrete their waste materials. Apart from these three fundamentals, to know the actual population sizes is also very important. The digestive processes of different aquatic birds also differ from each other. Aquatic birds as the birds in general can oxidize and utilize their food to a very high degree, thus they form relatively less excrements than another

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animals do. The feces of aquatic birds contain materials that cause eutrophication. In case of large population size and during migration periods, the aquatic birds move a large amount of organic materials into and out of the water.

The turnover of these end-products in the ecosystems depends on their carbon and nitrogen content. Higher nitrogen content causes humus formation and lower nitrogen content predisposes these materials to mineralizations (Andrikovics et al. 1997). The role of common aquatic birds in the aquatic material cycle in Hungary, were considered by Andrikovics et al. 1997, Gere and Andrikovics 1992, 1994, Juhász et al. 1998. Primarily the area of Kisbalaton, various standing waters and a few headwater streams were investigated (e.g. Andrikovics et al. 1997, Csörgő and Andrikovics 1985, Andrikovics and Horváth 1997). In these areas, the feeding connections of dipper (Horváth and Andrikovics 1991), warblers (Csörgő and Andrikovics 1985), cormorants (Gere and Andrikovics 1992), ducks and geese (Andrikovics et al. 1997, Gere and Andrikovics 1994) were studied and their effects on the water quality were also estimated. The aim of this study is to estimate the population sizes of waterfowl along the main river continuum in the Carpathian Basin, and to complete our knowlegde about the feeding parameters of black headed gull. This gull species was abundant and permanent in every habitat along the medium sized and large rivers in Hungary (Faragó 1996, Festetics and Leisler 1971). Along to the river continuum, we consider the population size and the feeding characterics of most abundant aquatic bird populations.

Place, time and methods

The smallest part of the Hungarian running surface waters belong to the small creeks situated in the inner range of Carpathian Mountains. The density of 1-3 order running waters in our mountains is very low. Most of the medium size and large rivers show medium section characters, - or because of the small slope - they often exhibit low section characters. Our running waters were regulated since more than one hundred years ago. The entire aquatic life was changed by these water regulations. Along our large rivers, we regularly find different standing waters (shallow lakes, oxbow lakes, ponds, wetlands). Only a few wetland reconstructions took place in the last few decades (e. g. Kisbalaton). In the Danube Valley, there are three large swallow lakes (e.g. Lake Balaton, Lake Velence and Fertő-Hanság sodic-bogy complex). The sketch map of the Hungarian sections of the Danube and Tisza with our investigated stream sare shown in figure 1. First, we estimate the most important aquatic bird assemblages along the Hungarian

river continuum. This approach is based on stream order, type of particulate organic matter, and type of benthic invertebrates present (Vannote et al. 1980). Headwaters (orders 1-3) mostly depend on the organic matters originated from the terrestrial systems. Photosynthetic production is small or is wholly absent. In Hungary, the dominant consumers are very often amphipodes, and not aquatic insects feeding on organic matters. These animals live on the gathering or splitting feeding methods. In Bükk, Zemplén and Aggteleki Mountains, along the small creeks, observations were carried out between 1994 and 1999, once per month, from April to November. Populations were divided into nesting and migrating ones.

Medium sized running waters (orders 4-6) are less dependent on the terrestrial habitats. The ratio of photosynthesis and oxygen consumption is higher than 1 (Vanotte et al. 1980). Dominant invertebrates consume fine particulate organic matters with graser and collector feeding methods. In our territory, the Bódva River was studied and aquatic bird populations were estimated from 1994 to 1999.

In larger rivers (orders > 7) there is a large quantity of sediment carried with the flow and plankton is established. The invertebrates are mainly characterized as collectors. Among the large rivers, we studied the populations of Bodrog and middle section of River Tisza. For comparison, new populations table of aquatic birds between Gönyű and Szob /river kms 1791-1708/ were compiled from the data of the detailed waterbird list of the Danube (Faragó 1996). The fish populations generally show a transition from cold-water insectivores to warm-water insectivores and piscivores, to planktivores (Vanotte et al. 1980). The original theory of river continuum can not be applied to huge rivers. Instead of continuity, the disconnection seems to hold (Schönborn, 1992). Standing waters belong to a different system containing smaller energy with no permanent water current but all the connections and structures that occur in running water may be present in standing waters, too (e. g. small vertical, and horizontal currents, material cycles etc.) Among the standing waters, the aquatic birds of Kisbalaton reservoir were studied (Fig. 1.). Kisbalaton is situated in the western part of Lake Balaton. River Zala is the greatest inflow to the lake. The water flowing into the Lake Balaton has very high P and N content and this is causing high trophic levels in the western part of Lake Balaton (Gere and Andrikovics 1992, 1994). The new resevoir system was planned to stop these processes. This reconstructed wetland ecosystem and reservoir become an extremely good habitat for aquatic birds. Estimations of population size were giren by Bankovics (1985), and up to date oral informations of Bankovics, Futó, Lelkes, Lőrinc, Petrovics and Waliczky. In Ócsa, in Kelemenszék pond and in the reed belt of Lake Velence, the feeding of mars warbler, reed warbler and great reed warbler

were investigated. We applied the neck binding method in the case of the warblers (Csörgő and Andrikovics 1985) and we analyzed the food items from the spittles of dipper (Horváth and Andrikovics 1991). In the case of waterfowl, we combined the laboratory analysis and field observations. In our laboratory, cormorants, ducks and greylag goose were fed with measured amounts of food. Daily consumption, growing and other parameters were estimated (Gere and Andrikovics 1992, 1994), Andrikovics et al. 1997). Their droppings were also collected and measured. In the field we estimated the population structures of waterfowl in the area of Kisbalaton. In this study we studied the black headed gull in the laboratory and the populations of aquatic birds in the field were also studied (Fig. 1). The nitrogen content of droppings was measured by Kjeldahl method and the total P -after wet damage- as phosphate was measured with photometric method.

Results and conclusions

The examined aquatic birds were grouped six feeding groups. These were: insectivorous passeriformes /e.g. dipper and waigtails/, piscivorous birds /e. g. cormorant/, mainly fish and insect /occationaly, partly fruits/ eaters /e. g. gulls/, mainly invertebrate eaters /e. g. diving ducks/, mainly planktonic invertebrate and weed eaters /e. g. dabbling ducks/ and mainly grazers /e. g. grazing geese and crane).

Headwaters /1-3 stream orders/

Along the creeks the aquatic birds occured rather rarely. The common birds feeding from the 1-3 order running waters are shown in table 1. Amphipods and sometimes mollusc were dominated in the benthic assemblages. The simplified feeding connections are shown in figure 2. The characteristic insectivorous passeriformes had rather small populations along these small running waters.

Medium sized rivers /4-6 stream orders/

The River Bódva was investigated in detail. The aquatic birds feeding from this river are shown in table 2 and the simplified feeding connections are shown in figure 2. The population sizes of birds with aquatic radiation were much higher. The dipper disappeared. The small fish (and insect) eater kingfisher became more characteristic (table 2).

Large rivers and their flooded area /above 7 stream orders/

In higher-order rivers flood plain vegetation compensate the low in-river primary production and lack of coarse particulate organic matter. If we consider the seasonal flooded periods four types of the rivers can be distinguished. The eupotamon zone is the main chanel and the permanent side-arm. Benthic assemblages and fish populations are very diverse here, but their biomass is low.

Paramotamon zones are permanent in the side arms of the river with aquatic vegetation. These are rich in phyto- and zooplankton. Fish populations here are connected with rooted aquatic vegetation.

Plesiopotamon zones are separated from the main channel. Vertical thermal stratification may be developing. Dense macrophyte vegetation and phytoplankton are characteristic here.

Paleopotamon zones are standing water habitats: separated dead arms, oxbow lakes with dense macrovegetation and high level of organic materials. The biomass of cyprinid type of fish is highest here. The eupotamon and parapotamon types at Tisza and Danube were investigated. The results of monitoring of aquatic birds along the Mid-Tisza between Kisköre and Tiszaug are given in table 3. This is mainly an eupotamon zone. Apart from the 15 nesting species, the migrating aquatic bird assemblages were also very diverse. The common species along the River Danube were rather similar, as shown in table 5. (Faragó 1996, 1997). The flooded areas and wetlands provided not only very good resting and feeding places but the nesting assemblages were also very rich (table 4.). In the plesiopotamon and paleopotamon zones a lot of small standing waters (e. g. shallow lakes, ponds, and wetlands) can be found. In Kelemenszék saline pond and in Ócsa we analyzed the food composition of three warbler species (Figures 1 and 2.). From their esophagus, the insects were picked up and analyzed. Among the aquatic insects only damselflies and dragonflies were identified from the esophagus. They prefer to eat fully develeped Odonates which are not able to escape (Csörgő and Andrikovics 1985).

Along the river continuum, the feeding parameters and the quantity of consumed food were calculated. Four black headed gulls were fed and their feces measured in the laboratory. Together with our earlier data /Gere and Andrikovics 1992, 1994/ we used these feeding parameters for our calculations in population level.

Insectivorous passeriformes

Along the headwaters, the aquatic birds occur rather rarely. The typical aquatic bird here is the dipper. In 1999, only ten nesting pairs were found in Hungary. In the areas we studied they fed mainly amphipods and caddisfly larvae /figure 2./. In Hungarian Mts, dippers lived only in relatively small, peripherical populations but they always nested in creeks with excellent water quality.

Piscivorous birds (e. g. cormorants)

According to our investigations, cormorants eat only fish. In the vomited food remains, 12 fish species were found (Gere et al. 1986). One young cormorant consumed 16.9 kg living fish until fledging time. The daily food-consumption of adults was 345g. From these data, as well as their time spent in the studied area, we estimated the quantity of food consumed by the whole cormorant population during its stay in Hungary. In 1983, 1500 pairs nested in the Kisbalaton area. The whole cormorant population (1500 pairs and their fledglings) consumed 416.6 tons of fish (Gere and Andrikovics 1992). In 1999, the total number of pairs breeding was about 1750 in Hungary. From these data, the total fish consumption was 486.08 ts. Large nesting cormorant colonies can be found along the large rivers and in the Kisbalaton area (Haraszthy ed. 1998).

Fish and insect (occasionally fruits) eating birds (e. g. black - headed gull)

In 1998 there were 2000 nesting pairs of black-headed gulls in the Kisbalaton area; in 1999 2500 pairs were found in the same territory. The population sizes along the running waters, are shown in tables 2, 3, 4 and 5. We considered the nesting time in the Kisbalaton area, because in this period, the birds were closely connected to aquatic habitats. During the migration and in the autumn, they looked for feeding places far from the water, where they ate fruits, carcasses and garbage (Haraszthy ed. 1998). There were about 12.000 nesting pairs in Hungary. Nesting time was estimated 91 days. Estimates of food consumption were made by laboratory investigations. Three young black-headed gulls raised and fed in laboratory. Their body weights were registrated every day. The dry content of consumed food, as well as the amount of excrement was estimated. The daily consumption of an adult was 35g living mass. This is equal to 12 g dry material. From our results, the food-requirements of flying adults were estimated as 45g. The entire food consumption of a bird was calculated 4.1 kg during nesting time (91 days). The total food consumption of the whole black-headed gull population

(24.000 inds) during its stay in Hungary was estimated 98.2ts of organic material. We have to add to this figure the consumption of two or three young birds belonging to each nesting pair. In our laboratory experiments, we estimated that the excrements (dry weight) of the gulls were 28% of their consumed food. So, the total amount of excrements produced by gull population was 31.4ts. We measured that the N and P content of the urine and feces was 15.5% and 5.2% respectively. From our field observations, we estimated that the gulls spent 8 hours from 24 hours a day in the water or above the aquatic habitats, so they put about 10ts of excrement like materials into the water. The black-headed gulls take up a lot of material (mainly fish) from the water; therefore they increase the trophic level only by smaller degree. They have an important role in the material cycle of the River Danube, because between Gönyű and Szob about 2000 black-headed gulls were found in winter time (Faragó, 1996).

Diving ducks

Among the diving ducks, the pochards (Aythya ferina) play an importan role in the aquatic ecosystems. Their number is increasing. In 1984, Bankovics (1985) mentioned only 1000 nesting pairs. In 1998, the number of nesting pairs was estimated 5–10.000. In our calculations we used earlier data. During autumn (three months) we calculated with 4000 inds. In spring (two months) 7000 pochard stayd in Hungary. In winter and in summer their number strongly depends on the weather, but usually there are not so many of them. They like to feed in deeper fishponds. The consumption of an adult bird was 90.64 gramm living mass a day. In winter and in spring the whole Hungarian pochard population consumed about 81.7 ts food. During the nesting period and in summer time the adults ate a total of 21.7 ts of living mass. The whole consumption of adult pochard was 103.4 ts which was higher with the consumption of youngs. Their excrements /dry weight/ were 35% of their consumed food, in other words, the total amount of FU was 36.2 ts. The youngs put their excrements mainly on the land, but later, the adults get their feces into the water and they contribute to the eutrophication processes.

Dabbling ducks

Among the dabbling ducks, we studied the mallard and the gadvall. The total number of mallards in Hungary can be estimated as 250.000 individuals. Their population sizes along the running waters are shown in tables 2, 3, 4 and 5. The food consumption of the adults and their fledglings was 16.87

ts dry food. The excrements of birds were 35% of their consumed food. From these data the total amount of FU was 5906.6 ts. The majority of the adults arrived to the area at the end of February and left in the middle of December. Ducks of different ages have opposite ecological roles. In the beginning of their lives they reduce the trophic level but later they contribute to the eutrophication processes (Gere and Andrikovics 1994).

Herbivorous geese and crane

For the duration of a year, we estimated the number of greylag goose in the area of Kisbalaton; we estimated and observed their living habits. From the field data and laboratory results, we estimated that the amount of N and P produced by the population of greylag goose was insignificant for the inner load of Kisbalaton and Lake Balaton. From this data, it is obvious that the trophic states of small lakes and ponds can be easily changed by dense plant eating and omnivorous bird populations. The greylag goose (*Anser anser*) is a tipical plant eater, graser bird species in Hungary. It is the only nesting goose species in Hungary. Their average number increases. In the previous years /1997–1998/, there was an average of 2000 pairs nesting in Hungary (Bankovics pers. com.). The population characteristics along the running waters are demonstrated in tables 2, 3, 4 and 5. Disregarding the fluctuation of the population, their number staying here during the whole year can be considered almost the same. According to our data, the average body mass of an adult bird was 3000 gr (Andrikovics et al. 1996 and Juhász et al. 1998). The average consumption of adult birds was about 200 gr of dry weight a day. Total consumption of the adult population in Hungary was 292 ts. They bred 4-5 goslings, whith each consuming 18 kg of food until adult age. The total consumption of goslings in Hungary was 90 ts annualy. From these data, we estimated the total food requirements of Hungarian greylag goose population, which were about 382 ts of dry weight a year. The main part of this material is originated from the land (e.g. corn, wheat and different grasses). The main part of their excrement also was taken on the land. Generally, the grazing birds increase the trophic level of the aquatic habitats, but the amount of nutrients geting into the water is insignificant to the impact of the littoral zone (Andrikovics et al. 1996).

The opposite situation can be found in the case of migrating and wintering geese. Among these the white-fronted goose (*Anser albifrons*) can be found in the largest numbers with 80.000 individuals. This goose species is entirely vegetarian, and grazes partly on the land and partly from the water. It has been observed that this bird spends about 75% of their time in the water; that means they mainly put their excrements into the water. This goose

species feed 1248 ts food during 78 days and they produce 327.6 ts feces+urin. These excrement materials were put into the waters of Great Hungarian Plain. Its migrating population size was not important along the studied river sides tables (2,3,4 and 5). The same calculation of the bean goose (*Anser fabalis*) is as follows: this species migrates and winters in Hungary at about 100.000 individuals. These geese feed 3000 ts food during 150 days of staying in Hungary. Total amount of their excrement is 1050 ts from which they put 787.5 ts into the water. They migrate and winter mainly along the large standing waters of Transdanubia. More than 10% of their population migrate and winters along the River Danube. The crane (*Grus grus*) also increases the trophic levels locally causing eutrophication. During the time of migration, they stay in large flocks /altogether 60.000 individuals/ in the territory of Hortobágy and Kardoskút /figs. 1 and 2/. At present this species does not breed in Hungary. During their migration they mainly feed from the corn-field, but they spend the night standing in the shallow water; that is their excrement is mainly put into the water.

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Table 1: Aquatic birds feeding along the creeks of Bükk Mtns, Zempléni Mtns and Aggtelek-Carst Mtns in 1999

Species	Creeks in Bükk Mtns		Creeks in Zempléni-Mtns		Creeks in Aggtelek Carst Mtns	
	Nesting inds	Wintering migrating inds	Nesting inds	Wintering migrating inds	Nesting inds	Wintering migrating inds
1. Ciconia nigra	6	-	14	-	4	-
2. Anas platyrhynchos	30	100	20	30	10	20
3. Anas querquedula	-	10	-	10	-	5
4. Charadrius dubius	-	4-6	-	4-6	-	2-3
5. Tringa ochropus	-	4-6	-	1-2	-	1-2
6. Actitis hypoleucos	-	6-8	-	2-3	-	2-3
7.Alcedo atthis	10-16	10-15	16-20	10-15	2-4	10-12
8. Cinclus cinclus	4-6	5-6	4-6	5-6	2-4	4-5
9. Motacilla alba	80-100	50	120-140	80	50-60	50
10. Motacilla cinerea	60-70	-	50-60	-	30-40	-

Table 2: Aquatic birds feeding from the Bódva River /from Hidvégardó to Boldva/ in 1999

Species	Nesting pairs	Wintering inds	Migrating inds
1. Podiceps ruficollis			25
2. Ardea cinerea			25
3. Ciconia ciconia	9		20-30
4. Anas platyrhynchos	40	4-500	4-500
5. Anas querquedula			50-60
6. Charadrius dubius	16-20		10-15
7. Tringa ochropus			4-5
8. Actitis hypoleucos	30-50		
9. Alcedo atthis	30-50	25	100
10. Motacilla cinerea			20
11. Motacilla alba	100	50	300

Table 3: Aquatic birds feeding from the waters of Tisza between Kisköre and Tiszaug in 1999

Species	Nesting inds	Wintering inds	Migrating inds
1. Gavia arctica	-	1-2	-
2. Podiceps ruficollis	60		30
3. P. griseigena			1-2
4. P. cristatus	10	4-5	4-5
5. Phalacrocorax carbo	400	300-400	
6. P. pygmaeus		2	
7. Botaurus stellaris	2-4	1	1-2
8. Ixobrychus minutus	8-10		3-4
9. Nycticorax nycticorax	20		100-150
10. Egretta alba	-	10-15	80-100
11. E. garzetta			70-80
12. Ardea cinerea	400	8-10	300-400
13. A. purpurea			4-5
14. Ciconia nigra			80-100
15. C. ciconia			300-400
16. Platalea leucorodia			70-80
17. Anser albifrons			50-80
18. Cygnus olor	-	3-4	15-20
19. Anas plathyrhynchos	300-400	800-1000	8000-10000
20. Anas crecca			1500-2000
21. A. penelope			10-15
22. A. acuta			5-6
23. A. clypeata			5-6
24. Aythya ferina			20-30
25. Aythya nyroca	16-20		15-20
26. Bucephala clangula		8-10	
27. Mergus albellus		2-3	
28. M. merganser		2-3	
29. Pandion haliaetus			4-5
30. Milvus migrans	6		5-6
31. Haliaetus albicilla	8	8-10	
32. Circus aeruginosus			15-20
33. Grus grus			50-60
34. Galinula cloropus	100-120		70-80
35. Fulica atra	160-200		150-200
36. Charadrius dubius			5-10
37. Tringa hypoleucos			50-60
38. Gallinago gallinago	10-12		15-20
39. Larus ridibundus		100-200	200-300
40. L. cachinnans			8-10
41. Sterna hirundo			8-10
42. Chlidonias niger			8-10
43. Alcedo atthis	16-20	8-10	40-60

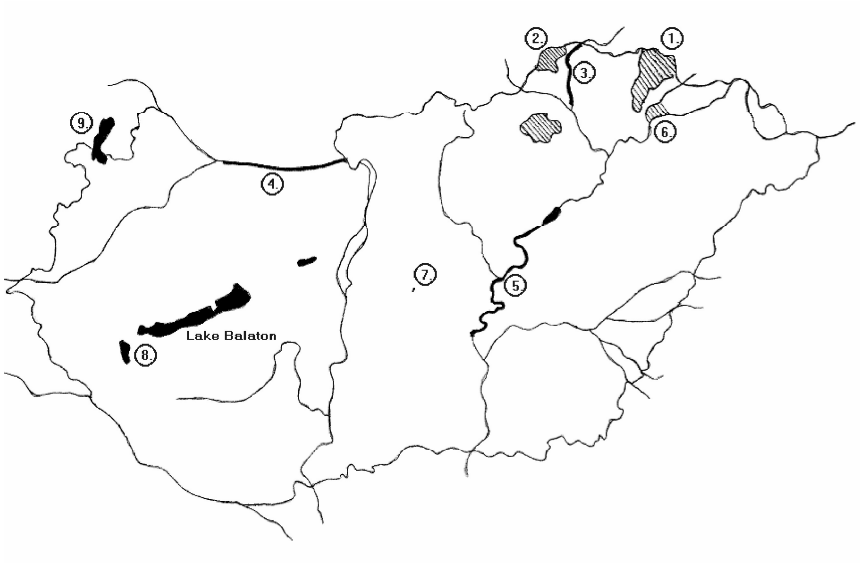
Table 4: Aquatic bird populations in the riparian wetland of Tisza and Bodrog in 1999

Species	Populations in early spring /inds/	Populations in late summer/inds/	Migrating inds	Wintering inds
1. Podiceps ruficollis	50	100	30	-
2. P. nigricollis	30	20	-	-
3. P. griseigena	15	30	-	-
4. P. cristatus	80	100	12	4
5. Phalacrocorax carbo	300	600	100	-
6. Botaurus stellaris	6-8	10-12	10-12	1-2
7. Ixobrychus minutus	1-2	1-2	1-2	-
8. Nycticorax nycticorax	10-15	200-300	20-25	-
9. Ardeola ralloides		5-10		
10. Egretta alba	300-350	500-600	1200	6-8
11. E. garzetta	60-70	200-220	200	-
12. Ardea cinerea	300-350	500-600	500-550	20-25
13. A. purpurea	40-45	80-100	80-90	-
14. Ciconia nigra	20-25	180-220	10-15	-
15. C. ciconia	80-100	150-160	10-12	-
16. Platalea leucorodia		20-25		
17. Cygnus olor	10-12			60-80
18. Anser anser	80	100		
19. Anas strepera	1-2			
20. Anas crecca	400-500			
21. Anas plathyrhynchos	800-1000	500-6000	600-700	400-450
22. A. acuta	1-2			
23. A. quqerquedula	1000-1200			
24. A. clypeata	4-5			
25. Aythya ferina	100-120	200-220	200-220	
26. A. nyroca	20-25	20-25		
27. A. fuligula	50-60			
28. Bucephala clangula				40-50
29. Mergus albellus				40-50
30. Pandion haliaetus	1-2		1-2	
31. Haliaetus albicilla	2-3	4-5	4-5	8-10
32. Galinula chloropus	30-35	40		
33. Fulica atra	1000-1200	100-110	500-600	10-15
34. Gallinago gallinago	10-20	40-50	10	-
35. Tringa hypoleucos	10-15	20-25	50-55	
36. Larus ridibundus	2000-2200	2500-2600	400-450	
37. L. cachinnans	10-12			
38. Chlidonia hybridus	500-550	1000	100-120	
39. Chlidonias leucopterus	40-45	60-65		
40. Chlidonias niger	200-220	300	10-20	
41. Alcedo atthis	8-10	8-10	40-50	

Table 5: Aquatic birds along the middle section of River Danube /1791-1708 fkm/ between 1982-1992 (Faragó 1997)

Species	Nesting pairs	Wintering inds	Migrating inds
1. Gavia artica	-	4	-
2. Podiceps ruficollis	-	-	20
3. Podiceps nigricollis	-	1	-
4. Podiceps cristatus	-	8	8
5. Phalacrocorax carbo	20	100	700
6. Ardea cinerea	125	635	650
7. Egretta alba	-	4	13
8. Egretta garzetta	-	2	-
9. Nycticorax nycticorax		3	110
10. Ciconia ciconia		1	
11. Cygnus cygnus			1
12. Cygnus olor			
13. Anser anser	-	1	3
14. A. fabalis	-	4600	8200
15. A. albifrons	-	-	150
16. Anas platyrhynchos	4000	12000	130000
17. Anas querquedula	9	6	15
18. Anas crecca	20	2	7
19. Anas clypeata	2	1	12
20. Aythya ferina	1	11	600
21. Aythya fuligula	-	2000	4000
22. Aythya marila	-	-	2
23. Aythya nyroca	-	-	11
24. Bucephala clangula	-	1800	8000
25. Mergus merganser	-	6	1800
26. M. albellus	-	15	900
27. M. serrator	-	-	8
28. Fulica atra	-	-	80
29. Vanellus vanellus	-	-	130
30. Charadrius dubius	-	-	2
31. Haliaetus albicilla	-	-	4
32. Tringa nebularia	-	9	55
33. Pluvialis apricaria	-	-	345
34. Mellitta fusca	-	-	8
35. Larus ridibundus	-	3000	2000
36. Larus argentatus	-	100	800
37. Larus minutus	1	2	9
38. Larus fuscus	-	-	1
39. Alcedo atthis	1	2	3
40. Larus canus	-	-	1
41. Clangula hyemalis	-	-	3
42. Mellitta nigra	-	-	8
43. Limosa limosa	-	-	1
44. Hydroprogne caspia	-	-	1

Figure 1.



1. Zemplén Mountains
2. Aggteleki Mountains
3. Bódva River
4. Examined section of River Danube
5. Examined section of River Tisza
6. Foodplain of Tisza and Bodrog
7. Kelemen-szék
8. Kisbalaton
9. Fertő

Figure 1. Sketch map of Hungary with the investigated running waters and standing waters supporting the studied populations of aquatic birds

Figure 2.

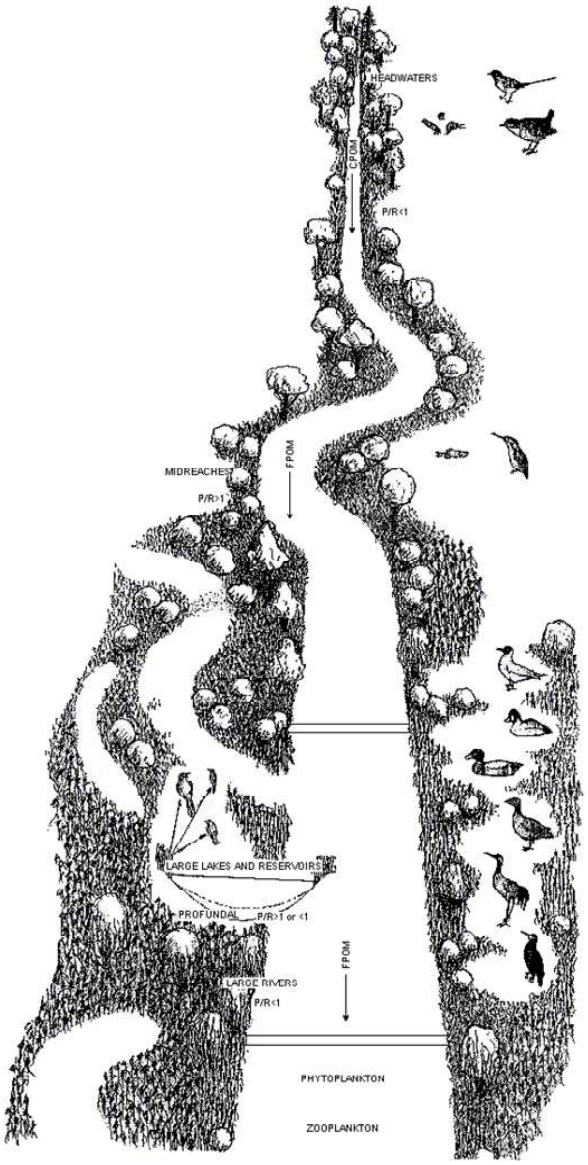


Figure 2. A drawing of river continuum in Middle Europe with the simplified feeding connections showing the roles of examined aquatic bird populations /upper or one arrows show the direction of organic material, lower arrows shows the main direction of dropping (into the water or on the riparian/litoral land), detailed calculations in the text/

References

Andrikovics, S. & R. Horváth, 1997: The dipper (Cinclus cinclus) as the indicator of water quality in creeks of Hungary. Wetlands International Publication 43 (Hungarian Waterfowl Publication 3. 229–238.

Andrikovics, S., Gere, G. & E. Futó, 1997: The nutrition of greylag goose and its effect on the eutrophication of Kisbalaton (Hungary). Wetlands International Publications 43 (Hungarian Waterfowl Publication 3. 199–210.

Andrikovics S. Gere G. & A. Lelkes 1996: A nyári lúd hatása a Kisbalaton eutrófizációs folyamataira. 2. Kisbalaton Ankét (Összefoglaló értékelés a Kisbalaton Védőrendszer 1991–1995 közötti kutatási eredményeiről): 504–513.

Bankovics A. 1985: A Balaton átvonuló és telelő vizimadarainak állománybecslése. Aquila 92: 55–64.

Csörgő, T. & S. Andrikovics, 1985: A szitakötők (Odonata) jelentősége a nádi énekesmadarak táplálkozásában. Állatt. Közlem. 72: 27–31.

Faragó, S. 1996: Water-bird stocks at the Danube reach Gönyű-Szob (river km 1791–1708) investigation conducted in a 10-year period. Hungarian Waterfowl Publications No. 1.: 461 pp.

Festetics, A. & B. Leisler 1971: Ökologie der Schwimmvögel der Donau, besonders in Niederösterreich. Arch. Hydrobiol. Suppl. 36(4): 306–351.

Gere, G. & S. Andrikovics 1992: Effects of waterfowl on water quality. Hydrobiologia 243–244: 445–448.

Gere, G. & S. Andrikovics 1994: Feeding of ducks and their effects on water quality. Hydrobiologia 279/280: 157–161.

Gere, G., Andrikovics, S., Csörgő, T. & J. Török 1986: A kárókatonák (Phalarocorax carbo) szerepe a Kisbalaton vízminőségének alakításában. MME II. Tud. Ülése, Szeged. 88–94.

Haraszthy, L ed. 1998: Magyarország madarai. Mezőgazda Kiadó, Budapest, pp. 441.

Horváth, R. & Andrikovics, S. 1991: A vizirigó (Cinclus cinclus L., 1758) téli táplálékösszetételéről. Aquila, 98: 147–162.

Juhász, J., Gere, G. és Andrikovics S. 1998: Felnőtt nyári ludak produkcióbiológiai paramétereinek vizsgálata, és hatásuk a Kisbalaton vizminőségének változására. Acta Acad. Paed. Agriensis 22: 47–60.

Schönborn, W. 1992: FlieBgewasserbiologie, G. Fisher Vlg. pp. 504.

Vanotte, R. L., Minshall, G. W., Cummins, K. W., Sedell, J. R. & Cushing, C. E. 1980. The River Continuum Concept. Can. J. Fish. Aquat. Sci., 37: 130–137.