Ecology of waterfowl in the region of Lake Neusiedl, Austria, particularly in the World Wildlife Fund Seewinkel Reserve

ANTAL FESTETICS and BERND LEISLER

In the List of European and North African Wetlands of International Importance (Olney 1965) the region of the Lake of Neusiedl, Austria, was considered of high importance for the future of European wildfowl populations. The first World Wildlife Fund Reserve in the region having been founded in 1965, the scientific council of the Austrian National Appeal (Chairman: Dr. A. Festetics), together with the Austrian Delegation of the International Wildfowl Research Bureau (geese: Dr. K. Bauer; ducks: K. Mazzucco; waders: B. Leisler), decided to start ecological research in the whole of the region and particularly in the Reserve with a view to establishing a management plan. The programme follows that of Szijj and Hudec (1968), namely: (1) compilation of wetland lists; there exists a good summary by Löffler (1959) and in 'Landschaft Neusiedlersee' published by Sauerzopf and Tauber (1959). (2) Quantitative faunistic research: useful quantitative data is only available from 1966 onwards. (3) Establishment of an ecological sketch: this paper is the chapter concerning waterfowl. (4) Research on the effects of habitat factors: some of our collaborators have started work on these problems. (5) Ecological report on the development of the wetland as a transition towards its practical management.

For advice and stimulation we thank Dr. Luc Hoffmann (I.W.R.B.), for support and help Dr. F. Sauerzopf (Burgenländische Landesregierung) and Dr. H. Freundl (W.W.F., Austrian National Appeal) and finally, but very sincerely, the students of zoology of the University of Vienna and the collaborators of the Austrian Bird Station to whose harmonious team-work it is due that the basis of this work has been established so quickly.

I. The region of the Lake of Neusiedl

(See Plates V to VIII, p. 84)

The region of Lake Neusiedl (hereafter called simply 'the Lake') represents a mosaic of varied types of habitats in the middle of Central Europe and is situated mainly in the Burgenland, the easternmost Austrian province; only a very small part is in Hungarian territory (Figure 1). It is confined by lateral spurs of the Alps (to the west), by those of the Carpathians (to the north), and by the Little Hungarian Plain (to the east and south). The Lake itself is bordered in the west by the Ruster Höhenzug and the Leithagebirge, in the north by the Wagram of the Parndorfer Platte, in the south by the Wagram of the alluvial gravel terrace between Sopron and Kapuvar (which is in Hungary). Eastwards the basin is open towards Hungary over the steppe of the 'Seewinkel' and the bogs of the 'Hansag'. The region may be sub-divided into five parts:

1. *Leithagebirge and Ruster Höhenzug*

The Leitha hills, an almost unbroken chain about 30 km. long and on average 400 m. high, and the Ruster Hills, 21 km. long and 280 m. high, were originally covered with oak woods. Their eastern slopes now hold chiefly abandoned pastures and vineyards. Besides a typical Central European fauna, e.g. Red Deer *Cervus elaphus*, Edible Dormouse *Glis glis*, Woodcock *Scolopax rusticola* and Chaffinch, *Fringilla coelebs*, many arid-region forms can be found on the eastern slopes, e.g. Green Lizard *Lacerta viridis*, Roller *Coracias garrulus*, Hoopoe *Upupa epops*, Ortolan Bunting *Emberiza hortulana*.

2. *The Parndorfer Platte*

This alluvial gravel terrace, on average 40 m. higher than the surface of the Lake, is about 20 km. long and 18 km. broad, and falls steeply southwards into the Lake. Originally covered with short grass pastures and grazed fairly extensively, it is now almost entirely arable. Some vanishing elements of the Pannonic steppe fauna, e.g. European Suslik *Citellus citellus*, Great Bustard *Otis tarda*, Stone Curlew *Burhinus oedicnemus*, Saker Falcon *Falco cherrug* and Bee-eater *Merops apiaster* are here gradually replaced by managed game, e.g. Hare *Lepus europaeus*, Roe Deer *Capreolus capreolus*, Partridge *Perdix perdix* and Pheasant *Phasianus colchicus*.

3. *The Lake of Neusiedl and its reed belt*

The Lake is 36 km. long, 7 to 15 km. wide, covers 320 km². (124 sq. miles) and on average is 1 to 1½ m. deep. Two-fifths of it is reed beds. Its only influx is the

River Wulka and the only outlet was the Einser Canal, built in 1910, by which the Lake should have drained towards the Danube. This artificial outlet, however, is silted up. The Lake is therefore without outlets and shows strong fluctuations. Long-term fluctuations have led to total drying-up more than once (for example in the years 1865 and 1872). Seasonal variations are very important for the breeding birds as the average difference between spring and summer water level is 25 cm. Sudden changes in level are due to changes in direction and strength of the prevailing winds. Waves of more than a metre high can then be raised and parts of the Lake's bed uncovered. Northerly or southerly winds often cause 'catastrophes'' i.e. mass death of fish, and the prevailing winds also limit the expansion of the reed belt on certain stretches of the Lake. The Lake is very slightly brackish with inorganic turbidity colouring it milky-white. Due to the strong turbulence no vertical stratification of plankton is possible, and horizontal dispersion predominates. One stretch of the Lake shore (at Podersdorf) is free of reeds, but along the southern, western and northern shores a large uniform reed bed is bordered lakewards by a zone of submerged plants such as fennel-leaved pondweed *Potamogeton pectinatus*.

The fish live mainly in the reeds and

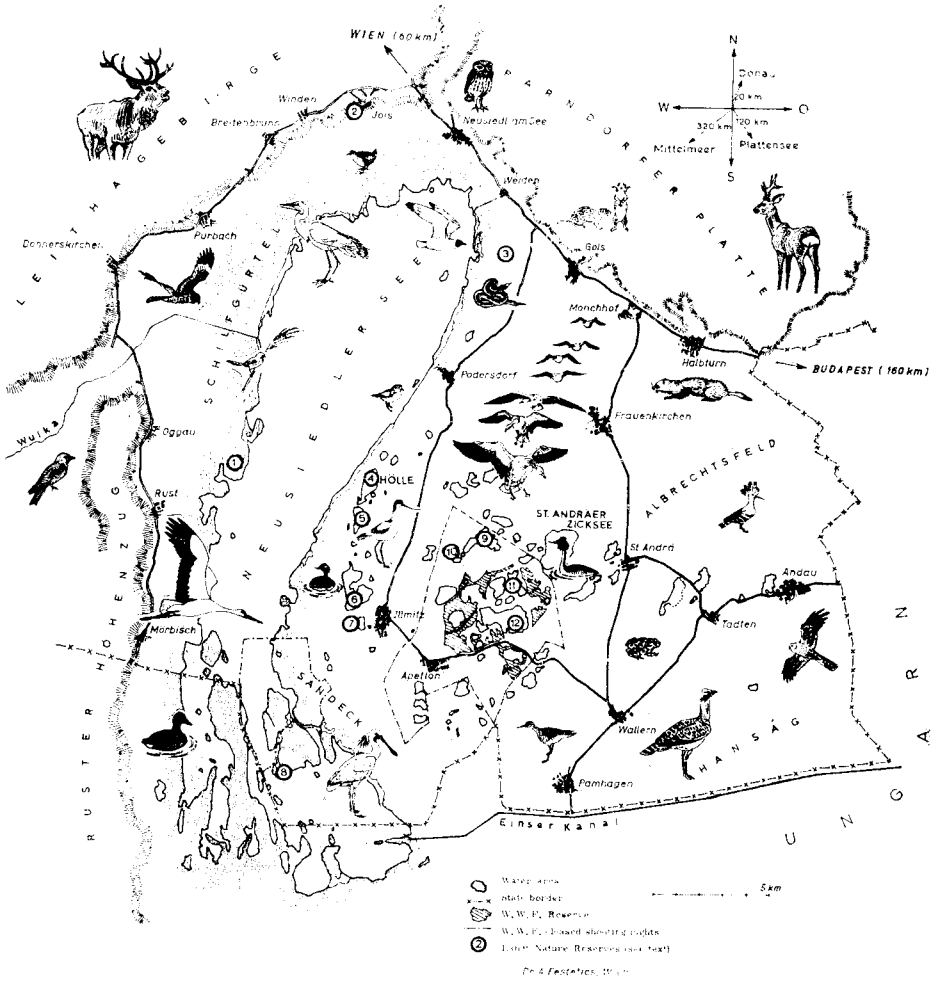

Figure 1. The whole region of Lake Neusiedl
The parts of the area are indicated with their German names and are explained in the text. Seewinkel (not mentioned on the map) is the whole area between the Lake Neusiedl, the Parndorfer Platte and the Hungarian border. Only the Hansag in the south-eastern point is to be considered apart.

pondweed belt because organic decay produces 'brown water' which is clear compared to the turbid open Lake. The main species are Hungarian Wild Carp *Cyprinus carpio* var. *hungaricus*, Pike *Esox lucius* and Rudd *Leuciscus erythrophthalmus*. The reed *Phragmites communis* can grow up to 5 metres high and forms large undisturbed areas. Great White Heron *Egretta alba*, Purple Heron *Ardea purpurea*, Grey Heron *A. cinerea* and Spoonbill *Platelea leucorodia* breed here in four to six large colonies totalling 800 to 900 pairs. In this continuously-flooded reed belt many other bird species breed, including 5 species of warblers *Acrocephalus* spp. Near the shore the reed belt is seasonally dry with an undergrowth of large sedges *Carex* spp., the breeding habitat of the Marsh Harrier *Circus aeruginosus*, Water Rail *Rallus aquaticus*, Spotted Crake *Porzana porzana*, Little Crake *Porzana parva*, Bluethroat, *Cyanosylvia svecica*, and Bearded Tit *Panurus biarmicus*. This zone is followed by sedge and rush marsh *Carex* and *Juncus* spp. and grass fields *Festuca rubra* in which breed Yellow Wagtail *Motacilla flava* and Lapwing *Vanellus vanellus*.

In between this large grassland zone and the first outliers of the mountains there is a wide zone of arable land and orchards.

4. *The Seewinkel*

This is the plain between the Lake and the Hungarian border, with the exception of the 'Hansag' in the south-east, about 120 m. above sea level. It can be divided into three soil regions: (a) the eastern Lake shore where a natural sandy dyke, 4 m. high, follows the whole length of the shore; (b) the northern part, together with the 'Albrechtsfeld' in the east, which consists of a black-earth terrace; and (c) the southern, Seewinkel, which has a continental salt soil. The W.W.F. reserve is at its centre (Figure 1). The eastern Lake shore (to the north of Podersdorf) is wet grassland with Orsini's Viper *Vipera ursinii*, Redshank *Tringa totanus* and Black-tailed Godwit *Limosa limosa*; to the south it is sandy and gravelly with Little Ringed Plover *Charadrius dubius*, Kentish Plover *Charadrius alexandrinus* and Stone Curlew as breeding birds, but most of this area is now vineyards. Further to the south, the eastern shore becomes marshy at Sandeck. There the W.W.F. has bought the hunting rights over 500 hectares. The black-earth terrace, originally used for grazing, is now almost entirely converted into arable land. The saline soil terrace is the most important part of the whole region for most of the bird groups. About 30 large shallow impermanent alkaline ponds, with white salt shores in summer, give their own charm to the region. They can be divided into 'black ponds' with rich vegetation and organic decay, and 'white ponds' with poor vegetation and inorganic turbidity. The average depth of these ponds is 40 to 60 cm., and only the St. Andräer Zicksee is 1.5 m. deep and so — by limnological definition — a lake, whereas even the Lake of Neusiedl should in fact be called a pond! The St. Andräer Zicksee and a few other of the bigger ponds hold water during the summer (Lange Lacke, Darscho Lacke, Fuchslochlacke, Ochsenbrunnlacke), the others drying up completely. In the last decades increasing expansion of reed in the pond region has caused the local replacement of coastal species like Common Tern *Sterna hirundo* and Avocet *Recurvirostra avosetta* by species typical of reed-covered inland lakes, e.g. Bittern *Botaurus stellaris*. The ponds which are in part very brackish (the main salts are Na_2SO_4, $NaCO_3$, $MgCl_2$) have a plankton relatively poor in species but locally and temporarily rich in individuals, especially small halophilous crustacean such as *Branchinecta ferox* and in Cyprinid fish such as Crucian Carp *Carassius carassius*.

On the open soda areas grow typical halophytes such as a pepperwort *Lepidium cartilagineum*, a saltwort *Camphorosma annua* and a saltmarsh grass *Puccinellia limosa*. Halophile sucking-bugs *Rynchota* and beetles *Coleoptera* such as the Salt Ground Beetle *Cicindela nemoralis* live there, also the southern Russian Tarantula *Allohogna singoriensis*. This is the breeding habitat of the Kentish Plover and Avocet. In addition to wet grassland with Lapwing, Redshank and Black-tailed Godwit, we find here the last grazed steppes of the whole region. The lower and less salty regions consist mainly of a plant association characterised by salt mud rush *Juncus gerardii*, the higher places being overgrown by dry grassland associations dominated by a fescue *Festuca pseudovinae*. Cattle have rendered this grassland felt-like by trampling, grazing and dunging. It forms, with some scattered prickly restharrow *Ononis spinosa*, musk thistle *Carduus nutans* and bermuda-grass *Cynodon dactylon*, a habitat for many burrowing rodents, such as the Common Vole *Microtus arvalis*, also the Asiatic Polecat *Mustela eversmanni*

and Skylarks *Alauda arvensis*. The main part of this region, however, has been converted into arable land and vineyards.

5. *The 'Hansag'*

The south-eastern end of the 'Seewinkel' is the tip of a boggy region mainly situated in Hungary and called the 'Hansag'. It consists of peat overlying alluvial gravel. The fields of large sedge and purple moor-grass *Molinia caerulea* associations are sparsely overgrown with solitary common sallow *Salix cinerea* and birch *Betula pubescens*. In the last decade the 'Hansag' has largely been ploughed up. On the remaining wet peatland live Great Bustard, Montagu's Harrier *Circus pygargus*, Curlew *Numenius arquata* and Roe Deer *Capreolus capreolus*.

Of these five main regions the first (Leithagebirge) has no direct ecological importance for wildfowl. The second (Parndorfer Platte) plays a role as a feeding ground. The third (Neusiedl Lake and its reed belt) is very important as a breeding, feeding, resting and moulting area. The fourth (Seewinkel) will be treated separately because of its outstanding importance, and the fifth (Hansag) is only of minor importance as a breeding and migrating area.

Although the first measures for conservation in this area date from the first World War when the Society of Zoology and Botany of Vienna leased the meadows of Zitzmannsdorf (to the north of Podersdorf), many of the efforts were unsuccessful. Indeed, this first region has been ploughed up, although it was declared a Nature Reserve by the provincial government in 1963. Since 1936 the Austrian Federation for Nature Conservation has leased the most important ponds. This lease was finally taken over by the Government of the Burgenland in 1964 and 1965 (nature conservation in Austria is not a matter of the Federal Government but of the various *Land*). In the region of Lake Neusiedl we now have twelve nature reserves (numbered on Figure 1): 1. Gade-Lacke for the heronries; 2. Hackelsberg for the Pannonic flora; 3. Meadows of Zitzmannsdorf for the Pannonic flora, arthropods, Orsini's Viper, and waders; 4. Oberer Stinkersee for the soda pond habitat; 5. Unterer Stinkersee for waders; 6. Illmitzer Zicksee for marsh birds; 7.

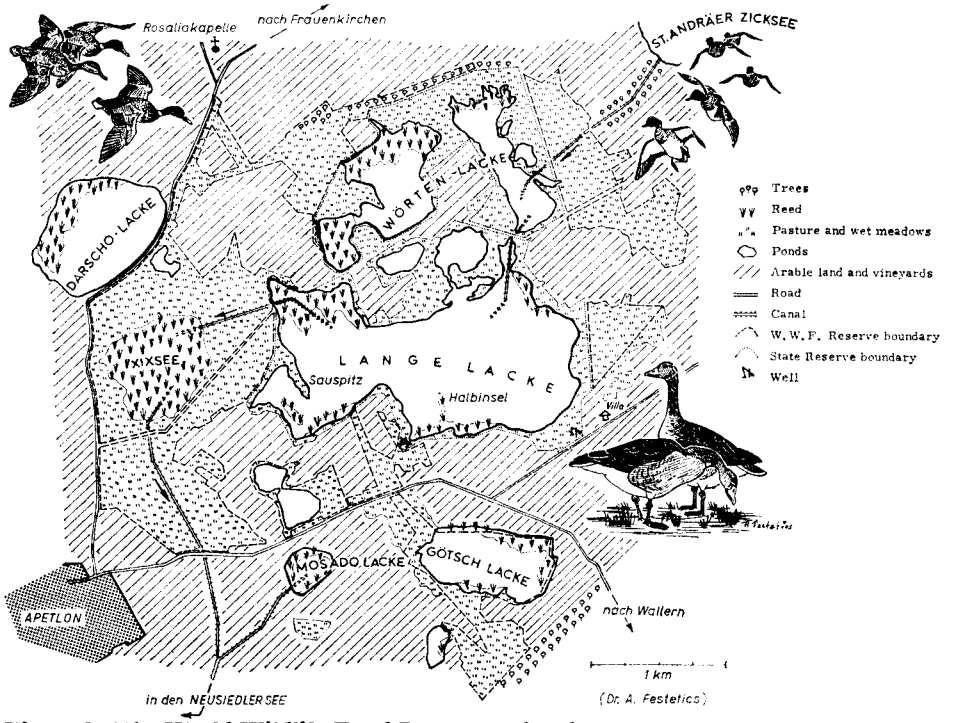

Figure 2. The World Wildlife Fund Reserve at Apetlon
The shorelines of the ponds are variable, e.g. the Wörtenlacke is given on the map at low water, at high water it is one continuous water surface. The channel connects five water surfaces and leads to the Lake Neusiedl. The limits of the reserve correspond roughly with the limits of the last pastures and wet meadows.

Kirchsee for waders; 8. Sandeck for the heron and Spoonbill colonies; 9. Fuchslochlacke for marsh birds; 10. Obere Halbjochlacke for waterfowl; 11. Wörtenlacke for marsh birds; and 12. Lange Lacke as the most typical of the Seewinkel habitat.

Nearly all these reserves are small or consist only of the water surface without any 'buffer zones'. The W.W.F. reserve Lange Lacke (barred on Figure 1, see also Figure 2) is therefore the first large refuge in the Seewinkel. It includes the previously existing government reserve Lange Lacke surrounded by the protective belt of the Hunting Reserve leased by the W.W.F. (Plate V).

II. Waterfowl

This paper will be one of a series forming a complete study of the birds of the Lake of Neusiedl. Each part will deal with one important ecological group. This one, dealing with 'waterfowl', will therefore cover 49 convergent species of various evolutionary origins, in the families: Gaviidae (2 species), Podicipitidae (5 spp.), Phalacrocoracidae (2 spp.), Pelecanidae (1 sp.), Phoenicopteridae (1 sp.), Anatidae (35 spp.), Rallidae (1 sp.) and Alcidae (2 spp.). Of the Anatidae there are 2 swans, 11 geese, 8 surface-feeding ducks, 11 diving ducks and 3 sawbills. They are grouped according to their ecological importance in the region, not according to the systematic order.

Group A includes the 18 species which either breed in the region or of which more than 100 individuals regularly visit it. Group B includes those 10 species of which less than 100 individuals regularly visit the region. Group C is composed of 21 occasional visitors. The species are further grouped according to their systematic position, but only their status and numbers are treated. The numbers are only approximate because systematic and synchronised censuses have only been undertaken since 1966, and are not yet fully analysed.

Group A. Breeding birds or species occurring in large numbers

1. Greylag Goose *Anser anser*

This is a typical breeding species of the region, with the largest stock in Central Europe. The Seewinkel breeding population is estimated at 70 to 100 pairs, and has increased recently because of the increase of reed on the ponds. About the same number may breed around the lake itself, but no *good* estimates are available. The nests, the size of a cart-wheel, are on the outer edge of the flooded reed belt towards the lake, mostly on dead reed. During the breeding season the birds are seldom seen, because they live in the reed and only the non-breeding population (about 200 in all) remains in the centre of the Seewinkel throughout the year. In late spring and early summer the parent birds with their young appear on the meadows which border the reed belt. After the young have fledged and after the moult, the Greylag concentrate mainly around the ponds of the central Seewinkel and along the eastern shore of the Lake. The autumn migration begins in September and a strong influx occurs in October, when numbers reach 2,000 to 5,000 birds. The geese leave in November. Lately there has been a tendency for a few birds (less than 50) to remain in mild winters. When the lakes freeze up completely most of the wildfowl of course leave. Part of the breeding population returns by early February. Up to 1,000 to 2,000 birds pass from the beginning to the middle of March, and are more evenly dispersed on the whole Seewinkel than the autumn migrants.

2. White-fronted Goose *Anser albifrons*

At present the most numerous goose in autumn, the White-fronted Goose visits the region from the beginning of October until the end of November with a maximum concentration of 10,000 to 15,000 birds in November. Compared with the low populations of this species recorded in the early nineteen-sixties, these numbers show a distinct recovery. A small number (less than 1,000) remains even when the lakes are frozen. The spring migration, from the end of February until the beginning of March, involves about 2,000 birds, and tails away quickly.

3. Bean Goose *Anser fabalis*

The large autumn migration, from the end of September to mid-November, reaches a maximum of 10,000 to 12,000 birds at the beginning of October. Its numbers have recovered since the eraly sixties, but less so than those of the White-fronted Goose. Both are far from being as plentiful as they were, sometimes over 100,000 in all (Olney 1965). The Bean Geese also winter in smaller numbers than the Whitefronts (less than 100). The spring migration starts at the beginning of March and goes on until early April with a maximum of about 3,000 birds in mid-March.

4. Mute Swan *Cygnus olor*

Although the Mute Swan is not indigenous, it is mentioned as an example of the risks taken by the casual introduction of foreign species by well-intentioned 'friends of nature'. Since 1941 one to two pairs of Mute Swan have repeatedly been introduced (by the Communities of Neusiedl and Rust) to the reed belt of the Lake. These swans have shown temporary increases but were also depleted either by hunters or by cold winters.

5. Mallard *Anas platyrhynchos*

The Mallard is the most numerous breeding duck. In the Seewinkel there are more than 200 breeding pairs. In the reed belt of the western and northern parts of the Lake itself there are many times more, but we do not have counts. It is all the more difficult to estimate the populations exactly since in the last 20 years semi-feral hybrids between Mallard and domestic duck have several times been introduced and have reproduced in the wild. These again cross-breed with the local wild Mallard and there is now a wide spectrum of colour and sizes. The Mallard nest on floating dead reed, on the banks of ditches, or sunken boats, in weekend-houses, on piles of straw, reed or maize stems, on nests of birds of prey (in the Hansag) and lately also in the nest-baskets put by hunters along the lake shore.

From July onwards the numbers increase rapidly and in mid-September reach a maximum of 15,000 to 35,000 birds for the whole Seewinkel. Of these, about 17,000 to 25,000 birds are on the Lange Lacke alone. The Mallard is the only dabbling duck which breeds and winters (maximum 2,000 birds). These small winter populations fluctuate strongly according to the amount of ice, probably by interchange with those of the Danube, only 20 km. away. The breeding birds return immediately there is a thaw, and begin to pair, becoming difficult to count as they disperse into the reed belt. A small spring passage takes place with a maximum of less than 1,000 birds in mid-March.

6. Teal *Anas crecca*

This species is the second commonest of the migratory ducks. It breeds on most of the nearby wetland areas, i.e. on the Danube, the Morava and in the marshes of the Pre-Alps. Strangely enough, no proof of breeding in the Lake Neusiedl area has been established, though the summering of a few pairs (less than 20) on the Lake, makes this probable. From mid-July onwards numbers increase, reaching a maximum of 2,000 to 5,000 at the beginning of October. The migration ceases in November and only a few birds (less than 50) winter on ice-free ponds. In a total frost they probably move to the Danube (Figure 1). The spring migration is much smaller, starting in mid-February and reaching its peak at the end of March and the beginning of April, but no numbers are available.

7. Garganey *Anas querquedula*

This species is the second commonest of the breeding species with more than 150 pairs in the Seewinkel, but probably none on the Lake. It is typical of the small ponds, ditches and flooded and dry pastures. They often nest up to 500 or even 1,000 m. from the water protected by spiny plants unpalatable to cattle, prickly restharrow and musk thistle. The populations increase from early July to a maximum in the first half of August, and then decrease rapidly in September. No Garganey winter in the region and the spring migration starts at the beginning of March, reaching its peak in mid-April with 1,000 to 1,500 birds. By the end of this month only the breeding birds remain.

8. Shoveler *Anas clypeata*

About 80 breeding pairs of Shoveler nest in dense sedge stands in the Seewinkel. It nests only sparsely and sporadically in the reed belt of the Lake. Breeding Shoveler are strongly dependent on water level fluctuations, having been rare for example in 1934 and 1935, but the commonest nesting duck, after Mallard and Gadwall, in 1940 (Seitz 1942). Autumn passage lasts from the second half of August until all have left by the end of November. The peak is as late as mid- or end October. More birds pass on spring passage which lasts from early March to mid-May and culminates with up to 200 or even 500 individuals in mid-April.

9. Gadwall *Anas strepera*

Fifty breeding pairs of Gadwall breed in the Seewinkel, but only a few in the reed belt of the Lake. They depend even more strongly than the Shoveler on fluctuations of the water level. Since 1937 the species has rapidly increased (Zimmermann 1944) and in 1951 (very high water) the Gadwall was the most numerous breeding duck species in the Seewinkel (Bauer, Freundl and Lugitsch

1955). After that, during some dry years, it has probably only sporadically bred around the lake. The nests are in the wet meadows and on the landward side of the reed belt. The autumn migration is relatively late, occurring in September and October, with a maximum of 500 birds, and all have gone in November. Spring migration starts at the beginning of March and also culminates rather late — from end March to mid-April — with a maximum of 500 to 1,000 birds (500 of them on the Illmitzer Zicksee alone).

10. Pintail *Anas acuta*

This is the rarest of the breeding dabbling ducks with a maximum of 15 pairs and these are restricted to the W.W.F. reserve in the Seewinkel. The nests are completely open in the short grass fields and are the furthest away from water (up to a kilometre). Like the nests of Garganey, they are often protected by prickly restharrow and musk thistle. A small autumn migration occurs, and a stronger spring migration with a maximum of 200 to 500 birds around the beginning of April. The Pintail does not winter in the region. All these numbers vary markedly according to the water level fluctuation.

11. Wigeon *Anas penelope*

There is a regular passage of Wigeon with the largest concentrations on the Lange Lacke from the second half of August until mid-November; the peak (less than 100) occurs in mid-October. None winter, but a very extended spring migration between the beginning of March and the end of May reaches a maximum of 100 to 200 birds in April.

12. Ferruginous Duck *Aythya nyroca*

This is the most numerous breeding diving duck, with about 50 breeding pairs in the Seewinkel and probably fewer in the reed belt of the Lake. Being the most dependent of the diving ducks on water level fluctuations, it is in dry years less common as a breeding species than the Pochard. Breeding has increased since the forties (Zimmermann 1944) and since the fifties it has been common (Bauer, Freundl and Lugitsch 1955). The Ferruginous Duck breeds in the reeds and other densely-growing vegetation along the pond shores. Autumn migration in the region is probably only small and no wintering occurs. Spring migration (from mid-March to the end of April) is more important with a miximum around mid-April of 100 to 200 birds.

13. Pochard *Aythya ferina*

This is the typical diving duck of the soda ponds with 30 to 40 pairs in the central Seewinkel (about half of the breeding stock is on the St. Andräer Zicksee). In the last few decades during its general expansion in Europe (Bezzel 1967) it has also distinctly increased in the Seewinkel. The nests are in the reed beds and on the flooded meadows, on small mounds in the water (the remains of sedges or gull nests), or on the shores of the ponds. The small autumn migration takes place in September with a maximum of less than 500 birds. There is no wintering. The Pochard is the only diving duck species which has a strong spring migration, and in mid-March there are 500 to 1,000 birds for a short while.

14. Goldeneye *Bucephala clangula*

The autumn migration of this species in November and December involves less than 50 birds. A small population of less than 30 birds may winter on the Lake and the St. Andräer Zicksee, if the weather is mild. Spring migration lasts from February to April, exceptionally until mid-May, and reaches its maximum in March with 100 to 200 birds mainly on the larger and deeper ponds and on the Lake.

15. Coot *Fulica atra*

This is a very numerous breeding bird over the whole region. It breeds on nearly all the ponds and along the Lake shore in homogenous stands of reeds, sedges and rushes with high cover; nesting mounds are built on shallow water. In late summer it concentrates on the St. Andräer Zicksee but the breeding birds disappear during September and the last Coot leave at the end of October or the beginning of November. Some single birds may winter on open water. Nothing is yet known about the spring migration. In March about 2,000 to 5,000 birds, including the breeding birds, are present.

16. Black-necked Grebe *Podiceps nigricollis*

Between 150 to 200 pairs breed on the ponds in the Seewinkel. On the Lake it nests only locally and sparsely, with probably less than 50 breeding pairs. There is wide variation between individual ponds, some having whole colonies, and others no breeding at all in some years. The largest colonies are to be found on the Illmitzer Zicksee (up to 70

pairs). It also breeds on small, milky-turbid, strongly-brackish ponds, where cover is good, and often in loose colonies near large colonies of Black-headed Gulls *Larus ridibundus*. The nests are either floating or built on small mounds of the remains of grass or sedge. They are found in the reeds, in sedges or in flooded fields. From the end of August until the end of November the numbers increase slightly but it is not possible to separate migratory from breeding populations. No birds winter and the spring migration, for which there are no quantitative data, lasts between the end of March and the middle of May.

17. Little Grebe *Podiceps ruficollis*

There are more than 100 breeding pairs in the Seewinkel and about an equal number on the Lake. The species has a different breeding habitat from the Black-necked Grebe. It avoids the strongly brackish ponds with inorganic turbidity or breeds there in very small numbers. Depth or the size of the pond are of less importance than the clarity of water together with cover. Suitable habitats exist in the reed belt of the Lake, on the flooded fields and meadows, on some of the ponds and in the many, often small, gravel pits. The floating nests are in loose vegetation, often grouped together but not in such distinct colonies as in the Black-necked Grebe. There is a small autumn migration between October and December. Wintering may occur exceptionally. The spring migration is between the end of February and the beginning of April.

18. Great Crested Grebe *Podiceps cristatus*

This bird breeds on the larger and deeper water areas with about 20 pairs in the Seewinkel and up to 100 on the Lake itself. When the water is low, breeding birds may be absent from the Lake (Koenig 1952). Years of high water have, however, caused an increase since 1940. The St. Andräer Zicksee holds the largest breeding population in the Seewinkel (15 pairs). The species needs a relatively large open water surface and a flooded reed belt where — on the open Lake border — the nests are found. A small autumn migration occurs between September and the beginning of December. No wintering occurs. Spring migration is also of little importance and takes pllace between February and April.

Group B. Species which occur regularly in small numbers in summer or on migration

1. Tufted Duck *Aythya fuligula*

For the last decade less than 10 pairs of this species have summered regularly in the central part of the Seewinkel. It is possible that the species, which is showing a general trend of expansion towards the south and the west (Festetics 1967), will shortly breed in the region. There is a small autumn migration in October and November and a larger spring migration, of less than 100 birds, in March and April.

2. Red-crested Pochard *Netta rufina*

For about three years, 2-3 pairs of Red-crested Pochard have been summering regularly on two small ponds. From mid-September to mid-November autumn migration takes place and from the end of March to the beginning of April there is a spring migration; both passages involve less than 50 birds.

3. Scaup *Aythya marila*

These are scarce passage migrants with less than 50 birds, mainly in the month of March, on the Lake and on the deeper ponds in the Seewinkel.

4. Goosander *Mergus merganser*

Single birds summer occasionally on the Lake. The species is regularly seen on migration with a maximum of 100 birds in autumn (November-December) and spring (March-April). The largest concentrations, about 50 birds, occur on the St. Andräer Zicksee.

5. Red-breasted Merganser *Mergus serrator*

A regular passage migrant with less than 50 birds, mainly on the Lake (up to 25 in one group) with a few on the deeper ponds.

6. Smew *Mergus albellus*

A regularly migrant with less than 50 birds in winter (December) and spring (February and March), mainly on the Lange Lacke (maximum of 10 birds) and on the St. Andräer Zicksee.

7. Cormorant *Phalacrocorax carbo*

Single birds occur erratically between July and September, mainly on the Lake and on the deeper ponds. Migrates regularly from February to April in varying numbers.

8. Red-necked Grebe *Podiceps griseigena*

These summer irregularly and even possibly breed on two small ponds of the Seewinkel. In the last two years they have regularly been seen on migration (generally less than 10 birds) on the Lake and the larger ponds in spring (between March and May) and autumn (November and December).

9. Black-throated Diver *Gavia arctica*

Regularly seen on migration (less than 20 birds) in November and December on the Lake and on the St. Andräer Zicksee.

10. Red-throated Diver *Gavia stellata*

Odd birds summer exceptionally. Rarely occurs on migration (less than 10 birds) in November-December, mainly on the Lake.

Group C. Irregular migratory species and 'accidentals'

Flamingo *Phoenicopterus ruber*, Whooper Swan *Cygnus cygnus*, Lesser White-fronted Goose *Anser erythropus*, Snow Goose *Anser caerulescens*, Pink-footed Goose *Anser brachyrhynchus*, Brent Goose *Branta bernicla*, Red-breasted Goose *Branta ruficollis*, Barnacle Goose *Branta leucopsis*, Ruddy Shelduck *Casarca ferruginea*, Shelduck *Tadorna tadorna*, Falcated Teal *Anas falcata*, Long-tailed Duck *Clangula hyemalis*, Common Scoter *Melanitta nigra*, Velvet Scoter *Melanitta fusca*, Eider *Somateria mollissima*, White-headed Duck *Oxyura leucocephala*, Slavonian Grebe *Podiceps auritus*, Pygmy Cormorant *Phalacrocorax pygmaeus*, White Pelican *Pelecanus onocrotalus*, Guillemot *Uria aalge*, and Puffin *Fratercula arctica*.

III. Ecology of the waterfowl in the Seewinkel

It is again stressed that this is only a first attempt to give a general idea of the ecology of water birds in a region where up to now a few scattered, specialised studies have been carried out; hence the questionmarks and gaps. Corrections will be necessary later through the further research that we hope will be stimulated. A study on bird ecology was carried out on the reed belt of the western shore of Lake Neusiedl (Koenig 1952). Papers on the Seewinkel (Seitz 1943) and on the whole region of Lake Neusiedl (Zimmermann 1944, Bauer, Freundl and Lugitsch 1955) were mainly faunistic reports. Extensive studies are in preparation on the breeding populations of Anatidae (Leisler and Mazzucco), on the migratory birds (Leisler) and on the ecology of grazing animals (Festetics).

Our quantitative data on the Lake region are still meagre, but, thanks to the smaller and more regular human influence there, the ecological problems are less urgent than in the Seewinkel. This latter region, about 450 km.^{2} between the Lake and the Hungarian border, underwent great changes at the beginning of the fifties, after the departure of the occupation force. Some of the larger ponds, e.g. Golser Lacke, and surrounding wet pastures were drained and two very important wetlands, the Zitzmannsdorfer Wiesen to the north of Podersdorf on the eastern shore of the Lake, were partly drained and ploughed. At the same time most of the pastures in the central Seewinkel were progressively converted into arable land, until the World Wildlife Fund leased the remaining 400 ha. at the last minute (1965) (Figures 1 and 2). Today, with the exception of repeatedly flooded areas, vineyards and other croplands border the ponds, the breeding and 'buffer'-zones (wet, damp, and dry meadows) which are so important for water birds are limited to small stretches of shore. At normal water level the water surface of the ponds in the Seewinkel still totals 2,800 ha. and their sinuous shorelines provide a maximum of edge. Furthermore, the rich variety of wetland habitat types provide highly interesting conditions. The main importance of the region to Anatidae is not for breeding, although Greylag, Gadwall and Shoveler find better conditions here than elsewhere in Central Europe, and the variety of breeding species is impressive. It is much more important for autumn migration, being situated on the western edge of the Carpathian basin and affected by the movements of the birds of the Hungarian plain. Lake Neusiedl is, therefore, one of the most important inland resting places in Europe. The sub-continental climate brings long dry summers and long winter frosts, both forcing water birds to leave the region. The spectacular autumn migration regularly ends with the start of the winter frosts.

1. *Breeding populations*

The 12 species, not including Coot, which breed most frequently in the Seewinkel total about 1,200 pairs, quite remarkable for the size of the water areas. Most of these are Mallard, Garganey, Greylag and Black-necked Grebe. Salt concentration is less important than the

nature of the soil and the consequent structure of the shore, in deciding which ponds are used by waterfowl. In the case of diving ducks, for instance, it seems probable that neither available food nor clearness of the water are the limiting factors, but rather the lack of suitable nest sites. The ponds which are most markedly 'white' with a strong inorganic turbidity and open shores with a scanty halophyte vegetation completely lack breeding dabbling ducks. On ponds with belts of the rush *Bolboschoenus maritimus* breed Coot and Garganey. The most favoured ponds for breeding dabbling ducks are those with dense vegetation belts including associations of reed, large sedges, small sedges and hay-meadows. In years of high water temporarily flooded fields and meadows become important and very rapidly colonised. In recent decades the breeding biotope of Pintail has decreased very much, with the decline of short-grass fields. On the other hand, the decrease of grazing on large parts of the area has led to strong development of the reed belt, providing Greylag with more opportunities for breeding. The Lange Lacke, for instance, was entirely reed free in 1940; now, its shores are one-third covered with reed (Figure 2) and this has attracted two to four breeding pairs of Great Crested Grebe and about 10 pairs of Greylag. The Illmitzer Zicksee, which started to develop reed as long ago at 1941, holds about 20 breeding pairs of Greylag.

Compared with the five species of dabbling ducks, only two species of diving ducks breed (breeding of both Teal and Tufted Duck are expected soon). The reason for this is the shallowness and impermanent character of the ponds (in dry years 20 to 25 of the 30 larger ones dry up completely), as well as the inorganic turbidity of most of them. The two diving ducks are mainly vegetarian and, therefore, ecologically close to the dabbling ducks, but they do not occur in the same biotope. The Ferruginous Duck live on the eutrophic, black, freshwater ponds with dense vegetation, whereas Pochard are to be found on the white, brackish ponds where only reed grows. Among the surface-feeding ducks Teal live on the fresh, clear water while Garganey breed on the soda ponds. Finally, the Little Grebe prefers clear ponds with much cover, the Black-necked Grebe very brackish and turbid ponds. Large uniform zones of marsh plants provide the breeding birds with undisturbed areas, but often lack nesting sites. Therefore, every small structure — old drowned boats, abandoned reed huts, empty nests, and islands of floating reed—form welcome bases for nests.

Very little is known about moulting places and dates. The majority of Greylag seem to moult in the thinner parts of the reed belt on the western and southern shores of the Lake, for instance, in the W.W.F. reserve Sandeck. The Mallard, and probably other dabbling ducks, moult mainly in the larger reed patches of the Seewinkel ponds, but also on the Lake.

Among the main egg predators are the very common Hooded Crow *Corvus corone cornix* and Polecat *Mustela putoris*. The Marsh Harrier takes young birds, but has greatly decreased of late because of strong persecution, to about 20 to 25 pairs in the reed belt of the Lake and about 7 pairs in the Seewinkel (Vande Weghe *in litt.*). The main threat to the breeding waterbirds of the province of Burgenland is the very early opening of the shooting season (1st August), with no distinction between species, because hunters are unable to recognise them. The inadequate biological basis of the legislation becomes evident when 'Rail' are protected the whole year whereas 'Reedhen' (probably Moorhen!) and Coot can be shot the whole year. 1st August is a dangerous opening date because of the late end of moulting of the females of the surface-feeding ducks and because the diving ducks may still have unfledged young at this time. Worse still is the late end of the hunting season (28th February) especially for Greylag which have by then returned, paired, to their breeding areas.

2. *Migrating birds*

A maximum of 50,000 Anatidae occurs in September to October in the Seewinkel, mainly consisting of the three geese, Mallard and Teal. While Greylag maintain their numbers during those two months, the Mallard is the most numerous species at the beginning of the autumn, replaced later by the Bean Goose which, in turn, yields first place to the White-fronted Goose. In spring no more than 13,000 Anatidae are simultaneously in the region. This low number is largely due to the remarkable reduction in migratory Mallard in spring. But the Garganey is then more numerous, and becomes the fifth most important species. In recent years the W.W.F. reserve at the centre of the Seewinkel has become very important as a refuge to the migratory birds. A strong preference for the Lange Lacke has developed

so that about half of all the ducks and geese of the Seewinkel are there in autumn and nearly *all* geese come to roost. This concentration is certainly a consequence of the protection afforded. Before the protection of the pastures, the hunters lined the shores during the autumn migration season and only the open water provided refuge to the birds. Now the wet meadows and pastures of the W.W.F. reserve and a large surrounding belt of arable land freed from hunting through the W.W.F., have created together an ideal refuge for Anatidae.

The large concentrations in autumn, of course, use it mainly as a resting and sleeping place, though Greylag and Teal feed within the borders of the reserve complex, mainly on natural vegetation. The large scale reclamation of arable land in recent years has therefore not had an adverse effect on them.

Mallard perform spectacular dusk flights in late summer and autumn north and north-east from Lange Lacke and Lake Neusiedl, to the corn fields, particularly to those of the Parndorfer Platte and the Albrechtsfeld. They come back from more scattered directions in the dawn. The diurnal White-fronted and Bean Geese reverse the pattern, heading north and north-east to the arable areas in the morning. The evening flight back is rather late. Greylags have been observed to have three different activity patterns. (1) A small number remains day and night near Lange Lacke (the breeding population in spring and early summer) and moves frequently from water to land, roosting on either. (2) The majority move mainly at night. During the day they feed or sleep in arable fields and towards the evening fly in small groups to the ponds to drink, preen and sleep. At dusk they move again to the shore and feed slowly through the natural habitats (*Bolboschoenus maritimus* stands, wet meadows and pastures) up to the corn fields. In the morning they are pushed back to the ponds by the arrival of the farm workers. (3) A small group flies every morning from the roosting pond to the corn fields and back again every evening in the manner of the White-fronted and Bean Geese and sometimes with them. They often visit distant corn fields away from the disturbance of farm workers. The proportions of the three groups vary throughout the season. It seems that the movements of our Greylag Geese have a pattern different from that of the Dutch coastal populations which depend on tidal rhythms (Lebret and Leisler, in prep.). The patterns have certainly also changed in recent years following the extension of agriculture.

Teal are confined to the natural habitats but make many local movements. Eight other duck species, in order of decreasing abundance: Garganey, Pochard, Gadwall, Shoveler, Pintail, Goldeneye, Ferruginous Duck and Wigeon, concentrate mainly on the Lange Lacke which always retains a sufficiency of water, though in spring the Illmitzer Zicksee may hold the largest numbers. This latter pond is often dry in autumn but presents very favourable conditions in spring. Fortunately it is, like the Lange Lacke, a full nature reserve. Gadwall concentrate in autumn on three small ponds (Fuchslochlacke, Auerlacke and Stundlacke), of which only the first is a government refuge surrounded by land leased by the W.W.F. The two others should also be leased as soon as opportunity offers. On spring passage they disperse over the whole Seewinkel with largest numbers on the Illmitzer Zicksee. Pochard stay in autumn on their breeding ponds (St. Andräer Zicksee, Auerlacke and Fuchslochlacke) and on the Oberer Stinksee, while in spring, as well as their breeding ponds, they frequent the Illmitzer Zicksee. The rarer wintering diving ducks, sawbills and divers, usually stay on the Lake and on the St. Andräer Zicksee.

Finally is should be mentioned that some natural predators on wildfowl have unfortunately been exterminated in recent years. Only one or two Peregrines *Falco peregrinus* visit the region during migration, despite the amount of potential prey. In similar wetlands in Hungary many more birds of prey hunt ducks and waders. The White-tailed Eagle *Haliaëtus albicilla,* which used to take the waterfowl wounded by hunters, has also become a rarity in recent years. Only the Fox *Vulpes vulpes* feeds abundantly on sick and dead wildfowl around the ponds. The shooting of geese over live decoys (despite its illegality) and on specially cultivated colza fields, as well as the shooting competitions in which as many as 30 to 50 birds per hunter per day may be killed, are very damaging to the populations. The hunting statistics of the district of Neusiedl over the last decade indicate an average yearly kill of 1,800 'wild geese' and 2,100 'wild ducks'.

3. *Food ecology*

The ecology of the region strongly

favours the vegetarian water birds. Fish-eating species, in summer the Great Crested Grebe, in winter three sawbills and two divers, amount to less than 200 birds. This is not due to a lack of fish, but rather to the opacity of the water. The two small grebes, which feed almost entirely on the larvae of aquatic insects, on molluscs and more rarely on small fish, amount to about 500 birds in the summer. Goldeneye and Tufted Duck, about 200 birds, stay in the region during the winter and feed for the most part on bottom-dwelling invertebrates and to a lesser extent on submerged plants.

An intermediate group consisting of Pochard, Ferruginous Duck, Shoveler, Garganey (all breeding) and Teal (only on passage) feed almost equally on animals and plants, but the proportion may vary according to seasonal availability. About 650 birds of this group stay in summer, about 8,000 in autumn and about 6,000 in spring. They are, therefore, the largest feeding group in the region. The Mallard is omnivorous and feeds to a great extent on human waste. Pintail are mainly vegetarian and animal food forms only a small proportion of their diet. During the breeding season there are about 30 birds of this species and during migration between 200 and 500.

There are two entirely vegetarian groups. Gadwall, Coot and Greylag feed on submerged plants (especially filamentous Algae, *Chara*, *Potamogeton* and their tubules), and seeds of marsh plants (especially *Bolboschoenus maritimus*). Coot and Greylag also feed on the young shoots of reed and of winter field crops. About 6,000 birds of these species occur in this region. Wigeon, White-fronted Geese and Bean Geese dabble a little but are typical grazing birds, the first two feeding mainly on the pastures and the Bean Geese preferring the winter arable crops. Fifteen thousand birds of these species occur in autumn and about 4,000 in spring.

4. *Management problems*

Recent changes in the habitat have raised three important problems. The first is the rapid increase of the reed belt. Originally the whole Seewinkel was to a large extent pasture land, the northern part (black-earth) being better for grazing than the southern part (salt soil). The Hansag in the south-east was the poorest of the whole area because of its acidity. When the Burgenland became a part of Austria and was progressively reclaimed in the twenties, the first efforts were of course made in the most fertile northern part, where the pastures were ploughed. Natural pastures remained longer in the less favourable south and the last remnant is still to be found in the W.W.F. reserve. The survival of grazing in this region therefore depended on the poverty of the saline soils which could only be used as pasture. In the last few years even these have been taken into use for vineyards and so pasture was restricted to regularly flooded transitional meadows. Cattle had maintained the short-grass habitat by trampling and grazing, and also checked the reed expansion, the rhizomes of *Phragmites* being very sensitive to mechanical damage. Therefore, although other factors may have contributed, the reduction of grazing during the last two decades has encouraged the expansion of *Phragmites* in the ponds and along the eastern shore of the lake. About a decade ago, for instance, the community of Apetlon still had three large herds, totalling 1,000 animals, grazing around the Lange Lacke between 1st May and 15th October. Today only one herd of 320 animals grazes the area. Consequently the peninsulas of the Halbinsel and the Sauspitz, which were then completely free of reed, are now covered with *Phragmites*. The first positive attempt at nature conservation in the region was to protect the shores of the pond and the Halbinsel and Sauspitz peninsulas from grazing because the greatest danger was thought to be the trampling of the nests. But the cows step on clutches only when they are driven fast in dense groups along the shore lines; grazing cows move slowly and avoid the sitting birds. The function of the cattle in treading down the reed rhizomes is far more important than any damage done to the nests.

For wildfowl these close-grazed fields are doubly important. Besides being breeding grounds for Pintail and Garganey, they are feeding grounds for Greylag and White-fronted Geese and to a smaller extent Bean Geese and Wigeon. The vegetation of wet meadows near the shores, including salt-marsh grass *Puccinellia* spp. and bentgrass *Agrostis* spp., form a dense carpet and are of particular importance to geese. These wildfowl are secondary grazing animals which follow the cattle (the primary grazing animals) and partly replace them during winter. High dry grass stands have developed on abandoned pastures of the eastern shore of the Lake and these are no longer used by wild geese. The influence of a goose flock of several hundred birds on a small area is quite comparable to that of a small

herd of cattle. Of course their manner of grazing and manuring differs, and they do not tread down the grass. The most important task for future management is to maintain short-grass pastures by securing sufficient grazing. (Plates VI-VIII).

Three species actually feed on *Phragmites* shoots in spring, namely Musk Rat *Ondathra zibethica*, Coot and Greylag Goose. Nevertheless, only the Greylag has a visible effect (Koenig 1952), by grazing reeds on the margins and thus locally preventing their expansion into the open water; the Greylags also restrict the reed around their nests, and during the summer moult when they stay in parts of the reed belt. During this time the birds move only by swimming and they make 'paths' and small squares of broken reeds in their resting and preening places. This factor is of less importance on the Seewinkel where no moult takes place.

Finally there is the question of damage to winter crops. Although the Bean Goose is more specialised to feeding on winter crops, the Greylag causes the only real damage because it concentrates in the Seewinkel when the crop is germinating and easily pulled out of the ground. The masses of Bean Geese and White-fronted Geese normally arrive after the first frosts. An accurate assessment of the damage caused in the W.W.F. Hunting Reserve is however necessary because indemnities have to be paid to the farmers.

Summary

As a first step towards a management plan for the Seewinkel area east of Lake Neusiedl, with a special consideration of the World Wildlife Fund Reserve situated in its centre, the most important landscapes of the whole Lake Neusiedl region are described biogeographically. The Anatidae are classified in groups according to their ecology, and Coot, grebes, divers and Cormorant have been included. Eighteen species which are ecologically most important for the region have been treated in detail, 10 species occurring in smaller numbers only briefly, and 21 species which are rare are simply listed. Quantitative, phenological and geographical data are given as far as available. The inter-relationships between the various habitats and the 1,200 breeding pairs (12 species) as well as the 50,000 autumn migrants (mainly 5 species) are described. The feeding habits of these birds and the three main habitat management problems (increasing expansion of reed, decrease of short-grass pastures and damage to crops) are discussed.

References

BAUER, K., H. FREUNDL and R. LUGITSCH. 1955. Weitere Beiträge zur Kenntnis der Vogelwelt des Neusiedlersee-Gebietes. *Wiss. Arb. Burgenland* No. 7.

BEZZEL, E. 1967. Versuch einer Bestandesaufnahme und Darstellung der Arealveränderungen der Tafelente in einigen Teilen Europas. *Anz. Orn. Ges. Bayern* 8 : 15-44.

FESTETICS, A. 1967. Zur Okologie der Reiherente (*Aythya fuligula*), eines neuen Brutvogels in Osterreich. *Die Vogelwelt* 88 : 43-58.

KOENIG, O. 1952. Zur Okologie und Verhalten der Vögel des Neusiedlersee-Schilfgürtels. *J. Orn.* 93 : 207-89.

LÖFFLER, H. 1959. Zur Limnologie, Entomostraken—und Rotatorienfauna des Seewinkelgebietes (Burgenland, Osterreich). *Sitz. Ber. Osterr. Akad. Wiss. Mathem-Natur.* 168 : 316-62.

OLNEY, P. J. S. (Ed.). 1965. List of European and North African Wetlands of International Importance. *I.U.C.N. Pub. N.S.* No. 5.

SAUERZOPF, F. and A. TAUBER (Eds.). 1959. Landschaft Neusiedlersee. *Wiss Arb. Burgenland* No. 23.

SEITZ, A. 1942. Die Brutvögel des Seewinkels. *Niederdonau, Natur und Kultur* No. 12.

SZIJJ, J. and K. HUDEC. 1968. Programm zur Erforschung und Gestaltung der paläarktischen Wasserwildbiotope. *Proc. Int. Cong. Game Biol. Helsinki* (in press).

ZIMMERMANN, R. 1944. Beiträge zur Kenntnis der Vogelwelte des Neusiedler-Seegebietes. *Ann. Naturhist. Mus. Wien.* No. 54.

Dr. Antal Festetics, Zoologisches Institut der Universität Wien, Dr. Karl Lueger Ring 1, 1010 Wien, Austria.

cand. phil. Bernd. Leisler, Messerschmidtgasse 31/7, A-1180 Wien, Austria.