

DEVELOPMENT OF WINTERING WATERFOWL COMMUNITIES DURING THE AGEING OF MAN-MADE LAKES

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ABSTRACT

In the Donaumoos near Ingolstadt, Bavaria, a large number of gravel-pit lakes have been created during the last decades. Since the beginning of the 1980s they are under investigation with respect to the species succession of wintering waterfowl, with the increasing age of the lakes and regarding the maximum bird numbers in relation to biological and morphometric parameters of the lakes.

Though even on lakes smaller than 4 ha, great numbers of birds could be seen in some cases, however as a rule lakes had to be larger than 5 ha to be attractive for waterfowl.

Based on the investigation of 37 lakes an equation was found, which describes the correlation between the size of a lake and the maximum bird number found. Yet this equation is valid for mesotrophic lakes only, because apart from the size of the waterbody bird numbers are influenced by the trophic state of the lake and its structure and shape.

INTRODUCTION

The Donaumoos, where the investigations take place, is a flat terrain with high groundwater level in Germany's pre-alpine region south of the River Danube close to Ingolstadt (**Figure 1**). The fluvial sediments found there consist of high-quality gravel, which makes the area interesting for mining companies. Up to the sixties of this century, the size of the gravel-pits ranked between a few hundred square metres and about 10 ha. Since 1970, due to new techniques and changes in the legislative background, the size of the pits rose

rapidly. At the moment, the largest area being under excavation covers almost 400 ha, but there no uniform waterbody is being created, the lake is subdivided by dikes for reasons that will be discussed later on.

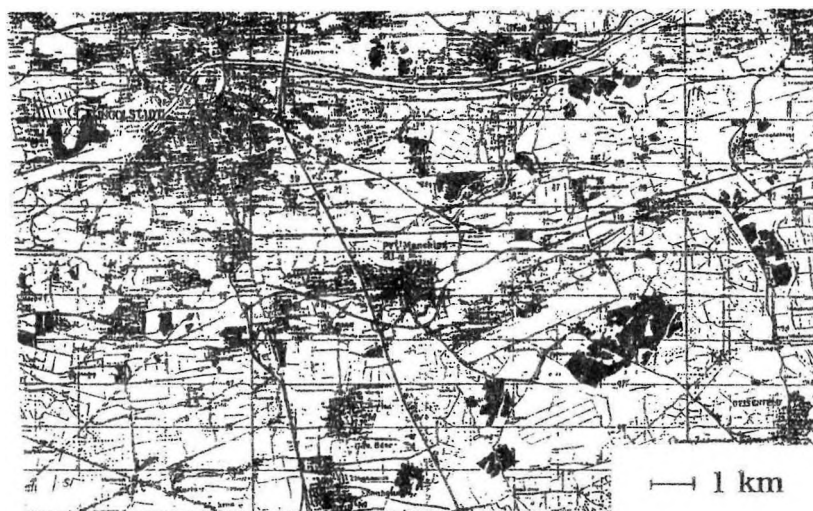


Figure 1: The Donaumoos near Ingolstadt, Bavaria. Black: gravel-pit lakes

The investigations that started in 1981 are being carried out, because there are two airfields in the Donaumoos, and the occurrence of waterfowl causes a risk to flight safety. The goal was to find out in which cases the lakes are most attractive to waterfowl and what can be done to reduce the attractiveness.

During the period of breeding and raising their young, ducks and most other waterbirds live hidden in the reedbelts and show little flight activity only. Therefore they normally do not cause problems to air traffic. (There are no breeding colonies of Laridae in the Donaumoos, for details about bird species see Schmager 1986.)

Of much greater importance with respect to potential hazards for flight safety are the migrating and wintering birds. That is because the risk of severe collisions between birds and aircraft increases with the number of birds, their flight activity, and their weight. For this

reason, special attention was paid to the development of the numbers of wintering birds on the lakes. The fact that the lakes meanwhile reached a magnitude that from a bird's-eye view the mere optical impression makes them very attractive already let the Donaumoos become an important area for wintering waterfowl.

RESULTS

Species succession

As an example the changes of the bird-population on the lakes in the Feilenmoos, the part closest to the Manching airfield, are presented in the following. Since changes take place slowly and step by step, on the figures for a better understanding only the conditions in 1981 and those ten years later are presented. In order to register the maximum numbers of wintering birds - because they cause greatest risk to flight-safety - the investigations were made at the end of November or the beginning of December, just before the lakes freeze over.

The largest one of the lakes (in the south-western part of the area) was created between 1970 and 1984 with minor changes till 1989. The size is about 50 ha, the maximum depth 6.5 meters, but even in the centre of the lake, there are shallow parts and islands.

In 1981, only Mallards (*Anas platyrhynchos*) were found (**Figure 2**), a bird species searching for food on the banks or in shallow water up to a depth of 48 cm. The lacking of diving birds was due to the turbidity of the water caused by inorganic particles (Secchi-depth 60 - 80 cm), because this prevented a colonization of the benthic regions by submerged plants, so there was no adequate food supply.

Five years later Mallards were still the most frequent species, yet the number of species was much larger already. The Pochard (*Aythya ferina*) was the first diving duck found there; its food consists of benthic macrophytes and animals. Two of the three fish-eating bird species (Crested Grebe - *Podiceps cristatus* and Cormorant - *Phalacrocorax carbo*) are divers, they profit from the increasing transparency of the water (Secchi-depth now: 2.1 m). Grey-lag Geese (*Anser anser*), though taking up their food on the surrounding agricultural land, use the lake as a roosting place because of its favourable structure (islands and great distance of the centre from the shore).

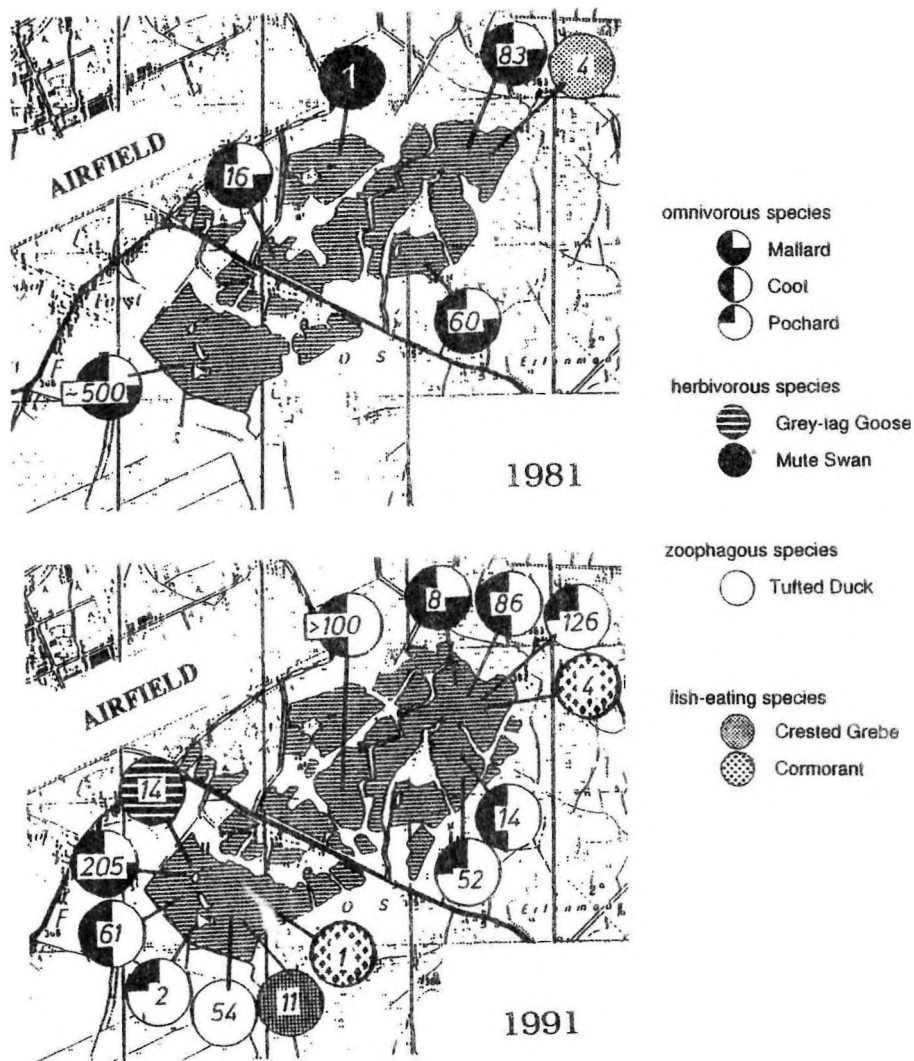


Figure 2, 3: Changes in species composition of wintering waterfowl during the ageing of gravel-pit lakes

Until 1991 (**Figure 3**) the number of species and individuals of diving birds had increased further because of the immense increase in benthic organisms that always results

from accelerated eutrophication of lakes. By this time, the zebra-mussel (*Dreissena polymorpha*) had been imported into the lake. This mollusc is the main food-source for the Tufted Duck (*Aythya fuligula*) and therefore the reason for the occurrence of this bird species.

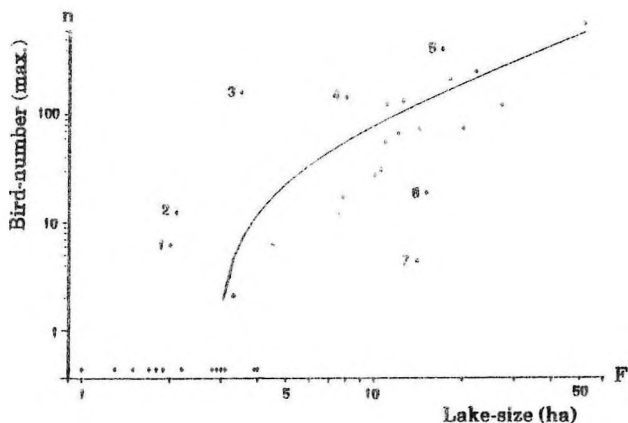


Figure 4: Correlation between lake size (F) and maximum bird number (n) on mesotrophic gravel-pit lakes: $n = 10.16F^{0.29}$

The north-eastern parts of the area had been excavated mainly between 1970 and 1980. Yet in some gravel-pits the works are still going on, besides new excavations partial refilling of lakes or their subdivision by dikes takes place. Until the end of the eighties, the water was turbid in most of the lakes. This hampered or even completely prevented the development of submerged macrophytes. Because of this, during that time only few birds visited these lakes, the Mallard being the dominant species (**Figure 2**). During the further development of the lakes, the transparency of the water increased and meanwhile the bottom of the older lakes was completely covered with macrophytes up to a depth of about 4.5 metres. In that vegetation great numbers of aquatic insect-larvae and mollusks were found, with the consequence of an increasing attractiveness of the lakes for diving birds (Coots, Pochards; **Figure 3**, in 1993 even Tufted Ducks).

The main reason for that unusually fast ongoing eutrophication and by that the development of a food-chain with aquatic birds at the end is the use of the lakes as fishing-grounds with the release of an inadequate amount of fish. To have the fishes grow the

fishermen either feed them or fertilize the water, both resulting in an increase of the trophic state of the water.

Bird numbers

Besides the lakes mentioned above, several other ones were investigated in the Donaumoos (37 altogether). On this basis, an attempt was made to correlate numbers of wintering birds with the size of the lakes, in a similar way as Reichholf (1990) did for man-made lakes in the Erdinger Moos and the region west of Munich.

Figure 4 shows the dependence between the maximum bird number (n) and the lakes' surface area (F). The correlation can be described by the formula $n=10.16F^{.29}$. (That means up to a size of about 3 ha, there is little chance only that birds consider a lake to be interesting enough to search for food or rest on it).

If the numbers are by far higher than on "average" lakes (see. no. 1 to 5 on **Figure 4**) this, as a rule, is the result of an extraordinary good food-supply. Lake no. 2 served as a receiving water for the sewage treatment plant of a small village for decades. Therefore the bottom is densely populated by chironomids and *Tubifex*. In lake no. 4, the bottom is completely covered with *Ceratophyllum* with up to 1700 water snails living there per m^2 . Because of the low depth (4.2-4.5 metres) this enormously rich food source can easily be reached by diving birds. Lake no. 5 is situated right on the outskirts of a larger town and therefore despite of its size, it has the character of a pond in a park with the birds being fed there by people. Prevailing species on that lake were those accustomed to the presence of man: Mallard, Coot and Mute Swan (*Cygnus olor*).

Yet in some cases the reasons for high bird densities remain unknown (Lake no. 1 and 3) if among a homogeneous group of lakes some are visited by flocks of birds while on the others there are no birds at all.

Below average bird numbers were observed in pits still under excavation and therefore with intensive disturbances, and if either the water is made turbid by morganic matter (lake no. 6) or if the shape of the lake is unfavourable, as it is the case with lake no. 7 in an extreme way. The latter lake is long and narrow, so the distance of no part of the surface is greater than

100 m from the closest bank. This obviously is adverse to the birds' need for safety and so they avoid landing there.

DISCUSSION

The investigations about the succession of waterfowl on man-made lakes reveal, that single birds visit the lakes already a short time after their completion, in the case of larger lakes even while they are under construction. Yet not earlier than about five years after the end of an excavation the colonisation of the lake by submerged vegetation is that dense that it - together with the inhabiting lower animals - can be the food source for a bird population rich in species and individuals.

The first species visiting a lake in search for food are dabbling ducks (food-uptake in the littoral zone). They are followed by diving species with a decreasing percentage of phyto-genic food. The last species appearing are those that feed exclusively on benthic animals, which in turn are the organisms that do not colonize the lake's bottom in sufficient numbers unless the lake has reached at least a mesotrophic state.

First appearance and numbers of fish-eating bird species however are no indicators for a certain stage of succession in a lake, since development, species composition and density of fish in almost all cases is the result of artificial measures.

As soon as the size of lakes exceeds the "threshold value" of about 4 ha, the number of birds increases quite steadily with increasing lake-size. But apart from the size, the structure and the trophic state influence bird numbers, to a certain extent the latter is the most important factor, because the available amount of food depends on it.

Structural parameters that influence bird numbers and thus cause deviations from the expected value for mesotrophic lakes given by the regression, are

- **water depth.** It has a positive effect, if it is that low, that the benthic region lies within the euphotic zone completely or at least to a major part. In this case macrophytes can grow there and the bottom can easily be reached by diving waterfowl.

- the **shape**. It has a negative influence, if the distance between the centre of a lake and its banks is shorter than the flight distance of the birds, that means if the lakes are narrow.

On the other hand lakes that have a too low trophic state or are too deep to serve as feeding grounds, can be attractive roosting places if the surface is large enough to satisfy the birds' need for safety. (In this case periodic flights take place between such a lake and the feeding grounds).

These results are the basis for management measures to keep bird numbers low, if it is not possible to prevent an excavation in the vicinity of an airfield. The water-depth of excavations is given by the thickness of the gravel layer and the ground-water level, so with this respect our influence is limited. Therefore large excavation areas are subdivided by dikes to create smaller and thus less attractive water bodies. Furthermore structures that are favourable for waterfowl have to be avoided: there must be no islands and the banks must be steep and straight to reduce the area that can be used for food-uptake by non-diving bird species. Yet all those measures are of little value only, if the trophic level of the lake rises; rich food supply causes high bird numbers even if the structure is not very favourable.

REFERENCES

- Reichholf, J. (1990): Untersuchungen über die Besiedlung von künstlichen Gewässern (Kies- und Sandabgrabungen) durch Wasservögel. *Vogel u. Luftverkehr* 10 (2), 86-97
- Schmager, P. (1986): Die Vögel des Donaumooses. *Anz. orn. Ges. Bayern* 25, 207-216.