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MAN-MADE WETLANDS AND FLIGHT SAFETY

Ekkehard Küsters
German Military Geophysical Office, Mont Royal,
D-56841 Traben-Trarbach, Germany
Email: EkkehardKuesters@awg.dwd.de

Abstract

Because of the destruction of natural wetlands that took place on a very large scale during this century, the importance of man-made wetlands is growing rapidly. Therefore the creation of new wetlands is appreciated by nature conservationists. Yet if those wetlands are created in the surroundings of airfields, they cause problems to flight safety because of their attractivity to birds. While bird numbers and their habits on natural wetlands do not change too much over the years and therefore the effects on flight safety can be calculated, man-made lakes in the beginning are in an oligotrophic state and therefore of little attractivity only. But because of the nutrient input with the rain and the groundwater, eutrophication takes place rapidly. As a consequence, bird numbers rise year by year, increasing the risk of birdstrikes.
The development of a gravel mining area that meanwhile forms wetlands of more than three squarekilometers close to an airfield in southern Germany has been investigated for almost 20 years now, showing alarming results with respect to the increase in bird numbers. But there are ways of making those lakes less attractive.

Key Words: Wetlands, Eutrophication, Flight safety, Waterbirds.

Introduction

In the Donaumoos south of the city of Ingolstadt (Bavaria) in southern Germany river sediments formed 6 to 10 m thick layers of high quality gravel. Gravel mining in this area started in the middle of last century already, but for technical reasons the excavations -if at all- did not go deep into the ground water during the first decades. Because of this there existed only a few relatively small gravel pit lakes in the surroundings of Manching airbase in 1955 (fig. 1). Not until late in the 1960s the size of the first pit exceeded 5 ha. By 1976 about 400 gravel pits existed in the Donaumoos, they covered approximately 1200 ha (Jürging & Kaule, 1977), that means the average size of the pits was 3 ha. Most of them were either very shallow or did not form lakes at all. Since that time the number of pits did not increase very much because in many cases small pits lying close together were excavated again, forming a single larger one afterwards. For this reason the average size of the gravel pits is more than 10 ha now with the largest ones being bigger than 50 ha, all of them form lakes now with a water depth between 5 and 8.5 m (fig. 2).
After the first dramatic increase in number and size of water bodies in this area pilots noticed more and more waterbirds. In order to find out whether waterbirds did prefer certain lakes and, in case they did, why they did so, investigations were carried out in that region since 1981. They consisted of bird counts once every year in autumn between the end of October and the beginning of December, when after the arrival of waterbirds from Scandinavia and eastern Europe highest numbers could be expected on the lakes (Küsters, 1996). Furthermore limnological parameters (water chemism) and the benthic flora and fauna were investigated.

Results

Under the aspect of potential hazard to air traffic migrants and wintering birds are of much greater importance than breeding birds because they are more numerous and the risk of severe collisions between birds and aircraft increases with increasing bird numbers, their flight activity and the weight of the birds.
Until, the beginning of the 1990s the gravel pit lakes in the Donaumoos -with only a few exceptions- were still in an oligo- to mesotrophic state and they were used as food sources by an average of about 10 birds per ha (Küsters, 1997). Almost exactly that number of birds was found on other lakes in Bavaria (Reichholf, 1990) and in other European countries, too, as was mentioned by many scientists during the “Limnology & Waterfowl“ workshop in Sopron, Hungary, in 1994.

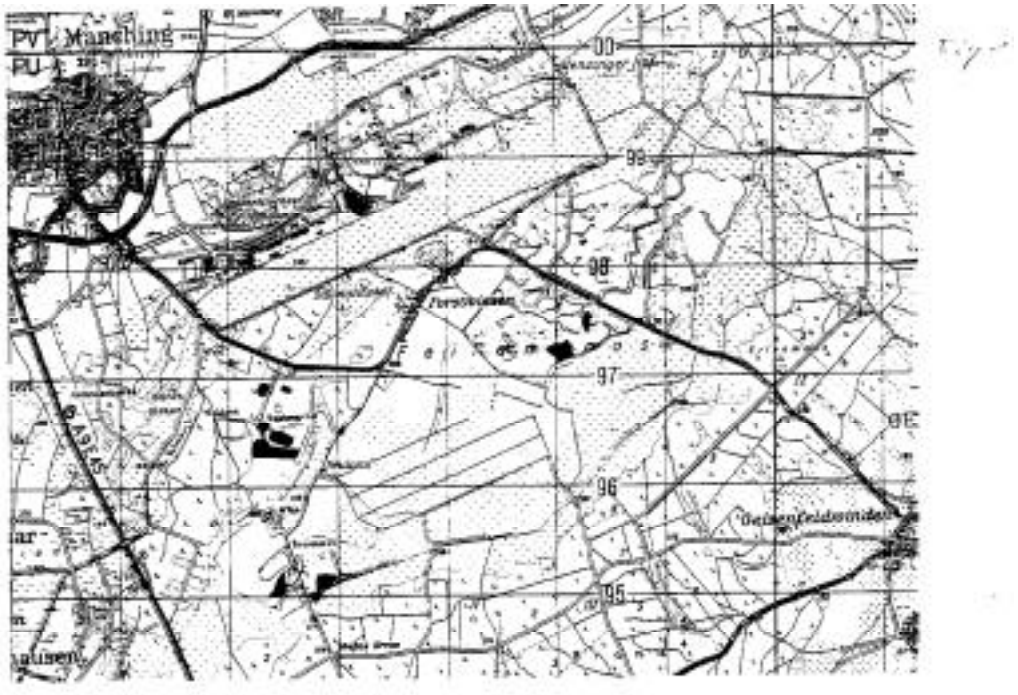

Figure 1. Gravel pit lakes (black) near Manching airbase (Bavaria) in 1955

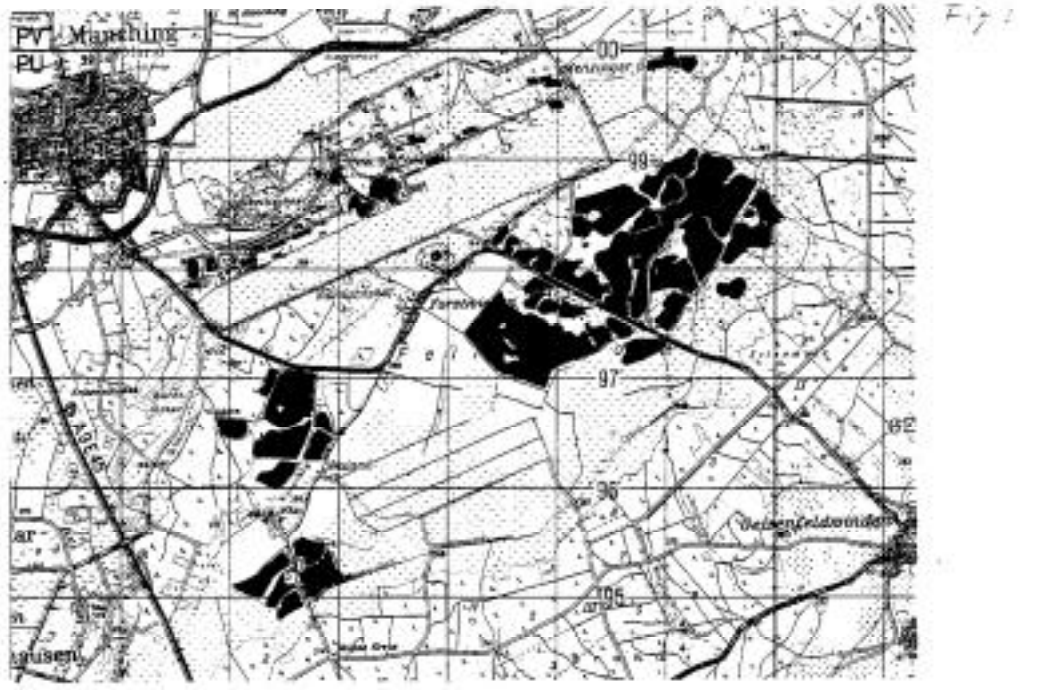

Figure 2. Gravel pit lakes (black) near Manching airbase (Bavaria) in 1999

Due to still ongoing gravel minimg there is a constant increase in open lake surface. Yet during the first decade of observations bird numbers in the Feilenmoos, the part of the Donaumoos that is situated closest to Manching airbase, did not rise corresponding to that increase (fig. 3). The most frequent bird species during that time was the mallard (***Anas platyrhynchos***).
But since those lakes have a very disadvantageous ratio between surface area and depth (they are large and shallow without a hypolimnion) they do not remain in an oligotrophic state very long because of the constant nutrient input through the air (15 - 40 kg nitrogen per ha and year), through the groundwater, that carries fertilizers from the adjacent agricultural areas and by fishermen who want to raise the productivity of the lakes by illegally adding fertilizers or organic material. For those reasons the trophic state of several of the lakes rose significantly since the beginning of the 1990s.
Since most of the lakes are that shallow that their bottom is completely within the euphotic zone (=zone that is penetrated by light), submerged macrophytes spread more and more. Because of the high transparency of the water the way this vegetation cover extended could be seen on aerial photographs that I shot every second year from a helicopter: the dark vegetation contrasted with the bright unvegetated sand and gravel. The development of the underwater vegetation during the past 12 years is shown on table 1.

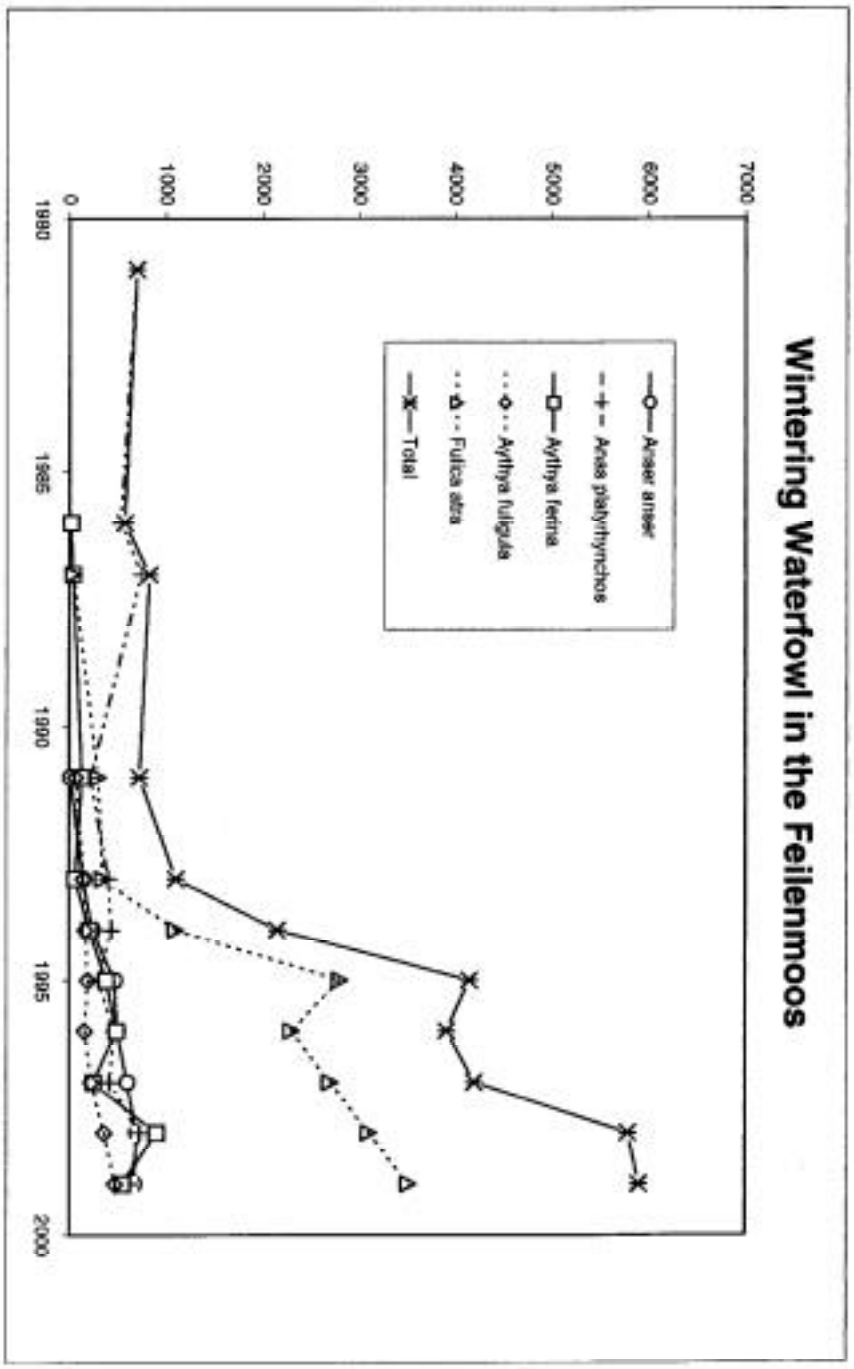

Figure 3. Numbers and species composition of wintering waterfowl in the Feilenmoos near Manching.

Table 1. Development of macrophytes in selected lakes in the Feilenmoos near Manching airbase. (Percentage of the total area of the lake bottom covered by macrophytes)
excav. = gravel pit still under excavation

Lake no.	1988	1991	1993	1995	1997
15	excav.	<10%	60%	70%	95%
16	<10%	25%	90%	100%	100%
18	<10%	10%	90%	100%	100%
19	excav.	<10%	50%	90%	100%
21	excav.	excav.	<10%	50%	75%

The submerged vegetation provides a rich food source for diving herbivorous and omnivorous waterbirds (Pochard ***Aythya ferina***, Red-crested Pochard ***Netta rufina***, and Coot ***Fulica atra***) and for aquatic snails which on their hand together with the zebra mussel (***Dreissena polymorpha***) that has been introduced into almost all of the lakes, are fed on by carnivorous birds (e.g. Tufted Duck ***Aythya fuligula***). The increasing number of fish attracts fish-eating birds (Crested Grebe ***Podiceps cristatus***, Grey Heron ***Ardea cinerea***, and Cormorant ***Phalacrocorax carbo***), yet their number is small compared with that of the omnivorous birds, therefore they are not depicted separately on figure 3.
As a consequence of that improvement in the quantity of available food bird numbers rose dramatically between 1992 and 1995 (fig. 3). The by far most abundant species is the coot, which according to Bezzel (1985) is an indicator of eutrophication.
Apart from the mallard, the number of which does not differ significantly from that found in the beginning of the investigations, all other species of waterbirds showed an increase during the past eight years. This increase followed the increase of benthic organisms that is most obvious in the zebra mussel (only a few in 1993, between 1000 and 1500 per m_ in 1995 and masses since 1997) and different species of snails (less than 100 per m_ in 1993, 500 - 1000 in 1995, more than 1500/m_ after 1997; average of four lakes). The biomass of macrophytes is between 1000 and 7000 g/m_ (freshweight of ***Chara*** spp., ***Myriophyllum*** spp., and ***Elodea canadensis***).
A comparison between the increase in lake surface and bird numbers from 1981 to 1999 (fig. 4) proves that the reason for higher bird numbers is not the enlargement of existing or the creation of new lakes. Between 1981 and 1999

the surface (and the bottom area that can be vegetated by macrophytes) of all the lakes in the Feilenmoos was enlarged from 240 to 340 ha, that means by little more than one third. During that same time bird numbers rose from 700 to 5900, that means by more than the factor eight. Even if the component of the increase in lake surface is eliminated, by the end of the 1990s bird numbers were more than five times as high as in the beginning of the 1980s. Comparing bird maxima on some of the large older lakes between 1981 and 1986 with maximum numbers on the same lakes between 1993 and 1999, the same significant increase, that showed with respect to the whole area, can be observed: between 1981 and 1986 the average number of birds on those lakes was 10 per ha; after 1993 it was 40 with a maximum of more than 50 per ha. On some of the lakes even an increase by the factor 10 could be noticed.

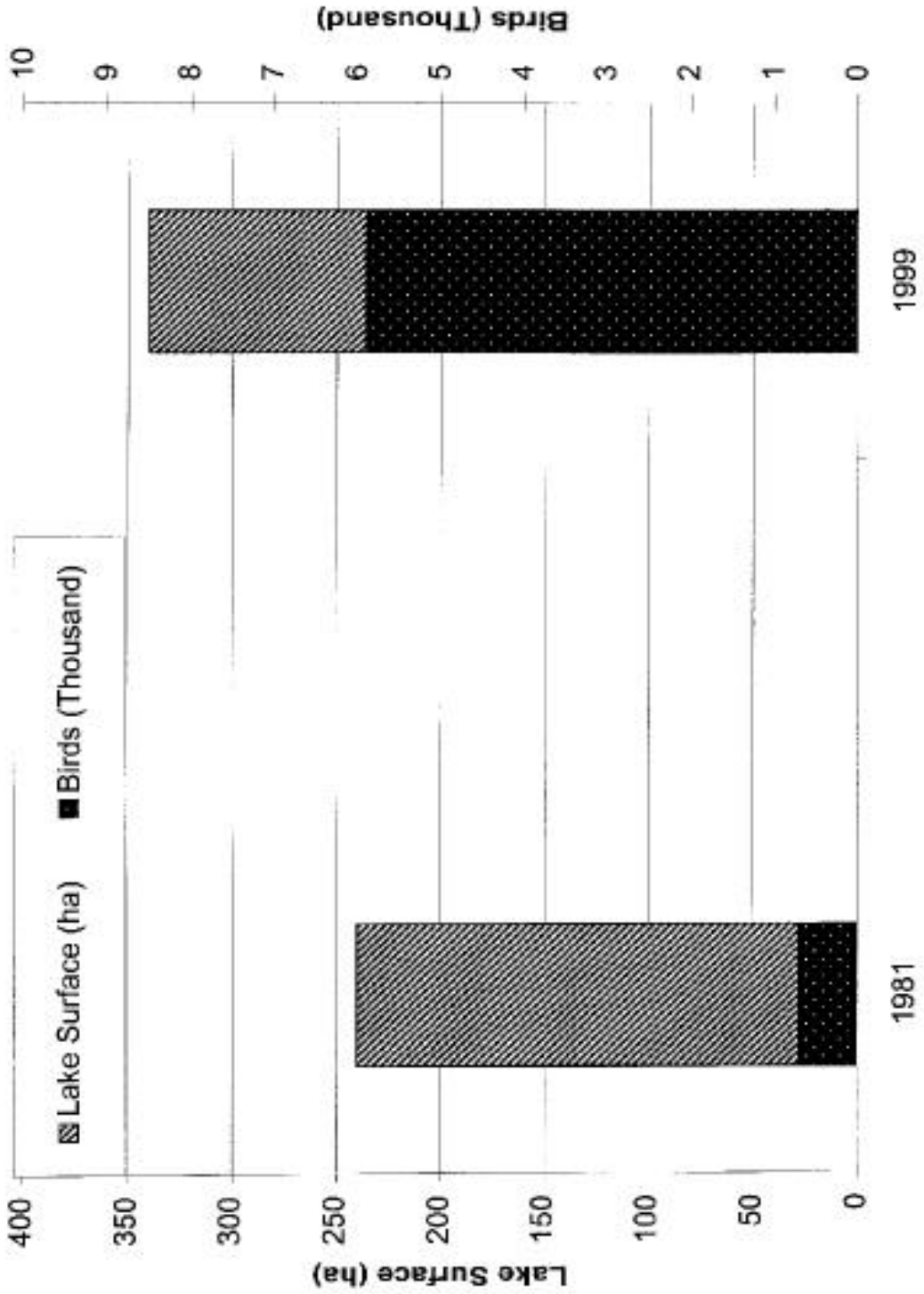

Figure 4. Increase in bird numbers on the larger lakes of the test area near Manching (Bavaria) between 1981 and 1999.

Discussion

Since in the area unter investigation there are still many young lakes that are in an oligotrophic state with very little vegetation only, and a lot of gravel pits that are under excavation, it can be expected that the total number of birds in that region will rise further during the next decades because it will not be possible to stop eutrophication and - as a consequence - the increase in the amount of food available for waterbirds.
The results of the bird counts show that without countermeasures the flight safety situation on Manching airbase will become worse every year. But what can be done?
One way would be eliminating the underwater vegetation either by chemical means or by introducing grass carps (***Ctenophyryngodon idellus***) into the lakes. But these are theoretical possibilities only, because for nature conservation reasons it is not possible to get permissions to do so.
The average number of waterbirds in the Feilenmoos is only 13 per ha, that means it is far lower than on the lakes with high bird densities. Searching for the reason , it was found out, that the larger the lakes are, the higher is - under the premise of equal trophic state - not only the absolute, but also the per hectare number of birds.

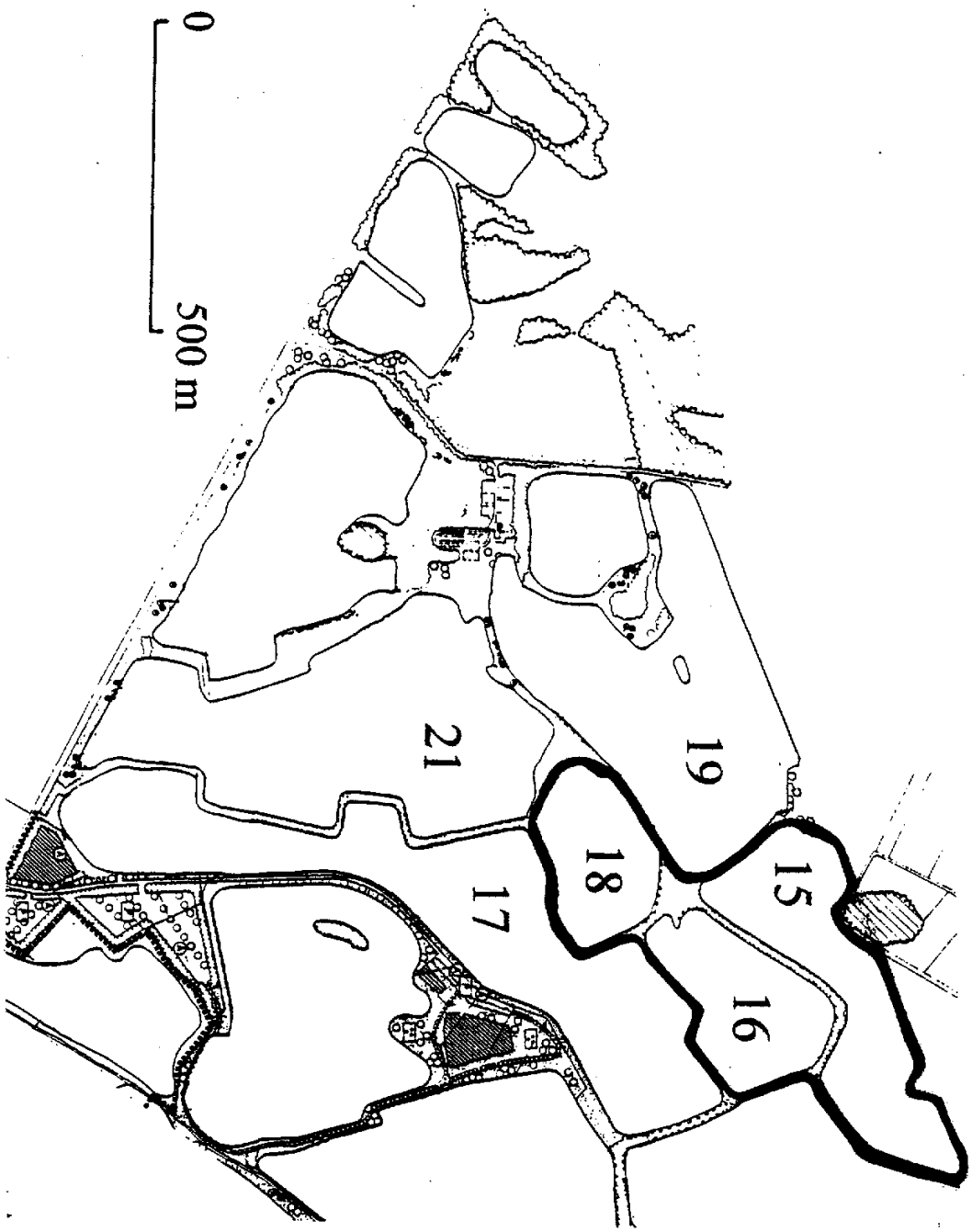

Figure 5. Main study area in the Feilenmoos (Bavaria). Lake numbers as referred to in the text.

Table 2. Relation between lake size and maximum bird number in the experimental area (see fig. 5).

Lake no.	Size (ha)	max. bird number
15	9.0	164
16	5.5	19
18	4.5	41
19	17.0	1200
21	19.5	1000

On lakes up to 6 ha there were 4 birds per ha on average, on lakes smaller than 3 ha the average number was even less than one bird per ha.
Because of this assumed correlation between lake size and bird density one mining company could be forced to have a new mining field of 19 ha subdivided by leaving dikes along the borders of the plots. This way small pits (4.5 ha, 5.5 ha, and 9,0 ha) were created adjacent to larger ones (fig. 5). Since the environmental factors are equal and the development of the lakes was the same, there was a possibility of a direct comparison between large and subdivided lakes.
Meanwhile the bottom of the three small experimental lakes (number 15, 16, and 18 on table 1) is covered by macrophytes between 95 and 100%, in the larger one next to them the cover reaches about 75%. It might be assumed that the greater amount of food in the smaller lake makes them more attractive to diving waterbirds, yet the availability of food is not a limiting factor at all. Birds consume only a very small amount of the standing crop; in spring 80 to 90% of last year's vegetation still exist. The result of the bird counts war that on the large lake there were approximately 1000 birds, that means more than 50 per ha. In contrast there were only 224 (= 12 per ha)on the three smaller lakes together. By this experiment regional differences and the influence of food could be excluded, ans the only factor that is different between the two test sites is that in one case there is one uniform lake while in the other case that same expanse of water is subdivided into three lakes. A further evidence of this result of the experiment was given by a lake of 17 ha that is a little bit older and has a complete macrophyte cover of the bottom (lake 19 on table 1), situated next to the lakes mentioned above: there were about 1200 birds, that equals 70 birds per ha.
So provided that environmental factors are the same, bird numbers are influenced by the lake size in that way that the smaller the lakes are, the lower is not only the absolute number of birds but also the number per hectare. The

reason for that ist that the birds tend to stay away at least approximately 80 to 100 m from the nearest bank during the hunting season (even if there are no hunters present). Therefore small lakes do not fulfil their safety requirements and they are used for feeding and resting much less frequent than large ones. With lake no. 17 on fig. 5 this is the case, too. Though ist size is about 18.5 ha, maximum bird numbers were below 100 because the shape of the lake is very unfavourable to birds.

Conclusions

Because of the immense economic importance of gravel mining, the creation of new lakes will continue. Since eutrophication of those lakes cannot be stopped either, they will always provide a rich food source for waterbirds if their depth is less than approximately 7 m which enables macrophytes to grow on their bottom. Yet the results of the investigation reveal that the attractivity of lakes to birds can be reduced by subdividing them. Therefore on mining fields in the vicinity of airbases and airports subdivision of large lake areas is an efficient management tool to keep bird numbers low and thus to reduce the probability of collisions between birds and aircraft.

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