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The development of the ecological balance under the influence of a colony of Black-headed Gulls *(Larus ridibundus L.)*

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Im bayerischen Alpenvorland wurde eine Population von Lachmöven (*Larus ridibundus* L.) und deren Auswirkungen auf das ökologische Gleichgewicht untersucht:

Die Entwicklung der Population verlief nach einer logistischen Wachstumskurve. In der Latenzphase wirkten Opponenz und z.T. Konkurrenz begrenzend, in der stationären Phase das Brutplatz- und z.T. das Nahrungsangebot. Die Kapazitätsgrenze liegt bei 4500-5000 Individuen. Die Regulation der Population erfolgt in der log- und stationären Phase durch dichteabhängige Faktoren. Innerartliche Konkurrenz um das Brutplatzangebot wirkt als Regler; Fertilität, Mortalität und Migration wirken als Stellglieder. Als Störgröße konnte Kälte im Überwinterungsgebiet nachgewiesen werden.

Der eigentliche Aktionsradius der Population liegt bei 7 km, der größtmögliche bei 16 km. Der Versuch der Bildung von Brut- und Nahrungstochterkolonien wurde beobachtet.

Während in der lag-Phase der Lachmövenpopulation in deren Lebensraum ein biozönotisches Gleichgewicht bestand, wurde dieses in der log- und stationären Phase durch die Lachmöven immer intensiver und räumlich ausgedehnter gestört.

Die Population stört in diesen Phasen das ökologische Gleichgewicht im natürlichen Ökosystem des Brutgebiets (Verdrängung der Wasservögel, See-Eutrophierung) und in produktiven Ökosystemen der Umgebung (u.a. Regenwurmpopulation der Äcker und Bestand der Fischteiche).

1. Introduction

There are colonies of Black-headed Gulls (*Larus ridibundus* L.) in many parts of Central Europe (CREUTZ 1965, REICHHOLF 1975), even all over Europe (ELDOEY 1976, LEBRETON et ISENMANN 1976, TALPOSH 1976). Whereas up to this day occurence, development and dynamic forces of the populations have been specified several times (REICHHOLF 1975, SCHMIDTKE 1975), only little research was done into their effects on the abiotic and biotic environment (EBER u. SCHÄFER 1973).

Therefore, in addition to the study of the population of Black-headed Gulls, their influence on the ecological balance is to be emphasized in the following contribution.

2. Research area, Methods

The breeding-area of the colony of Black-headed Gulls where research was done is situated in the foot-hills of the Bavarian Alps, 30 km southeast of Munich, on lake Egglburg.

The particular information about the development of the population and the ecological balance is based upon oral information given by the former commissioner for wild life preservation and by farmers, farmers in charge of the lake, hunters living near the lake.

The ecological interrelations have been studied since 1975 only. The data about the radius of action of the population resulted from many observations and numerous contributions given by local people. The development of the stock of waterbirds on lake Egglburg was followed up by observing the lake from the banks and from a boat.

Further information on the area of research and the methods applied will be published later.

3. Results

3.1 Development, regulation and radius of action of the population of Black-headed Gulls on lake Egglburg

3.11 The development of the population

Obviously it proceeded by a logistic curve of growth, according to the equation (WILSON u. BOSSERT 1973):

$$\frac{dN}{dt} = r \cdot N \frac{K - N}{K}$$

As can be seen from fig. 1, a respectively long lag-phase was followed by a short log-phase; at present the population is in the static-phase. The number of the breeding Black-headed Gulls was always the basis for the curve of fluctuation.

What was the development of the population characterized by? The long phase of latency (lag-phase) can be explained by a stabilized biocenotic balance in the sphere of existence of the gulls. Because of birds of prey (*Circus aeruginosus*, in the breeding-area; other birds of prey in the surroundings) and beasts of prey (foxes, *Vulpes vulpes*, in the breeding-area), enemy-prey-relations existed. Rival relations (established by *Corvus corone corone* and *Anas platyrhynchos* among others) helped to keep the Black-headed Gulls at bay.

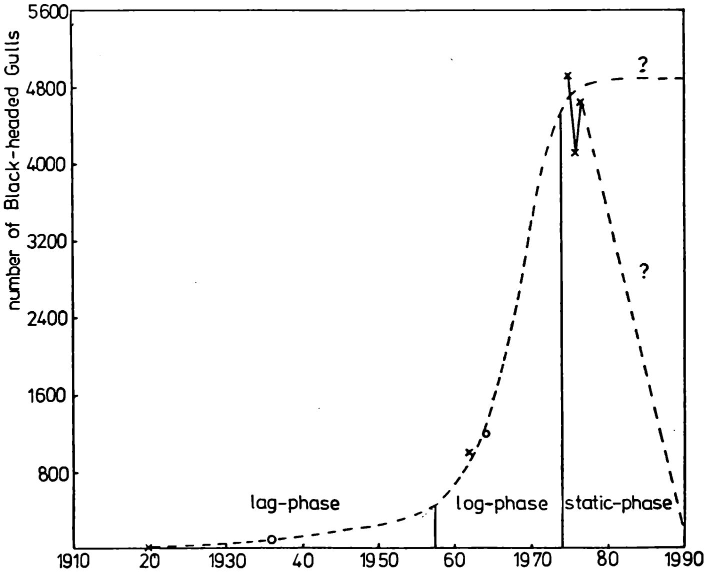

fig. 1: Development of the "Lake Egglburg" population of Black-headed Gulls
x = counted number
o = estimated number

The elimination of enemies was probably the reason for the transition into the log-phase. By gassing the foxholes the number of enemies in the breeding-area was decreased. The decrease of birds of prey in the surroundings, dependent on anthropogenic factors as well, reduced the number of enemies in the rest of their sphere of existence. The increasing population of Black-headed Gulls must have succeeded in displacing *Circus aeruginosus* by means of the group effect depending on the large number. After eliminating the enemies, however, the most important limiting factor had disappeared and, as a result of optimum environmental circumstances (breeding-grounds on the *Carex* islands; food in the surrounding productive ecosystems), there was a mass procreation. Above all, the Black-headed Gulls as r-strategists could immediately make use of the favourable conditions and occupy the ecosystem prior to rival species and displace them at the same time (especially *Anatidae*). It is possible that there was a migration to this place from breeding-colonies in the surroundings and this has probably happened from time to time. However, as the growth of the colony can be explained by the fertility of the population which is characteristic for the ecosystem, the migration to the place has probably played a minor part.

Whereas in the latency-phase especially the enemy-prey-relations were limiting factors, after the exponential growth the limit value K of the static-phase was gradually approached which is set by the breeding-grounds available.

Without anthropogenic measures the population would either remain in the static phase - combined with a possible migration from the place of surplus creatures - or break down as it was proved with other colonies (REICHHOLF 1975, SCHMIDTKE 1975). At present man is increasingly interfering - all the eggs are collected - in order to attain a decrease of the population.

3.12 Regulation of the population of Black-headed Gulls in the static-phase

The dynamics of abundance in the population on lake Egglburg can also be conceived and described from the view of kybernetics (SCHAEFER 1972) and can be represented in the following way (fig. 2):

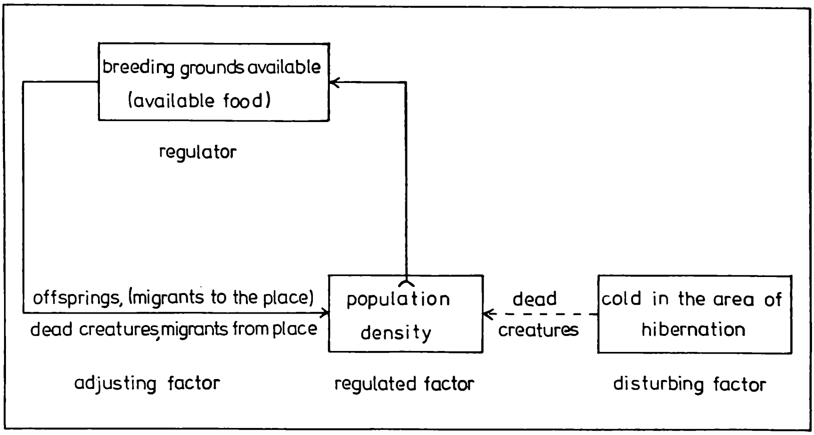

fig. 2: Regulation of the population of Black-headed Gulls in the log-phase and in the static-phase
——— = influences depending on population density
- - - - = influences not depending on population density

- Influences dependent on density: If the curve runs regularly (fig. 1) the fluctuation is above all dominated by factors dependent on density (ALTENKIRCH 1977). Because of the lack of enemies and rivals between the different species, the rivalry within the species is decisive, and here the competition for the breeding-grounds. The minimum distance of 30-40 cm is obtained in some places (REICHHOLF 1975). So, by interference, stress phenomena are the consequences and, as a reaction, migration from the place and forming of branch colonies (fig. 3). Food rivalry, e.g. for lumbricids when the fields are ploughed, can also be observed (ODZUCK, n.publ.). Breeding-grounds available (and partly available food) are regulators and provide the theoretical value. The theoretical value is 4 500 - 5 000 individuals here. In case of minor density of the Black-headed Gulls the theoretical value may be obtained if there is a high birth rate, less mortality and a possible migration to the place. If the density is too high (actual value > 5 000) it can be regulated again by influencing the adjusting factor (fertility, mortality or migration). A reduction of the birth rate could not be found, but since 1975 dead gulls were met in the breeding-area, an indication of an increasing death rate. Finally migration from the place is proved by the fact that brood and food branch colonies were established.

- Influences not dependent on density: Cold in the area of hibernation (southern Switzerland, southern France) caused a relapse in the development of the population (fig. 1). This is a factor not dependent on density which takes effect as disturbing factor (fig. 3). On the other hand, extreme wetness or dryness in the breeding-area had no effect on the development of the population.

3.13 Radius of action of the population in the static phase

From the breeding-area which is used as sleeping-ground as well the Black-headed Gulls fly away for providing food.

Up to a distance of 7 km the old birds might supply nearly their complete requirements of food (fig. 3). They don't go on farther reaching expeditions up to a maximum distance of 16 km until the breeding-period of old and little birds is over, that is with increasing abundance.

Furthermore the attempt to establish brood and food branch colonies was observed. They existed only one year each and were destroyed by man's intervention if situated near the mother-colony (fig. 3). A more extensive dynamic effect of dispersion could not be found. The spreading takes place in the direction of fish pond, fields and grassland. It is limited, however, by forest ranges and built-up areas, corresponding to the food available for the population.

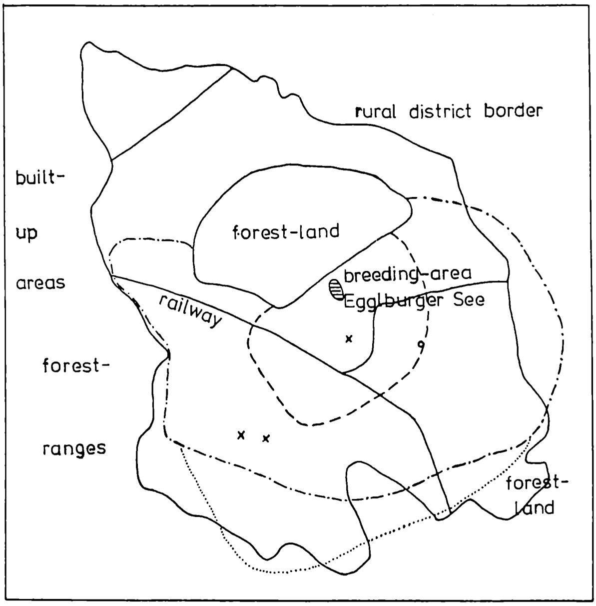

fig. 3: Radius of action of the population of Black-headed Gulls
- - - - = main area of distribution (- 7 km)
-·-·-·- = rarely frequent occurence (- 12 km)
······· = sporadic occurence (- 16 km)
x = brood branch colonies
o = food and sleeping-ground branch colonies

3.2 Development of the ecological balance in the radius of action of the population of Black-headed Gulls

3.21 Ecological balance in the static phase

As there are exact studies at hand about this problem, research shall be done first into this phase.

- Disturbances in the breeding-area: When the Black-headed Gulls are present, the lake is contaminated by droppings in the breeding-area. The consumption of oxygen directly correlates with the presence of the gulls. At the same time there is an increase of plankton. The lake is eutrophied. When the Black-headed Gulls arrive, the number of waterbird individuals extremely decreases; the number of species, however, does not decrease to the same extent (fig. 4). Some remaining specimen maintain themselves, but only rarely multiply. When this happened as with the ducks, the family was attacked by a swarm of Black-headed Gulls and the young were killed. After 14 days only 4 of 11 young ones were alive! For rivals, coexistence is possible only by giving way to the Black-headed Gulls during the presence of those. As there are no places of refuge in the very region of the lake, the ducks sometimes bred in the forest nearby or visited other lakes, ponds or ditches. Because of their different ecological niches (food and breeding behaviour) only *Podicipidae (Podiceps cristatus, Podiceps ruficollis* and *Podiceps nigricollis)* were not affected by the presence of the Black-headed Gulls. The H_S-value as an index for the diversity of the species clearly reflects the reduction of the variety during the presence of the Black-headed Gulls (fig. 4).

- Disturbances in the surroundings of the breeding-area: In the closer surroundings (up to 2 km) the lumbricid population in the fields is affected and the hay in the grassland is contaminated. In the surroundings farther off the contents of the fish-ponds is reduced (see tab. 1).

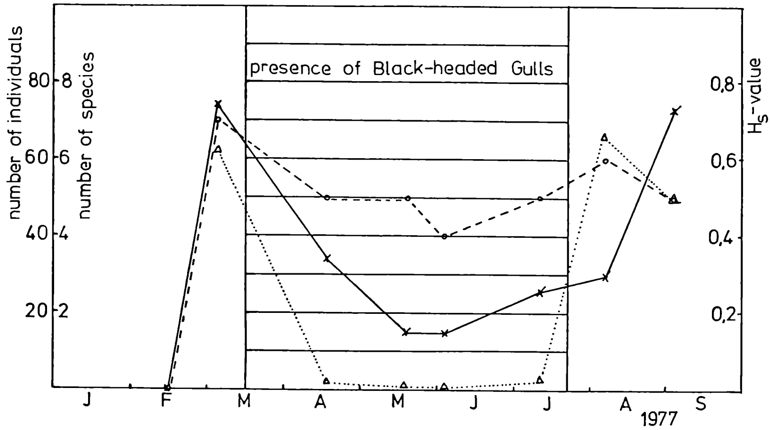

fig. 4: Development of the population of waterbirds in the course of a year
——— = number of individuals
– – – – = number of species
······· = H_s-value

Tab. 1: Development of the ecological balance in the radius of action of a colony of Black-headed Gulls in dependance on the phase of development of the population

area	phase of the colony of Black-headed Gulls: lag-phase	log-phase	static-phase
breeding-area			
Black-headed Gulls	0 ⟶ ca. 300	ca. 500 ⟶ 4000	ca. 4500
birds			
diversity of species	high	reduced	little
characterization	almost undisturbed trophic structure	displacement of rivals and enemies	monoculture of Black-headed Gulls
lake			
household	?	?	eutrophic
plankton	?	?	many blue algae
closer surroundings (up to 2 km)			
Black-headed Gulls	rarely frequent occurence	brood and food branch colonies = migration from the place	
fields and grass-land	not influenced	reduced population of lumbricids in productive regions, contaminated hay	
waters	not influenced	stock of fish in productive waters endangered	
wider surroundings (up to 12 km)			
Black-headed Gulls	missing	rarely frequent occurence	rarely frequent; brood branch colonies (migration)
areas of land	not influenced	not influenced	not influenced
waters	not influenced	not influenced	stock of fish in productive waters endangered

3.22 Development in the range of the population during different phases of development

In correlation to the phases of development of the population characteristic changes of the ecological balance turned out in the radius of action of the gulls (tab. 1).

In the lag-phase of the population there was an ecological balance in its spreading-area. All trophic levels and ecological niches were occupied. Stability prevailed because of the connections in the food relations. It was characterized by diversity of species and partly of space. As a result, there was a steady balance of the antagonistic relations. Caused by anthropogenic factors and intensified by the group effect of the colony, the enemies of the Black-headed Gulls were displaced. This loss of the enemy-prey-relations must have affected the regulating mechanism. The eliminating of the less regulating rival relations led to complete instability. After abolishing these limiting factors the growth of the population was only subject to rivalry within the species, with optimum environment circumstances. However, this rivalry began not before there was a considerable greater number of Black-headed Gulls. As a result, it came to an exponential growth up to the static phase. Here the variety of species decreased.

In the static phase the spreading area of the Black-headed Gulls developed from an area of latency to an area of damage. As enemies the Black-headed Gulls are very active and adaptable. A functional reverse reaction towards different kinds of prey (e.g. from lumbricid to fish) is no problem for them, and in productive regions they easily get prey. The process of rivalry within the species, however, only partly follows rules. Numerous interferences occur, and perhaps only migration from the place can abolish the danger of a breakdown of the population.

4. Discussion

The specifications made until 1975 (fig. 1, tab. 1) are not substantiated by scientific research. The results, however, can be considered as secured because they are logical within themselves and date from amateurs interested in biology (commissioner for wildlife preservation (SPONHOLZ 1963), farmers, farmers in charge of the lake, hunters). There were no contradictions in the different inquiries.

In some colonies after a short period of development of 4 up to 12 years the population broke down (REICHHOLF 1975, SCHMIDTKE 1975). In addition to a probably missing biocenotic balance the breakdown was caused by the fact that, influenced by the population of Black-headed Gulls, the limit of capacity was lowered. Conditions were different on lake Egglburg. K, i.e. the number of breeding-grounds, remained and remains constant there. Rivalry within the species is a limiting factor and migration is an additional outlet (fig. 2). So a short-turned breakdown cannot be expected with certainty.

On the other hand, the steps taken to reduce the number of gulls are not necessarily successful, because a migration to the place from adjacent colonies is possible.

The outlined regulation of population density (fig. 2) only applies to the log- and the static-phase. In the lag-phase other mechanisms like opposition and rivalry became valid.

The radius of action of the colony (fig. 3) is plainly smaller than the limit values of 20 to 30 km quoted by CREUTZ (1963) and REICHHOLF (1975). Consequently, the providing of food is unlike to be noticeable as clearly limiting factor for the growth and survival of the population yet. The development in the breeding-area in the course of a year (fig. 4) proceeded, on principle, in 1977 as in 1976. Differences in the household of the lake are caused by a concentration of all matters during the period of extreme dryness in 1976.

As without biocenotic regulation mechanisms a self-regulation only takes place on a level on which gulls affect both natural and productive ecosystems (tab. 1), interventions are necessary if there is no breakdown of the population. The number of Black-headed Gulls must be reduced until the biocenotic regulation is effective again or/and there will be a coexistence with the other species.

5. Summary

In the foot-hills of the Bavarian Alps research was done into a population of Black-headed Gulls (*Larus ridibundus* L.) and its effects on the ecological balance.

The population developed according to a logistic curve. In the lag-phase opposition and partly rivalry had a limiting effect, in the static-phase the breeding grounds and available food. The capacity is about 4 500 - 5 000 birds.

In the log- and static-phase the population is regulated by elements dependig on population density. Rivalry within the species for the breeding grounds available is a regulator. Cold in the area of hibernation could be proved as a disturbing factor.

The actual radius of action of the population is 7 km, the largest possible is 16 km. The attempt to establish brood and food branch colonies was observed.

Whereas in the lag-phase there was an ecological balance in the sphere of existence of the population, the disturbance was increasingly intensive and extended in space in the log- and static-phase.

In these phases the population disturbs the ecological balance in the natural ecosystem of the breeding-area (displacement of the water birds, eutrophic lake) and in the productive ecosystems of the environment (e.g. lumbricid population in the fields and the contents of the fishponds).

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