Factors affecting occurrence and size of breeding colonies, and reproductive success of the grey heron *Ardea cinerea* in Poland

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Introduction

The grey heron *Ardea cinerea* is a colonially breeding waterbird. This species is generally associated with aquatic ecosystems, however, as an opportunistic predator it may explore various habitats. Its diet consists mainly of fish but is supplemented by other prey, like small mammals, amphibians, reptiles and aquatic insects. Considering the food and habitat preferences of this species, the relationships between the availability of aquatic and inland habitats, and breeding ecology may be expected. The availability of habitats often affects colony size and reproductive success of waterbirds. The strength and character of this relationship may be scale-dependent because of different requirements of birds at nesting and foraging grounds, and varied availability of particular habitats at the regional and local scale.

Aims

The aim of this study was to analyse the habitat factors affecting occurrence of the grey heron, colony re-occupation probability, the size (number of nests) and changes in the number of nests in heronry, as well as breeding losses and spatial distribution of nests in heronry, and productivity in different spatial scales around the colonies. I also aimed to test which spatial scale is the best to explain the relationship between landscape features and productivity in this species. Additionally, my own method of data collection on the number of chicks in nests has been tested in the field.

Methods

To investigate the relationships between re-occupation, size and changes in the number of nests in heronries, productivity of the grey heron, and landscape features, I used GIS data (Corine Land Cover model and hydrographic network). I considered the following habitat factors: presence/area of aquatic habitats [rivers/canals, water bodies (lakes and fish ponds), inland marshes and sea], and inland habitats (forests, pastures, non-irrigated arable lands, agriculture areas, urbanized zones), heterogeneity of habitats (the number of patches of particular type of habitat), microscale variables (distance between the colony and the nearest river, water body, road, building, sea). In one of my papers, I also included fish ponds

characteristics, i.e. main cultivated species of fish, total pond surface area, type of water supply (springs, rainwater, river, lake), distance between pond and buildings and methods of protection from piscivorous species (overhead wires/lines covering the water surface, fencing the fish pond with concrete and/or wire fence, scaring (blanc firing pistols, firecrackers, hunting/killing, all methods combined or lack of protection)]. I also collected data about the grey heron colony size and productivity in the field. To analyse temporal changes in heronry size, I used historical data available in the literature.

Results and discussion

Factors affecting the presence of the grey heron at fish ponds in western Poland

The presence of piscivorous vertebrates at fish ponds, in that the grey heron, often ignites conflicts over fish resources managed by humans [1]. In this study, 104 fish farms in western Poland have been surveyed by telephone. The grey heron was the second, most commonly reported species (on 83% of the studied farms). It was observed most frequently at carp ponds, in all seasons throughout the year [the grey heron was presence during the breeding season (due to elevated energy requirements during reproduction) and during spring and autumn migration (stopover sites during migration) and in winter (wintering quarter)]. Carp ponds were preferred by this species as they offer abundant food supplies with a higher fish density compared to natural water bodies. In addition, this type of ponds are shallow, making fish easy to catch, particularly for herons which mainly forage in the shallow water zone. Additionally, carp ponds are usually characterized by a large area of open water surface and are not fenced and guarded. However, these features as well as the proximity of buildings were not important for this species [1].

The impact of the proximity of buildings on the spatial distribution and functioning of heronry in a suburban village

I documented a negative impact of human activity (pedestrian traffic, work of machines, close proximity to buildings) on the spatial nest distribution and reproductive success in the breeding colony in a suburban village in northern Poland [2]. I divided heronry into six sections located at different distances to the nearest buildings. I recorded the latest hatching date (one month later than in the other sections), the highest eggs' and fledglings' losses, and also the lowest occupancy of available nests in a section characterized by the highest proportion of the area covered by buildings within 200 m radius from the studied section,

frequent human presence (footprints, rubbish), the smallest area of wet ground and with adjacent paved pathway. Additionally, nests in this section were not occupied by the birds in the following seasons (in the past this section served as the main part of the colony). Higher reproductive parameters were recorded in another section adjoined by the build-up area. However, this section was located on wet ground, and a fence and a deep canal were effective barriers against human intrusion. At the colony scale, egg losses were not significantly related to the distances to the nearest buildings or roads. This suggests that direct human activity was more important than the proximity of buildings (i.e., pedestrian traffic within the colony, regular work of machines nearby). I reported also small decrease in the number of occupied nests (2.8%) in the studied colony between 2009 and 2012. Birds did not re-occupy sections regularly penetrated by humans and built new nests in the previously unoccupied sections (with wet ground and situated away from buildings). This suggest that the grey heron may respond to human disturbance without negative consequences for the population size by shifting to breeding in other sections or to more distant heronries in the following seasons [2].

Factors affecting size, re-occupation and the changes in the number of nests in heronries in northern Poland

For 28 grey heron breeding colonies in northern Poland, I analysed factors influencing re-occupation, colony size (the number of nests) and changes in the number of nests between 2004 and 2013. I analysed landscape features within a radius of 20 km around the colony [3], i.e., corresponding to the average distance of flight foraging trips for this species. Among 28 colonies occupied in 2004, 12 (43%) were re-occupied in 2013. Re-occupied colonies were characterized by a low number of pastures, lower area of water body shoreline zone and larger area of seacoast zone. There were no unoccupied colonies in the coastline zone within 20 km radius around the heronry. Larger colonies (>50 nests) were located in the areas with smaller number of forest patches (>60 ha). The number of nests increased between 2004 and 2013 in the colonies with greater areas of forest, greater number of water bodies, shorter distance to the rivers and longer distance to the sea. Both water bodies and rivers/canals serve as optimal foraging areas to herons. Positive relationship with forest area suggests that grey herons prefer compact forest patches creating wide buffer zones against human disturbance. Increase in the number of nests in re-occupied colonies was higher in the colonies situated further from the seacoast. It seems to contradict the positive effect of the area of seacoast zone on colony re-occupation and colony size. However, it may also indicate different demographic processes in coastal colonies, which are usually larger than inland ones. I found that the number of nests in

the colonies occupied in 2013 was higher in the heronries located at longer distance to the nearest road, and similarly longer distance to the nearest buildings was the best predictor of 28 colony re-occupation [3]. The proximity of those features results in excessive noise, intensive traffic of pedestrians and cars. Nesting in close proximity to humans not always affects waterbirds negatively; they may forage in human-altered parts of the landscape (e.g., at fish ponds). I recorded increase in the number of nests (119%) between 2004 and 2013 in the colony at Jawory situated in close proximity to the fish farm ponds (110 m).

The influence of habitat factors on the grey heron productivity in northern Poland

To investigate productivity of grey herons, I developed a method of indirect nest contents inspection that combined tree climbing and the use of a pole-mounted camcorder [4]. I tested this method on 77 nests in 5 heronries. Nests were situated on the trees at a height of 11–25 m. Thus, determining the exact number of nestlings from beneath nesting trees would be very difficult due to large diameter of the nests (to 1.2 m) and chicks often laying at the bottom of the nest. I found no significant effect of height or age of the inspected tree on recording time per individual nest. I did not record any visible reaction of nestlings to the presence of the climber manipulating the device, however I recorded visible reaction (i.e., threat postures and upright, forward and snap displays) among younger chicks (<4 weeks) to the close proximity of the camcorder. In older nestlings (≥4 weeks) I observed threat postures only occasionally. This method allows collecting data on the number of eggs and small chicks, presence of food or dead nestlings, i.e., data which are unavailable during the observation with binoculars or a telescope beneath the trees. Despite some limitations, our procedure is a good alternative to direct climbing to each individual nest. This method provides accurate data on the number of nestlings in nests [4]; moreover it reduces the duration of disturbance and the observer activity in the colony, and is safer for the climber as it prevents the risk of nestling attacks.

This method has been applied for collection of data used for the analysis of the relationship between habitat factors and productivity of the grey heron, (expressed as the number of 21-38 d old chicks per nest) in 6 breeding colonies in northern Poland in 2014 [5]. I analysed the relationships between landscape features and productivity of herons at four spatial scales around the colony: (1) close proximity of the colony (0–1 km), (2) closer foraging grounds (0–10 km), (3) far foraging grounds (10–20 km) and (4) far foraging grounds excluding close foraging areas and proximity of the colony (0–20 km) [5]. I did not find significant differences in the productivity among the colonies. At each spatial scale, except 10-20 km

radius, the grey heron productivity increased with increasing habitat heterogeneity and decreased with increasing length of rivers/canals and area of pastures. Several studies showed that greater habitat heterogeneity is associated with a greater variety of food. In the buffer of 0–10 km, the productivity increased with increasing area of water bodies, and in the buffer of 10–20 km with greater areas and higher number of urban zone patches (it may be unavoidable to breed in urbanized areas at this scale in the study area). In the buffer of 0–1 km the grey heron productivity increased with increasing area of agriculture lands. In 10–20 km buffer, it increased with increasing pasture patchiness. The productivity decreased with increasing length of river/canal banks and area of pastures in the buffer of 0–10 km. The greater areas of pasture around the colonies may reduce the area covered by optimal foraging areas (e.g. water bodies). Similarly, the changes in the number of nests in colonies were determined by the lower areas of pastures [3] and re-occupation in these colonies was determined by the lower number of pastures [3]. Probably grey herons avoid habitats considerably transformed by human activities (e.g. drained pastures and meadows). It may also be the result of competition with other species of birds, e.g. the white stork *Ciconia ciconia*, for which pastures serve as important foraging grounds. The highest number of significant relationships was recorded in 0–10 km radius around the colonies suggesting that this scale is most appropriate to explain the relationship between landscape features and productivity in grey herons [5]. The distance to the nearest river/canal banks was positively related to the grey heron productivity. Probably the length and area of water bodies might be more important for the grey heron than the rivers in the studied colonies. It may be explained by postglacial landscape characterized by the high number of lakes in the study area. We found that the productivity of grey herons increased with increasing distance to the roads and buildings [5]. Human disturbance may reduce breeding success due to scaring adult birds [exposure of eggs and/or chicks on various threats (chilling, predation from the air and falling chicks out of the nest)]. In this study, we did not find significant relationship between the productivity and colony size. Most probably, the size of the studied colonies does not exceed the food availability of foraging ground around colonies. I found significant differences in the grey heron productivity between the study sited and other colonies in Europe. In the colonies in south-western Poland, the productivity was significantly higher what may be attributed to their location at fish ponds. Heronries in France and Spain were characterized by significantly lower productivity what may be attributed to foraging in habitats with low food availability (e.g., rivers, irrigation canals).

Conclusions

My studies revealed that habitat heterogeneity and surface area of aquatic and inland habitats (both of natural and anthropogenic origin) are important factors affecting the presence of the grey heron, re-occupation of the same heronry in following seasons, spatial distribution of the nests in heronry, changes in the colony size, and finally the productivity of this species. Some of the studied parameters may be affected by other factors like predation, siblicide, population density, demographic processes, changes of climate and environment, and interspecific interaction, inter-individual transfer of information about the location of foraging grounds (colony as an 'information centre'), some processes in aquatic environments [e.g. eutrophication, decrease in the number and diversity of fish in rivers in central Poland and in the main lake districts (Masuria, Pomerania, Greater Poland)], weather conditions, age of parent birds or location of nest within the colony (in the centre or on periphery). Presence of human may also affect grey herons, both negatively (disturbance, modifications of the landscape), and positively [additional food source (fish ponds) or anti-predatory function of urbanized zones (scaring potential predators)]. The knowledge of relationship of landscape feature and feeding and breeding ecology in grey herons is crucial for effective planning of the species management and reducing conflict with farm owners without the risk of drastic population reduction. Despite limitation of our studies, observed desertion of 57% of the studied colonies and general decline in the size of re-occupied colonies (–59%) suggest decline in the local breeding population of the grey heron. At some locations, abrupt decline in the number of the grey heron nests and/or their abandonment may be attributed to the human activities (disturbance, i.e. scaring, shooting birds on fish ponds [1], destruction of nests, regular pedestrian traffic and machine noise in proximity to the colony [2]). In conclusion, this study has filled an evident gap in the knowledge about the relationship between the studied aspects of the grey heron ecology and landscape features.

References:

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