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SPATIAL PATTERNS OF BIRD MOVEMENTS ON AND AROUND AN AIRPORT, A CASE STUDY ON EINDHOVEN AIRPORT - EXTRA DIMENSIONS FROM THE PANORAMA-SCAN

M.J.M. Poot[1], R. Lensink[1], I. Tulp[1], J. van der Winden[1], S. Dirksen[1], A. de Hoon[2] & L.S. Buurma[2]
[1]Bureau Waardenburg bv,
P.O. Box 365, 4100 AJ Culemborg, The Netherlands
Email: M.J.M.Poot@buwa.nl
[2]Royal Netherlands Air Force, Support Operations Branch,
Nature Management and Ecotechnology Section, P.O. Box 20703,
2500 ES The Hague, The Netherlands

Abstract

In commission of the Royal Netherlands Air Force and the City of Eindhoven we registered the number of birds aloft on Eindhoven Airport between August 1998 and July 1999 by visual techniques using binoculars. Observations were conducted during four days each month and lasted the full daylight period. Two methods were used: observations in a fixed volume covering a part of the runway and bordering fields (fixed volume count) and observations in a radar-like way covering a much larger volume consisting of the total airport and surrounding landscape (horizon-scan). The focus of this paper is on the second technique.
Since the risk of bird strike is highest during take off and landing (i.e. the lower air layers), it is important to know the density and species composition of birds that are flying near and over runways. Questions from the perspective of bird strike risk and bird control are whether the numbers and species composition of birds flying over the runways show a relation with the surrounding landscape of the airport and whether bird flight routes occur in relation to landscape structures. Eindhoven Airport has an open landscape and is located in a forested area in the southeast of The Netherlands.
As the panorama-scan covers a much wider area than the single runway of Eindhoven Airport (as in the case of the fixed volume scan) this visual technique gives the opportunity to compare and relate the numbers of birds aloft above as well as around the airport. In this paper we show that with this technique, besides reliable information on densities of birds aloft, at the same time detailed spatial and flight direction information is gathered which makes it

possible to interpret the estimates of densities of birds aloft in an ecological context.

Key Words*:* Visual detection, Local movements, Risk assessment, Migration, Bird density, Bird strike, Aircraft, Collision risk

Introduction

In order to estimate absolute instantaneous densities of birds aloft (expressed in numbers/km^3 or in biomass/km^3) two visual techniques, conducted with binoculars by field observers, were developed and applied at Eindhoven Airport; the fixed volume scan and the panorama-scan. The focus of this paper is on the second technique, the panorama-scan. The principle of the panorama-scan is to record flying birds with binoculars in a fixed position in a full circle around an observer. The rationale, methods and results of the fixed volume scan are presented in more detail in Lensink ***et al***. (2000a).

With the available techniques it is possible to describe the patterns of densities of birds aloft during a year, during the day and for different species of birds on and around an airport as a first estimation of potential bird strike risks. Moreover, the obtained measurements of absolute densities of birds aloft can be used in the study of actual bird strike risks with aeroplanes to obtain more reliable estimates.

Although the first aim of the panorama-scan is to estimate densities of birds aloft, this is not the topic of this paper. Besides measurements of absolute densities the data collected during the panorama-scan allow a more detailed analysis of species-specific flight patterns. For a quick view on results of absolute estimates of bird densities aloft in numbers and biomass gathered by the panorama-scan we refer to the poster presentation of Poot ***et al.*** (2000), where densities of birds aloft are compared for two different locations in the Netherlands (Eindhoven Airport and a coastal location).

As the panorama-scan covers a much wider area than the single runway of Eindhoven Airport (as in the case of the fixed volume scan) this visual technique gives the opportunity to compare and relate the numbers of birds aloft above as well as around the airport. In this paper we will show that with this technique, besides reliable information on densities of birds aloft, at the same time detailed spatial and flight direction information is gathered which makes it possible to interpret the estimates of densities of birds aloft in an ecological context. As a consequence this offers different kinds of opportunities to apply the presented standardised techniques in the field of estimating and monitoring the densities of numbers of birds aloft on different airports and other (potential) airport locations, as will be outlined in the conclusions.

Methods

Study site and period

The study was conducted between August 1998 and July 1999 at Eindhoven Airport, The Netherlands. Eindhoven Airport is located in the south of the Netherlands, 5 km west of the city of Eindhoven, and c. 100 km inland (5º23' E, 51º27' N) (figure 1). Most of the area is characterised by a mixed agricultural/forest landscape. In the schematic figure of the area of Eindhoven Airport the main forest complexes are indicated, as well as the runway and a canal (figure 2).

Panorama-scans were conducted during two successive full daylight periods, every two weeks. Every clock hour in alteration of the two fixed volume scans, two panorama-scans of approximately 10 minutes each were carried out.

Figure 1. Location of Eindhoven Airport in The Netherlands

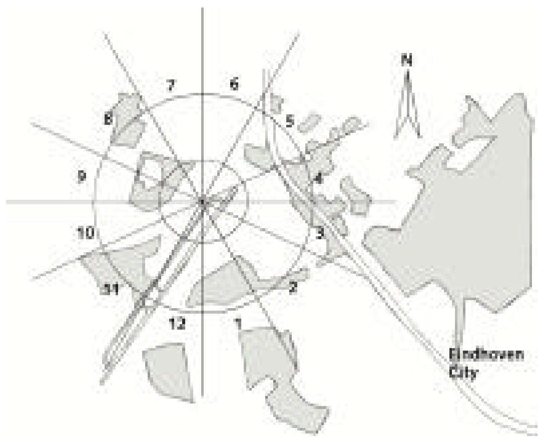

Figure 2. The coverage of the panorama-scan, the 12 segments of 30° and the boundaries of the distance classes at 500 and 1500 meter. Shaded areas are forest complexes. Also the runway and a canal is indicated.

Set up

Panorama-scans were carried out on a hill top, 15 m above ground level, just beside the runway. A pair of binoculars (10x42) was mounted on a tripod. The observer slowly moved around his axis and recorded every flock of birds flying in sight per segment of 30° (12 segments in total, see figure 2). The observer was connected with an open telephone line with a secretary, who also coached the observer concerning the observation time spent per segment. Actually this was the observer of the fixed volume scan, who was positioned in the traffic tower.

The panorama-scan was conducted in two binocular positions; one with the horizon halfway the view (level 1) and one with the horizon at the lower edge of the glass (level 2). Observations in level 1 and 2 partly overlapped. For a schematic figure of the method see Lensink ***et al.*** (2000b).

Recorded information

For every flock of birds seen, species, number in flock, distance (in three classes; 0-500m, 500-1,500m, >1,500m), flying altitude (in six classes) and behaviour (see below) was registered. With corrections, data up to 1500 meter can be used to estimate absolute densities, at further distances smaller birds will be mostly missed (Lensink ***et al.*** 2000c).

Directions of bird movements were estimated in four directions relative to the observer; towards the observer, from the observer, to the left and to the right. Besides these directions other categories were used for non-directive flight movements as hovering (e.g. Kestrel ***Falco tinnunculus***), circling (e.g. Buzzard ***Buteo buteo***, gulls ***Larus sp.***), display flights (e.g. Skylark ***Alauda arvensis***), landing etc.

In this paper only observations above 'treelevel' were used, which were selected on basis of the height classes in the database. In the presentations of flight directions per segment corrections were carried out for the area of horizon searched for the different distance classes.

Observational limitations

In this place we want to make a remark on the high demand which is put on observers as they must be able to record several observations at the same moment while conducting the panorama-scan. When a flock of birds is spotted, observers need to be able to recognise the bird species, and at the same time estimate the number, flight direction, distance and height. This means that in order to get reliable results, it is important to work with experienced observers. In the study of Eindhoven and in IJmuiden (Poot ***et al.*** 2000) this condition was met. As the same group of experienced observers conducted the bird scans on both locations these results can be compared directly. Nevertheless inter-observer effects and effects of weather conditions (visibility) occur, but these are limited within the 1,500 meter radius and can be corrected for (see for an elaborate analysis Lensink ***et al.*** 2000c).

Results

In this section some examples are presented as illustrations of different patterns of bird movements and their ecological context at Eindhoven Airport in August 1998 - July 1999. The arrows in the figures are based on absolute numbers. In the legends of these figures the total number of recorded birds (n) and the maximum number of the largest arrow (max) are indicated.

Lapwing flight movements as a first example

In figure 3 Lapwing ***Vanellus vanellus*** flight movements are presented during autumn on and around Eindhoven Airport. In the panorama-scan flight directions are categorised according to four directions relative to the observer.

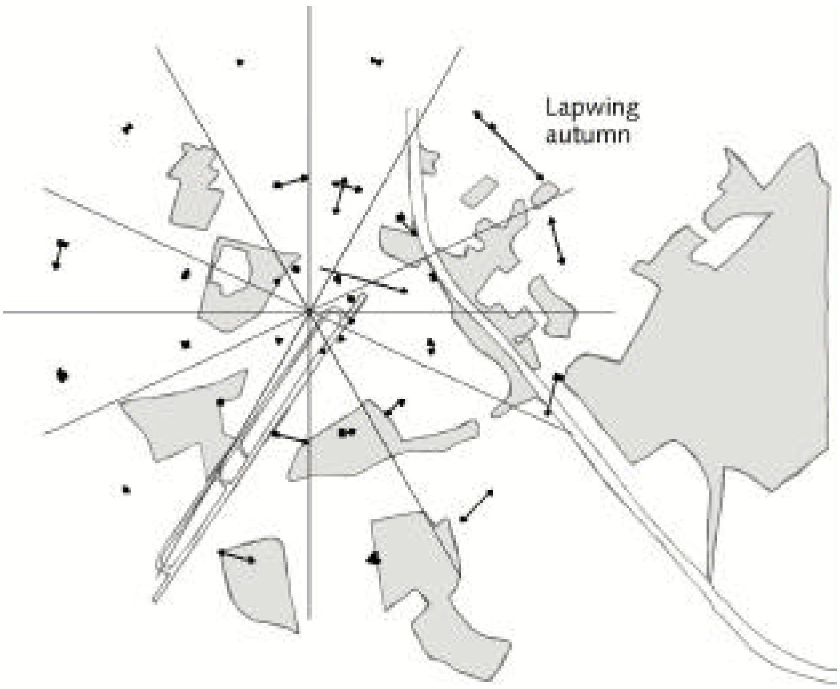

Figure 3. Lapwing flight movements during autumn above and around Eindhoven Airport (n=4,604, max=677). Flight directions are categorised according four directions relative to the observer.

In segment 6 in distance class 500 - 1,500 meter (see figure 2) most diverse flight movements were recorded in all four categories; left, right, towards observer and from observer. This pattern is explained by regular flight movements to and from an attractive moist spot in the Northeast area of the airport and between surrounding agricultural land outside the airport. This area was visited regularly by the bird control unit chasing Lapwings away.
As the observers move follow the horizon with their binoculars, observers tend to overestimate bird flight directions to the left and right. Especially in the distance class further than 1,500 meter this artefact occurs. Despite this, clear patterns of flight routes are recorded in a systematic way with this technique, as will be shown later in the other species.
In recent history the airport was much more attractive for Lapwings, but due to 'poor long grass' policy (Dekker 2000) and active bird control, nowadays only marginal numbers frequent the airport during the day. As figure 3 shows most flight movements occur outside the airport area, where birds find foraging and resting areas where they are not disturbed. During the night when the airport is closed and no active bird control takes place the birds come to the grasslands of the airport again to forage (own observations).

Chaffinch migration in autumn; an example of flight movements avoiding the runway

In autumn strong migration of Chaffinch ***Fringilla coelebs*** can occur in The Netherlands. Mainly birds of Scandinavian origin migrate in large numbers in this period to their wintering grounds in the British isles and South-western Europe (Speek & Speek 1984). Especially during headwinds in October strong concentrated migration can occur in the lower air layers. During peak migration Chaffinches fly in flocks up to several tens of individuals and can be a potential risk for especially fast-flying military aircraft.
During several days in October and November 1998 migration of finches was recorded. As figure 4 shows only very few individuals were seen crossing the runway, while largest numbers of birds were recorded in the segments of the panorama-scan outside the runway area. This is an indication that, although some birds were seen crossing the runway, the main stream of migrating birds avoid the open space in which this small forest species could be extra vulnerable to predation by raptors. Another reason for the pattern found is that low flying migrating birds tend to follow their ecologically preferred habitat in order to have a constant look-out for spots rich in food and safety for a stop-over. In case of the treeseed-eating Chaffinch, the birds follow treelines and forests while migrating.

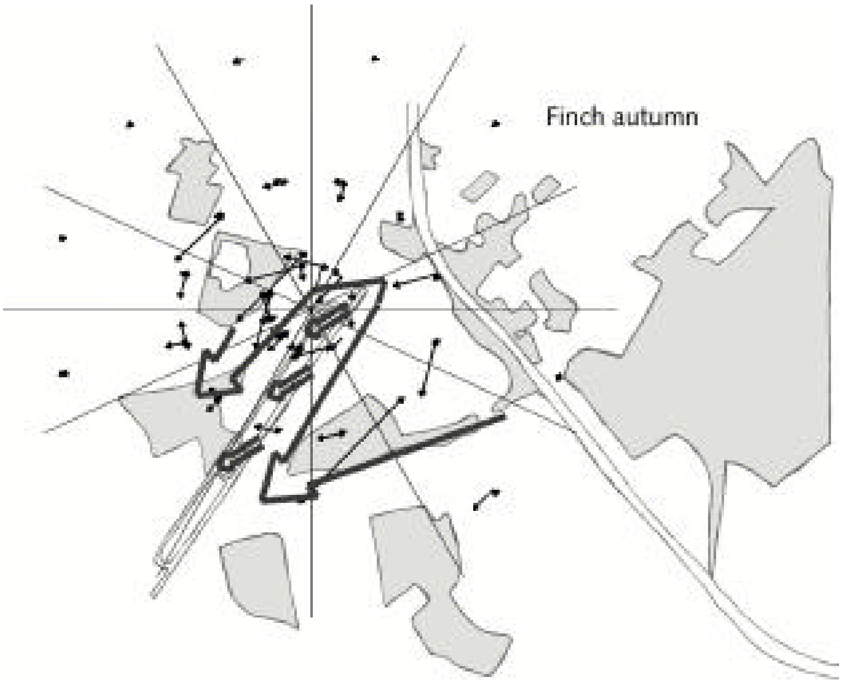

Figure 4. Chaffinch flight movements during autumn above and around Eindhoven Airport (n=1,800, max=301). Main flight paths in the direct vicinity of the runway are interpreted and summarised by schematic arrows, also based on observations outside the panorama-scan.

Stock Dove flight patterns as an example of seasonal effects

The Stock Dove ***Columba oenas*** is an example of a species showing a clear seasonal effect in hazardous behaviour. During winter the birds generally avoid the airport area as not much food is available. The birds concentrate at arable land where harvest leftovers form their bulk food. In winter 1998/1999 a maize field in the close vicinity of the airport just north of the runway was not harvested and generated more bird movements over the runway than normal (figure 5). Still, the number of potentially risky crossings and local flight movements of Stock Doves over and near the runway are marginal in comparison to the summer period (figure 6). Then Stock Doves frequently feed on the airport grasslands, where cloverseed is the main food source. Important to note is that the numbers of birds present in the area on and around the airport are very similar in both seasons. The difference between the spatial patterns of winter and summer are caused by the a different behaviour only.

Figure 5. Stock Dove flight movements during winter above and around Eindhoven Airport (n=600, max=168).

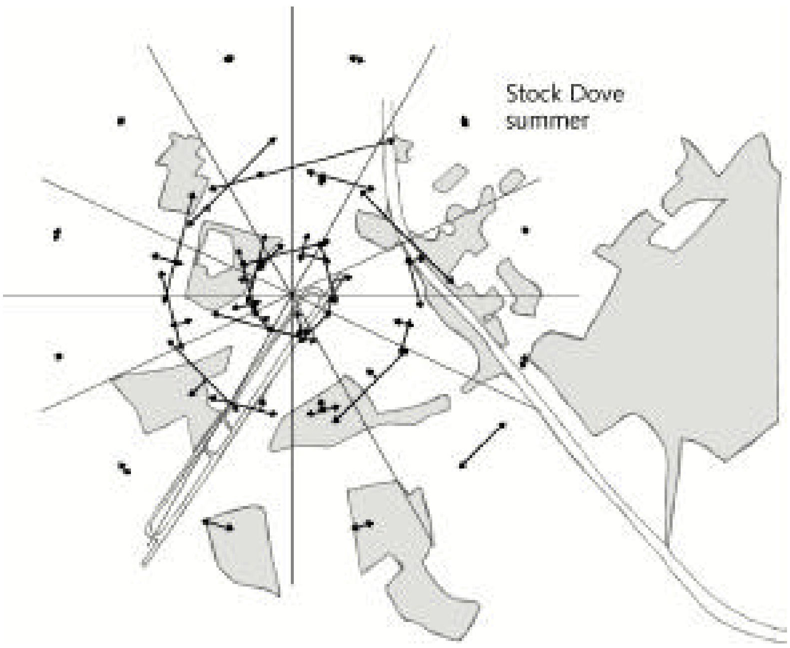

Figure 6. Stock Dove flight movements during summer above and around Eindhoven Airport (n=815, max=58).

Roost migration of gulls in the morning; an example of a hazardous flight movement

During January 1999 a period with intense rainfall occurred. This generated large areas of moist agricultural land west of the airport, but also the grasslands on the airport itself were wetter than normal, which meant an increased food availability for gulls and also other birds (Lapwing, Starling). In wet circumstances worms and other evertebrates become more accessible in the soft soil for the birds. This had strong consequences for the number of gulls crossing the runway, as the typical concentrated flight paths of gulls in the morning from their night roost were directly located over the airport (in the region of Eindhoven Airport mainly Black-headed ***Larus ridibundus*** and Mew Gulls ***L. canus*** occur) (see for this case also de Hoon & Buurma (2000)). In this period the bird control unit had a hard time to scare landing birds off the wet spots on the airport itself, but they could not influence the main stream of birds flying over the airport.

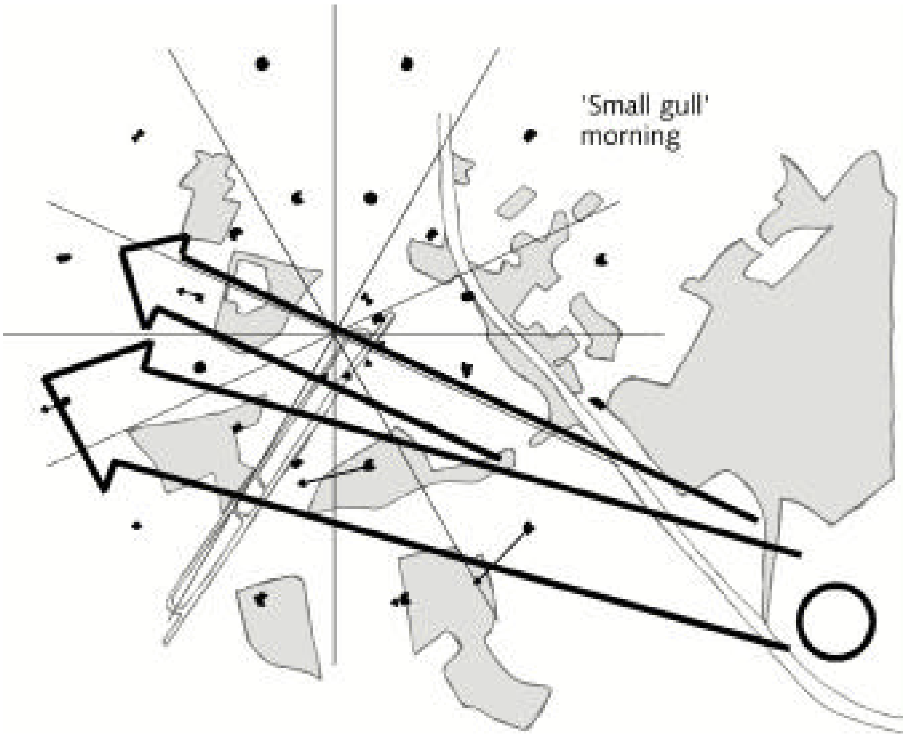

Figure 7. Gull (Black-headed and Mew) flight movements in the morning above and around Eindhoven Airport (n=2,475, max=676). Main flight paths above the airport are interpreted and summarised by schematic arrows, also based on observations outside the panorama-scan.

Conclusions

In this paper we have shown that with the use of the panorama-scan, it is not only possible to assess in a quick and direct way absolute densities of birds aloft within a 1,500 meter radius in the lower air layers (see other publications; Lensink ***et al.*** 2000a,c, Poot ***et al.*** 2000). The technique of the panorama-scan also gives the possibility, with the recorded additional details, to interpret the patterns found in the birds aloft in an ecological dimension. We believe that the panorama-scan, especially in combination with the fixed volume scan, is a powerful and useful tool to estimate, monitor and evaluate the numbers of birds aloft in a standardised way.

The power of the available techniques is determined by the accurate information on species composition, in combination with the spatial and directional information of the flight movements of the recorded birds aloft. The presented techniques are therefore also very useful to evaluate measures taken to minimise bird strike risks on and outside airports (vegetation policy, bird control, etc.) or to monitor unfavourable developments in relation to potential bird strike risks in the vicinity of an airport, the reason these techniques originally were developed and applied for. Moreover, the techniques seem also very useful in comparing different locations, for instance potential airport locations with existing locations (Poot ***et al.*** 2000), in order to estimate potential bird strike risks beforehand.

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