MONITORING AVIAN MOVEMENT USING BIRD DETECTION RADAR; IMPACTS OF NOCTURNAL MOVEMENT ON FLIGHT SAFETY AT A MILITARY AERODROME.

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Abstract

Spatial patterns of avian movement and their impacts on flight safety on a local scale are often poorly understood. Birdstrike statistics conclude that the majority of incidents occur on or around an aerodrome. Monitoring movements of birds both on, and around an aerodrome, can therefore provide significant insights into off-airfield flight safety hazards. These can then be identified, and efforts made to eliminate or reduce the risk associated with these sites through the safeguarding process.

Daylight movements were monitored and assessed using traditional visual techniques at Cotswold water park and RAF Fairford near Gloucester, England during March and December 2004. RAF Fairford is used by the United States Air Force (USAF) as a forward deployment base for American operations in Europe. Bird detection radar using x-band vertical and s-band horizontal scanning was implemented in parallel over two continuous five day periods to contrast diurnal movements, flightline directions and provide altitudinal measurements. Significant differences in the movements of birds were recorded depending on both time of day and species observed. Changes in the altitude at which birds fly at the local level could have significant impacts on birdstrike risks.

Monitoring using multiple techniques allows the hazards from particular sites to be identified, the risks they present determined and techniques applied to help meet the new ICAO standards for off-airfield bird management.

Introduction

Radar has been used for the detection, monitoring and quantification of bird movements in the atmosphere since the 1960s (Eastwood, 1967; Gauthereaux & Belser, 2003). It has the advantage of operating consistently in both daylight and darkness, and of detecting bird movements over large areas.

The diurnal and nocturnal localized movements of birds such as diving duck (*Athya* sp.), dabbling duck (*Anas* sp.), grey heron (*Ardea cinerea*), grey geese (*Anser* sp.), waders (*Charadriidae* sp.) and gulls (*Laridae* sp.) exploiting wetland environments are poorly understood in ornithology. Studies that have been undertaken in the UK have used the standard ornithological point count, transect or synchronised point count methods predominantly during diurnal periods.

This radar study was therefore undertaken to better understand the behaviour and spatial extent of bird movements around a military airfield encompassed by a wetland environment during both day and night. This research was undertaken around a complex of former minerals extractions (Cotswold Water Park) to assess the impact of waterfowl movements on flight safety at RAF Fairford.

Methods

- The CSL Bird Detection Radar was stationed at RAF Fairford for two five-day periods during 01-05.03.2004 (86hrs) and 20-24.12.2004 (70hrs).

- During these periods the radar unit ran continuously from stand 37 (Global Positioning System – GPS elevation 244ft North 51° 40. 793', West 001° 46. 854') at RAF Fairford with good coverage across the surrounding landscape.
- The S-band radar was operated at the 6NM/11.1km range setting.
- This position gave excellent all-round clearance for the propagation of the radar signal. There was no obstruction to the signal for a minimum of 200m.
- Simultaneous to operating the radar unit we conducted ornithological truthing in the form of vantage point surveys of bird movements in the vicinity of the aerodrome. These standard ornithological monitoring methods allowed us to identify species-specific movements simultaneous to being detected by the radar unit.
- The main aim was to identifying the proportion of avian activity associated in broad terms with nocturnal activity and particular those movements associated with water body features within the area surrounding RAF Fairford. This analysis of bird movement data recorded using radar was conducted within ArcMap Geographic Information System (GIS).
- An additional buffer of 250m was applied to allow for the fact that the first point at which the radar could detect avian movement in some areas close to water bodies may not have been directly overhead due to the shielding of landscape clutter.
- Therefore the areas selected for inclusion in this analysis were areas with high levels of radar detection available throughout the two study periods. The water bodies included in the analysis are therefore highlighted in red shown in Figure 2.

Results

- The Bird Detection Radar detected 24755 movements in March (86hrs) and 18635 in December (70hrs) (Figure 1).
- In March 41% of bird radar movements across the total area were during darkness and in December 50% of bird radar movements were during darkness.
- Within the 11.1km radar sweep (380km²) all bodies of water were identified using the Ordinance Survey 1:50000-raster coverage (excluding rivers and streams). This equates to approximately 662.04ha (6.62 km²) of open water within 11.1km of RAF Fairford (Figure 2).
- These water bodies therefore in terms of area constitute 1.74% of the land surface of the 11.1km radar sweep.
- However the contour topography of the environment prevented significant radar coverage to the west-southwest towards the area known as Cotswold Water Park (West).
- The 50 water bodies of Cotswold Water Park East (CWPE) shown in red constitute a total area of 3.03km² with a mean water body size of 0.06km² and a maximum size of 0.48km².
- These water bodies used in the analysis constitute approximately 0.92% of the habitat/land surface covered by the radar sweep in which detection of bird targets were recorded.
- Therefore during March and December 2004 approximately <1% of the habitat contributed 9.2% (2385 tracks) and 11.4% (2217 tracks) of the total bird tracks detected (Figure 3 and 4). These bird movement tracks were associated with water bodies either by being identified within them, originating from them or flying to them.
- The connectivity of these water bodies in terms of avian flights was also examined. These provided some interesting initial findings in respect of the scale of movements, connecting one water body to another, movements out of or into a water body and flights within a particular water body.
- These data indicated that 24% of bird movements were within lake. Approximately 6.4 - 8.6% of bird movements connected different water bodies. The bulk of all movements indicated movements into or away from individual water bodies (67 - 68%).
- Within the data lake zero a single water body to the east of the main runway accounts for 25% of all bird movements recorded by S-band radar in the sweep.
- However within these data from radar tracking with the S-band radar, low-level flight movements will be under recorded and also landscape clutter features will mask some bird movements.

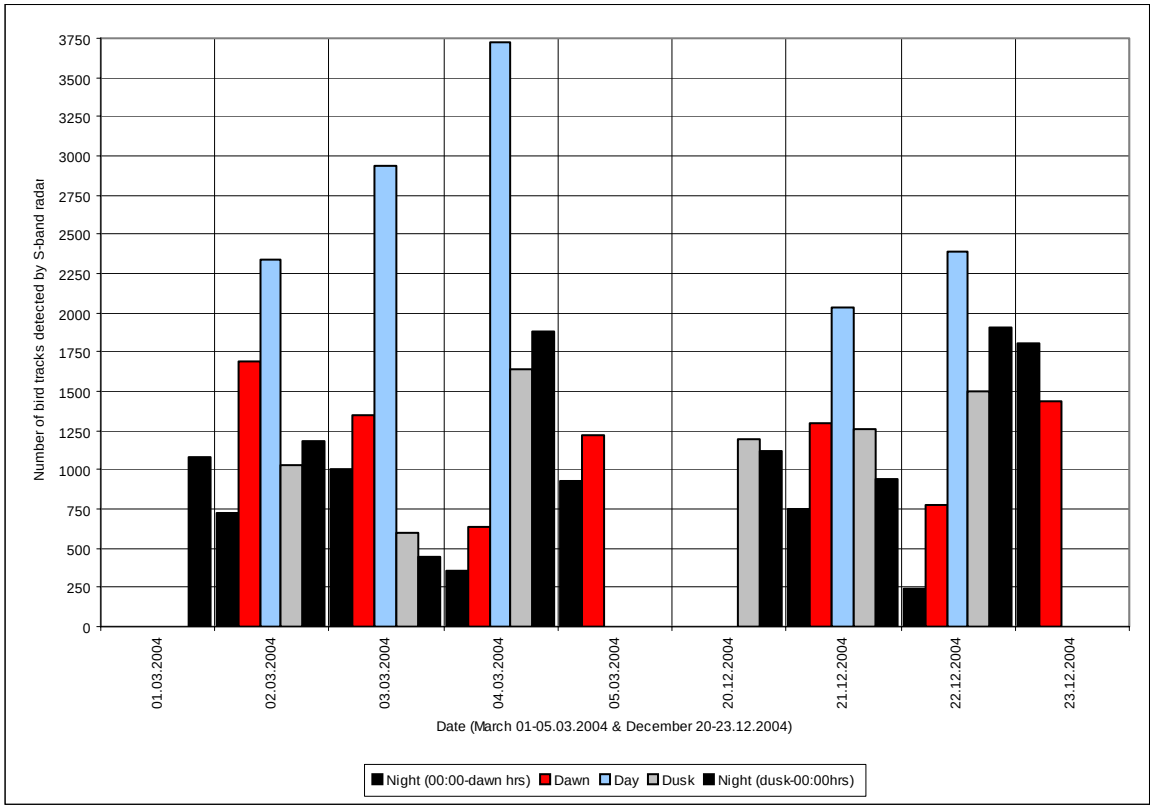

Figure 1. *Bird activity detected by S-band radar at RAF Fairford during March and December 2004.*

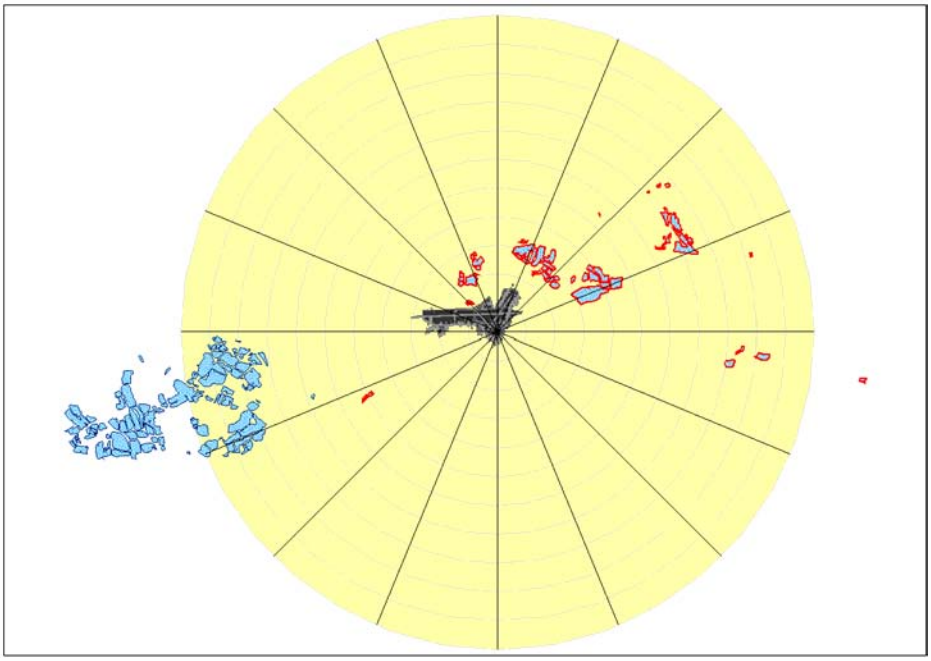

Figure 2. *The black and grey shape in the centre of the figure depicts RAF Fairford. The yellow circle displays the Bird Detection Radar S-band sweep from RAF Fairford, which is divided up by 1km range rings. The water bodies within the radar sweep are depicted in blue. The water bodies bordered in red are those used in the analysis of bird radar data.*

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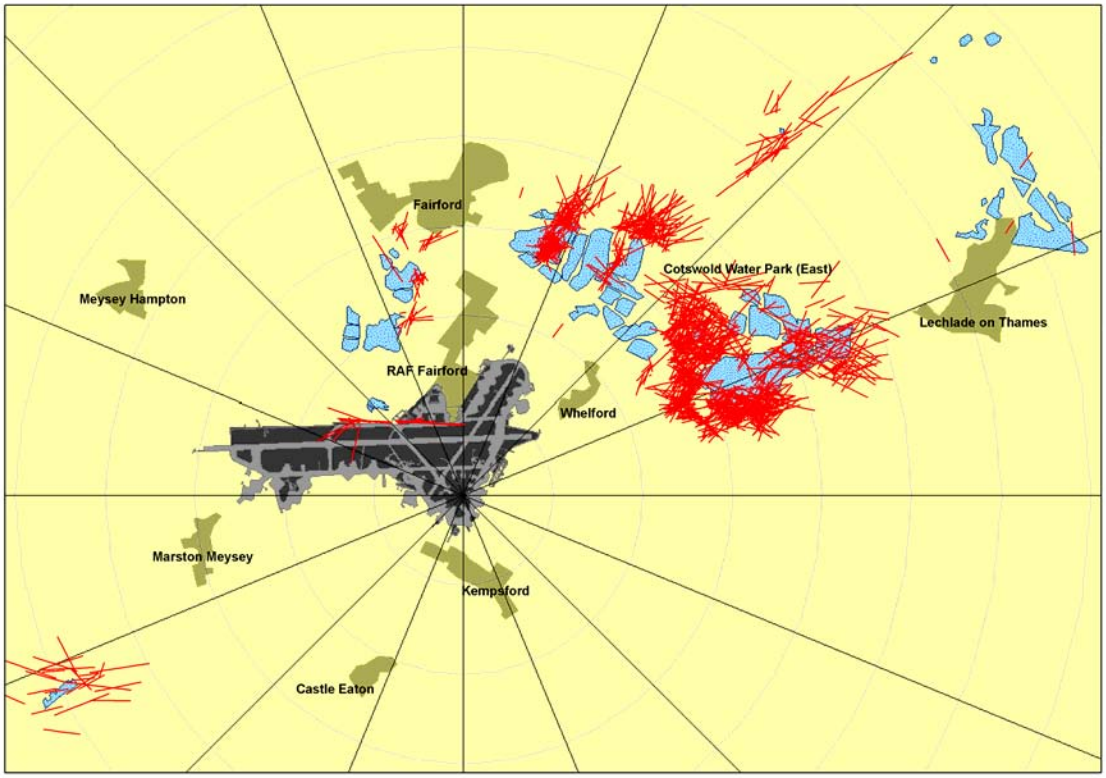


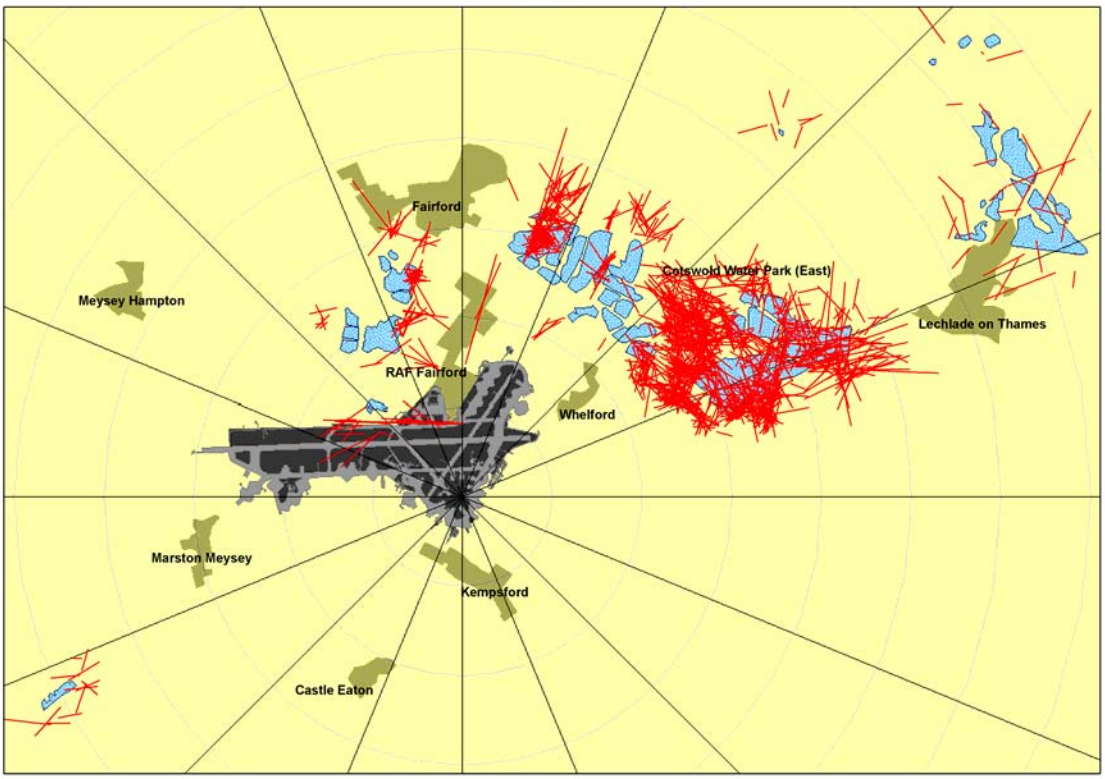
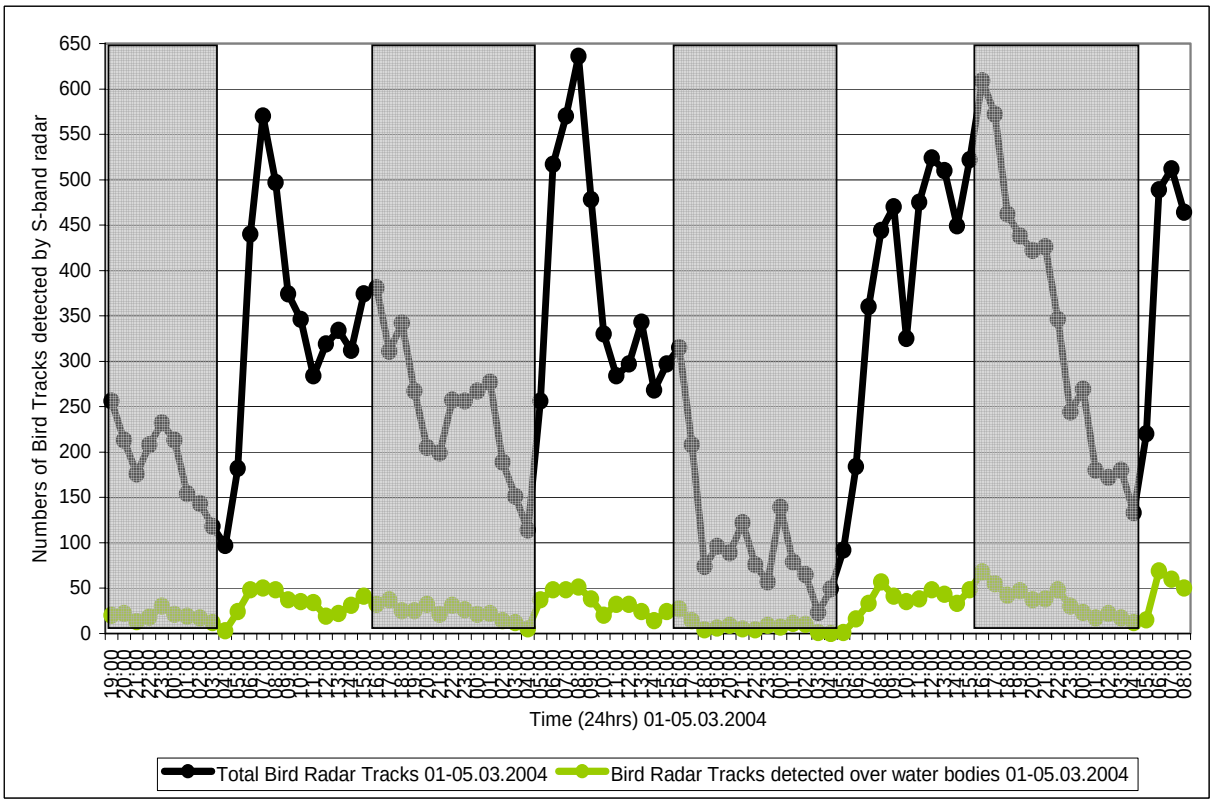


Figure 3. (<u>Top = March</u>) *and* ***Figure 4. (<u>Bottom = December</u>).***
Shows the Total numbers of avian tracks associated with water bodies at RAF Fairford during the two study periods.



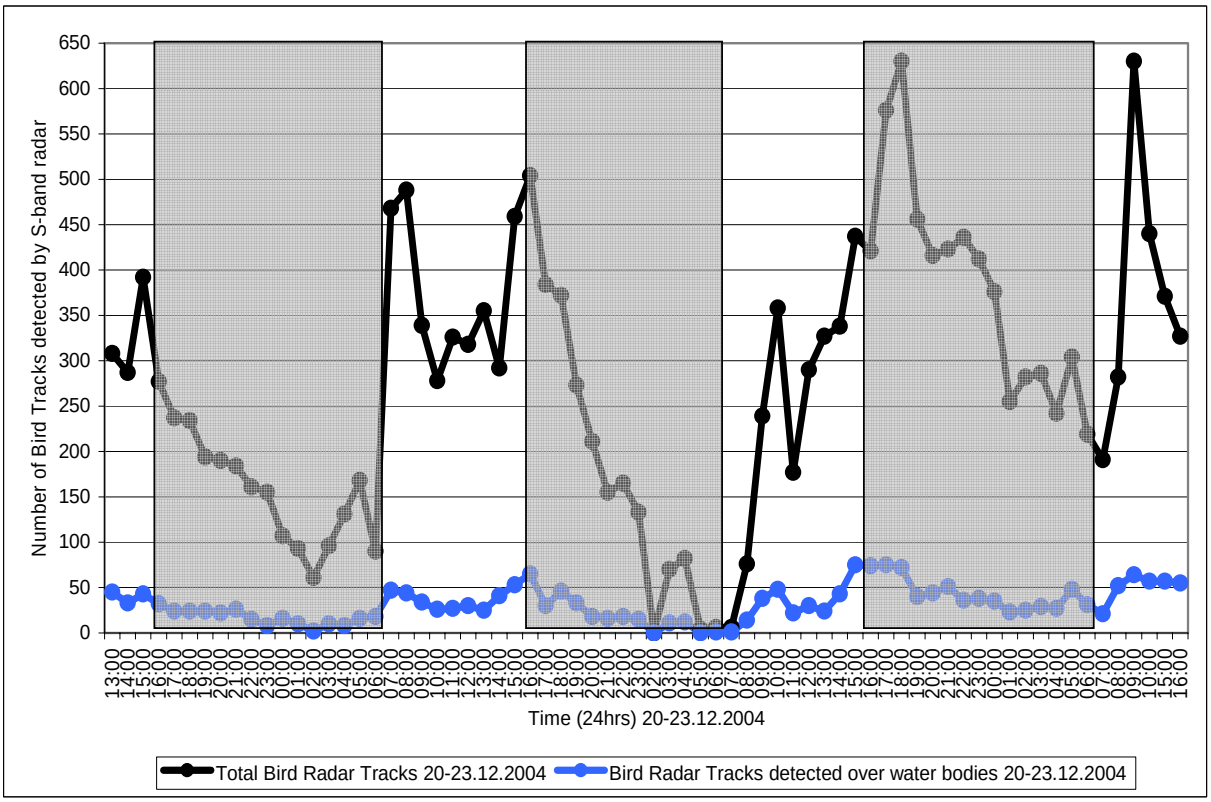
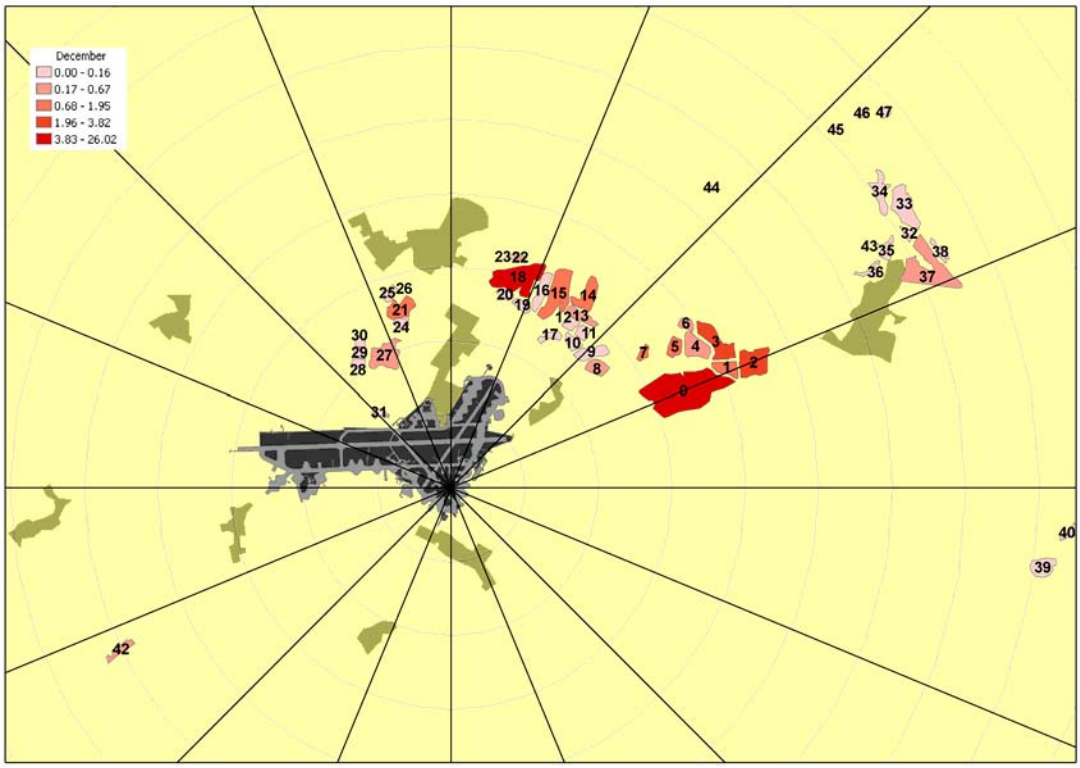


Figure 5. (Top = March) *and* ***Figure 6. (Bottom = December)***
The two line graphs A (March 2004) and B (December 2004) show the Total numbers of bird movement tracks (black line) detected by the S-band radar sweep and those bird movement tracks which were associated with water bodies (Green = March and Blue = December).



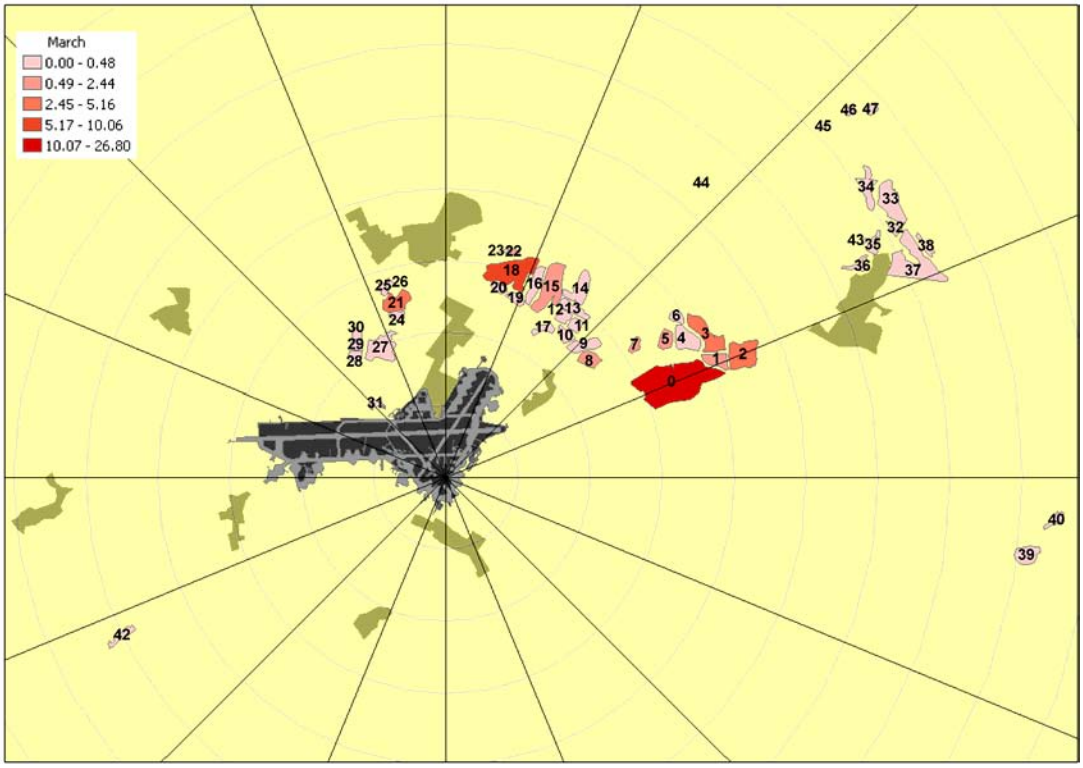


Figure 7. (Top = March) *and* ***Figure 8. (Bottom = December)***
Water bodies highlighted by shades of red as to the most frequently used indicated by bird movements recorded by S-band radar.

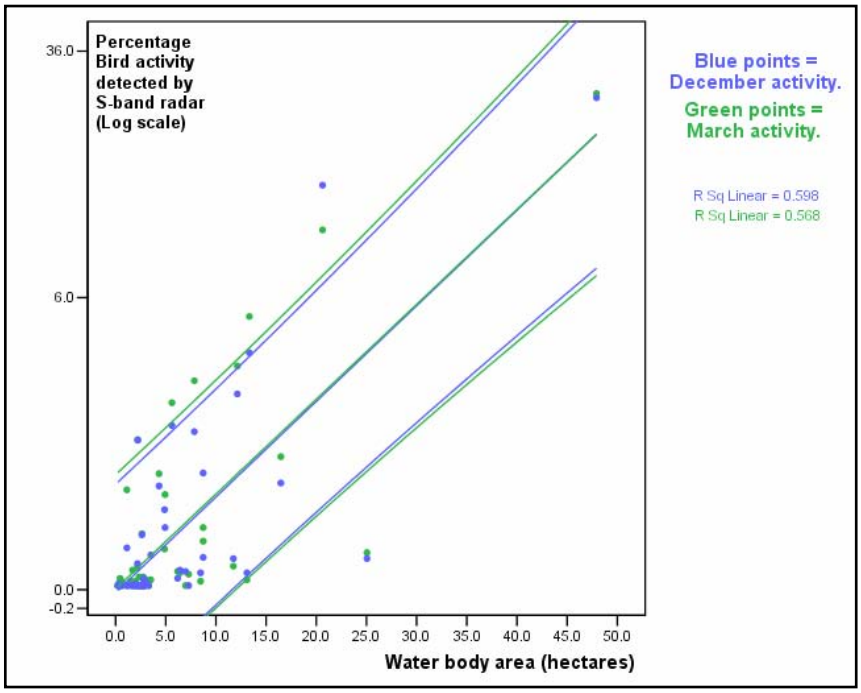


Figure 9. *Scatter plot of the relationship between the area of water bodies and the percentage of bird activity recorded within the S-band radar sweep during March and December*

Discussion

Quantifying bird movements with radar around airports provides valuable information in respect of the features, which aggregate bird movement at the landscape level. Information on movement rates associated with specific landscape features such as water bodies provides important data for airports, airport safeguarding, habitat management and birdstrike specialists at the landscape level.

Bird movements are ultimately determined by the BMR (Basal Metabolic Rate) of the bird species concerned and ultimately the availability of food items. To satisfy bird's individual daily requirements it requires their expenditure (i.e. flight costs to be below their input in food). In order to satisfy the daily energetic requirements of differing bird species, activity levels/movements can vary greatly. Bird activity is therefore determined strongly by seasonal, weather, temperature and habitat effects. During winter for example daylight hours are shorter and temperatures are colder increasing birds need to procure sufficient food reserves while expending the minimum energy possible. These conditions during winter force birds to increase their food input to counteract the effects of cold and exposure. This increased food need will also push birds to extend their hours of active foraging and also increase the number of fights to meet their BMR. Winter is also the period in the UK when daylight hours are at their shortest and so many factors are weighted against birds to survive the harshest months.

These factors in winter can consequently increase the hours that species such as gulls and waterfowl are active in the UK and consequently result in them being active for longer and increasingly during darkness. Nocturnal bird movements are difficult to assess using standard visual methods and as such quantifying areas of aggregated bird movements using radar can supply important data for airfield managers, airport safeguarding and planning.

Two periods in March and December 2004 of S-band radar monitoring at RAF Fairford identified approximately 10% of total bird activity in each period being associated spatially with water bodies, which constitute less than 1% of the landscape area. This qualifies that specific landscape features such, as water bodies can be significant attractants in terms of bird movements at a landscape level. This information alone is nothing that was not already known to ornithologists, however these data do

highlight the level of activity throughout 24hrs and over a number of days. It also enables us to pinpoint, which landscape features such as water bodies appear to show the most attraction for bird flight movements.

During March 30% and in December 51% of the bird tracks associated closely with the water bodies were detected during hours of darkness. The 50 water bodies included in this analysis do not have an even geographic spread of bird flightlines associated with them. Specific water bodies therefore appear to contribute a significant proportion of bird movements at the landscape level as detected by S-band radar at RAF Fairford.

Acknowledgements

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