STSM Report

INTRODUCTION

This is the report relative to the Short Term Scientific Mission (STSM) of Viviana Stanzione in the COST Action ES1305 (*European Network for the Radar surveillance of Animal Movement*, ENRAM), under Working Group 2: Improvement of weather radar data quality and validation of biological-classification algorithms

- **STSM Title**: “Radar calibration: differences and similarities among vertical-looking insects, fixed-beam birds and weather radar outputs during migration”;
- **Host institution**: Rothamsted Research (Harpenden, UK) hosted by the Insect Migration group led by Dr. Jason Chapman;
- **Date**: 27/10/2014 - 5/11/2014;
- **Purpose**:

  - ✓ To analyse data on insects migration collected from June to October 2014 using an *insect radar*;
  - ✓ To compare data gathered with the *insect radar* and that with a *fixed-beam radar* operating in the vicinity, during the same migration period.
  - ✓ To search for possible differences or similarities in the migration phenology of birds and insects.

METHODS

The data used in this STSM were previously collected in Rothamsted Research Centre (RRC) in Harpenden (UK) from June to October 2014. In particular, insects data were collected using a radar specifically developed by RRC (hereafter called *insect radar*) while bird data were collected using a radar designed to detect birds, developed by the Swiss Ornithology Institute (SOI) of Sempach (hereafter called bird radar). Both radars used a fixed beam oriented to scan a vertical area above their location.
For a better data visualization, the 24 hours period was divided in four periods:

- "Sunrise"= from 1h before sunrise to 1h after sunrise;
- "Day"= from 1h after sunrise to 1h before sunset;
- "Sunset"= from 1h before sunset to 1h after sunset;
- "Night"= from 1h after sunset to 1h before sunrise.

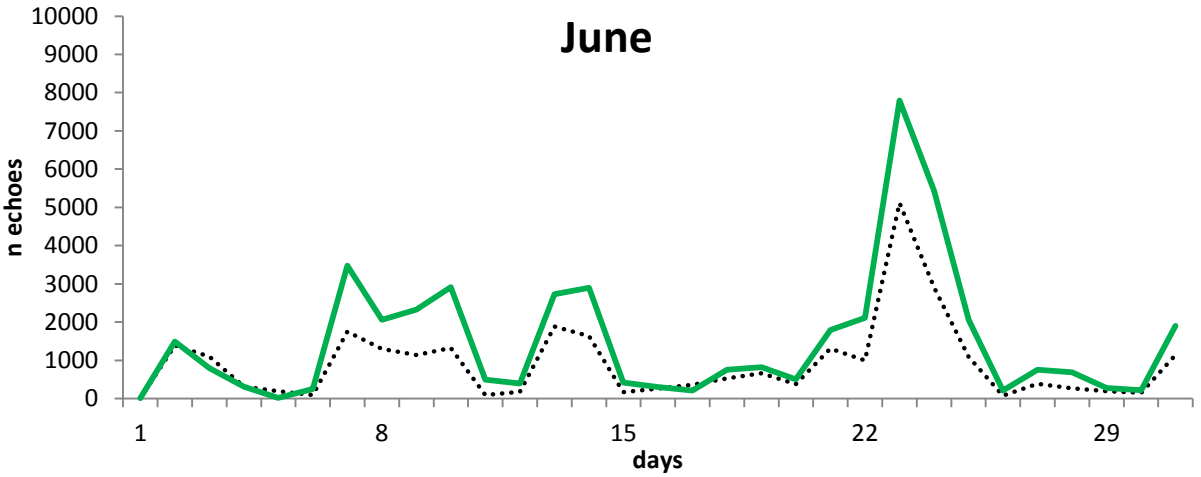
The insect radar allowed to record the height (m), the mass (mg), the density (mg^7/m^3) the velocity (m/s), and the direction of migration (degrees from North) of an insect echo detected up to a distance of 1200 m. In addition, it had an in-built algorithm allowing to separate "good targets" from "non good targets", these latter including rain, for example.
For the mass calculation we have selected five size categories: **1**=0-25 mg; **2**=25-50 mg; **3**=50-75 mg; **4**=75-100 mg, **5**=100-500 mg. To calculate aerial density, we first calculated the total density per hour, and then we averaged these values into a daily average. When we calculated flight directions we used the GenStat 16 software and we run Rayleigh test for each day dividing by day and night time (15 days at all). Then two total Rayleigh test have been produced: one for the day and one for the night flight directions
The data set used for the comparison of birds and insects radar data considered a two-week period (from 1/9 to 14/9) with relatively good weather conditions.
The parameters compared for birds and insects have been 1) the Migration Traffic Rate (MTR) per day (24h period) and per time categories; 2) the density per day (24h period) and per time categories and 3) the heights distribution during day and night time.
We used MATLAB Software for visualizing the day and night density in relation of the flight heights. The output has been created by Dr. Jason Lim using the new MATLAB function "Quickview3" which has been developed from a previous STSM carry out by Curtis Wood.

.*RESULTS & DISCUSSION*

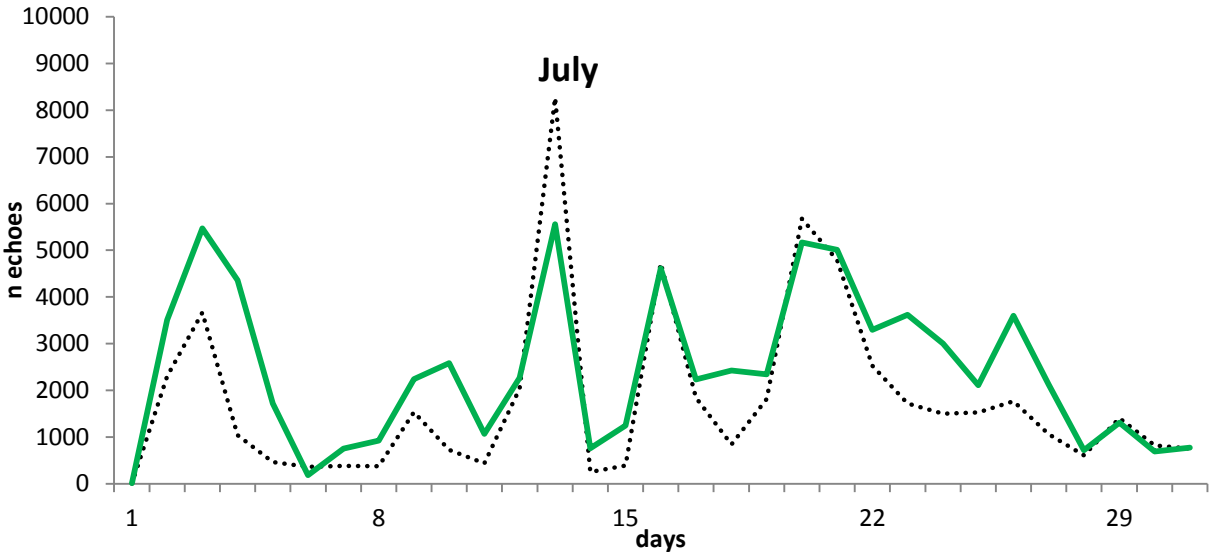
Insects movement (summer-autumn)

The following four figures show the time course of the number of insect echoes recorded during the whole study period. The green line represents the “good targets” (=insects), while the dotted line targets considered as noise. The most important passage occurred in July. [In **1A**: 62.1% of targets have been “good targets” (n=74.799); in **1B** 57.6% as “good targets” (n=13.1375); in **1C** 40.2% as “good targets” (n=29.269); in **1D** 27.4% as “good targets” (n=32.656); in **1E** 52.3% as “good targets” (n=11.750)].

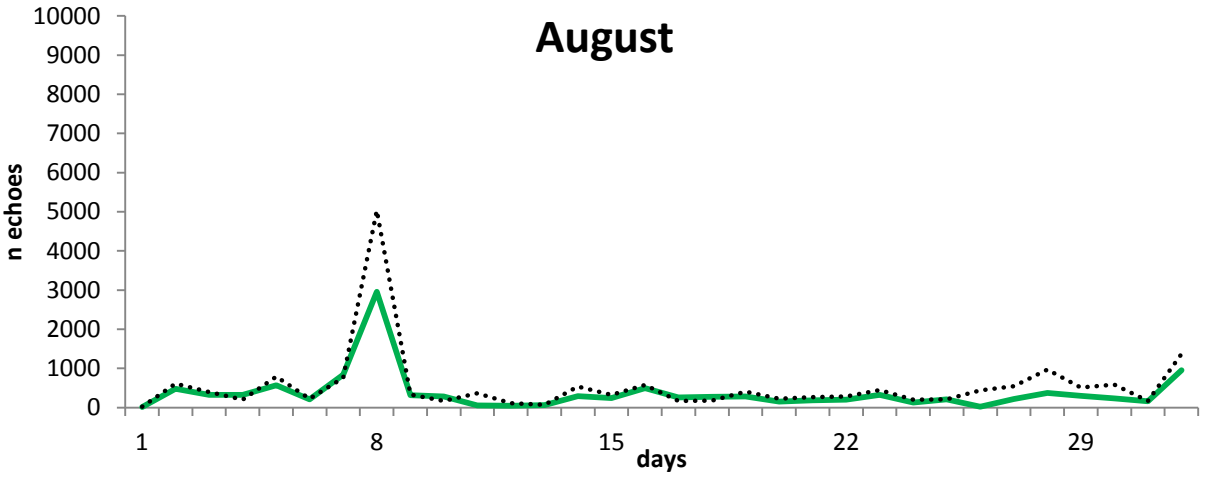
1A



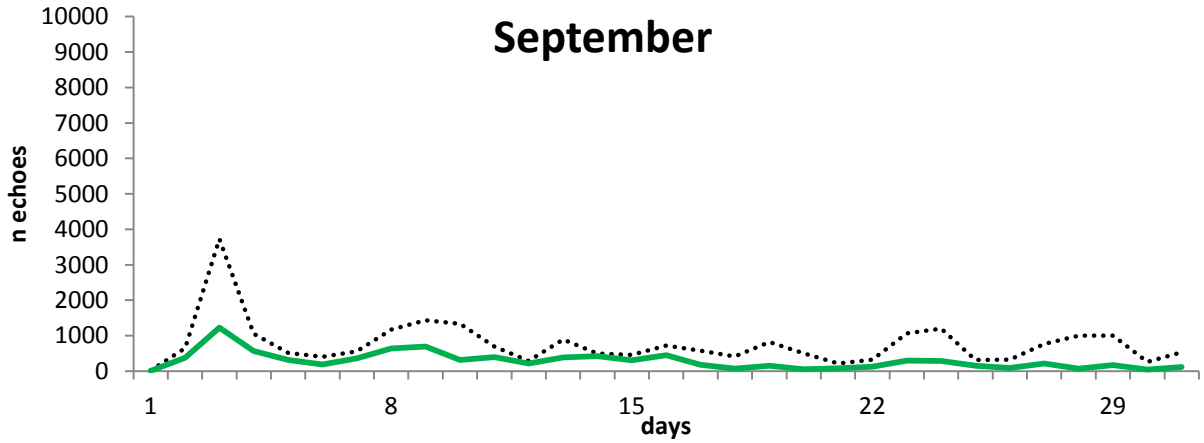
1B



1C


August
n echoes
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1
8
15
22
29
days

1D


September
n echoes
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1
8
15
22
29
days

1E

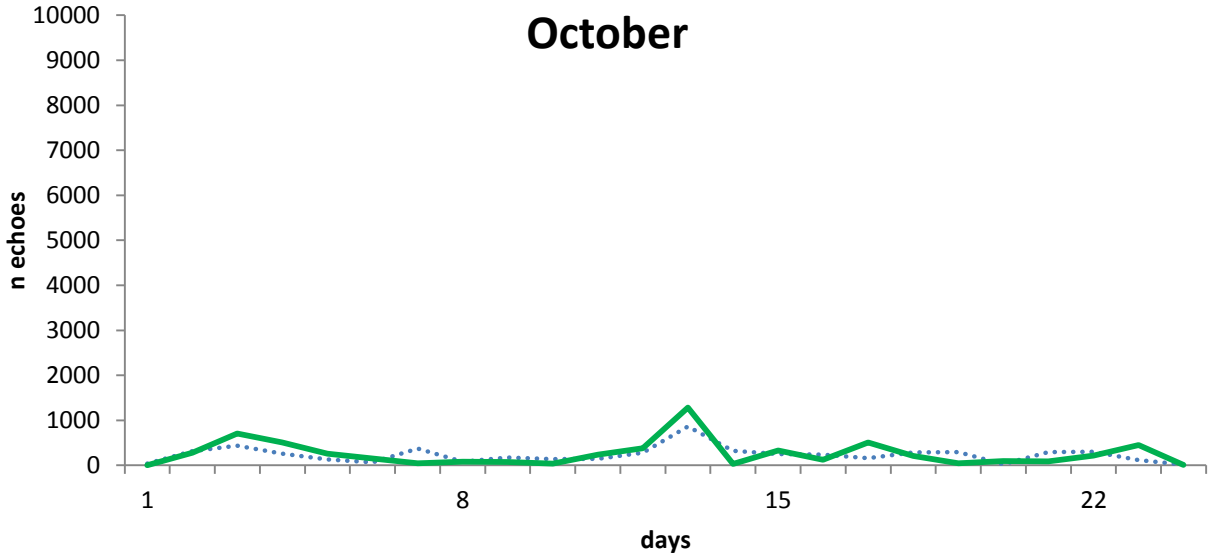
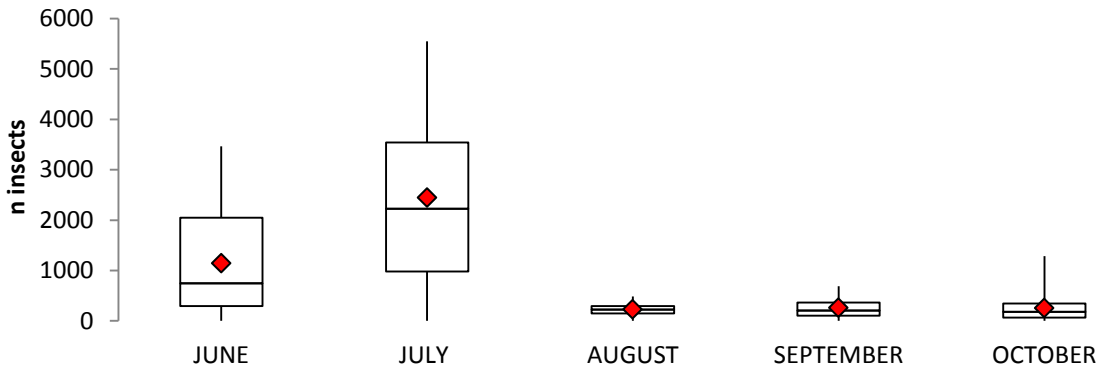

October
n echoes
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1
8
15
22
days

Figure **2** shows an overview of MTR from June to September. Note the intense decrease of migration at the end of summer time.

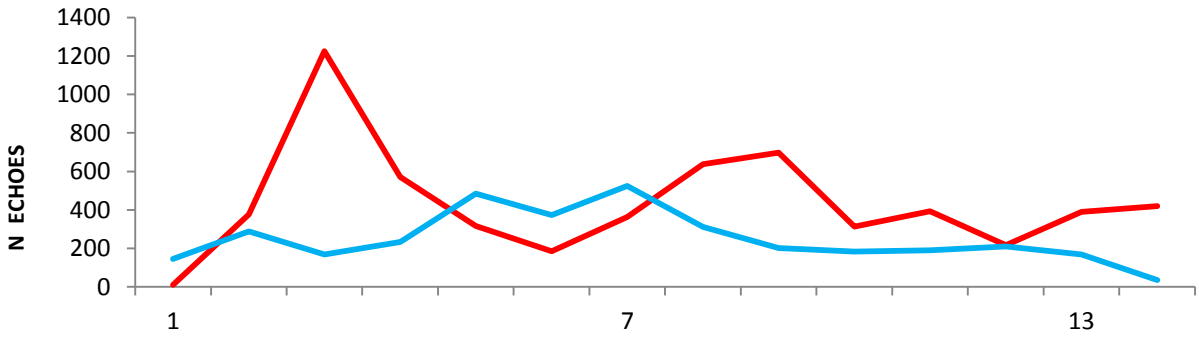
2



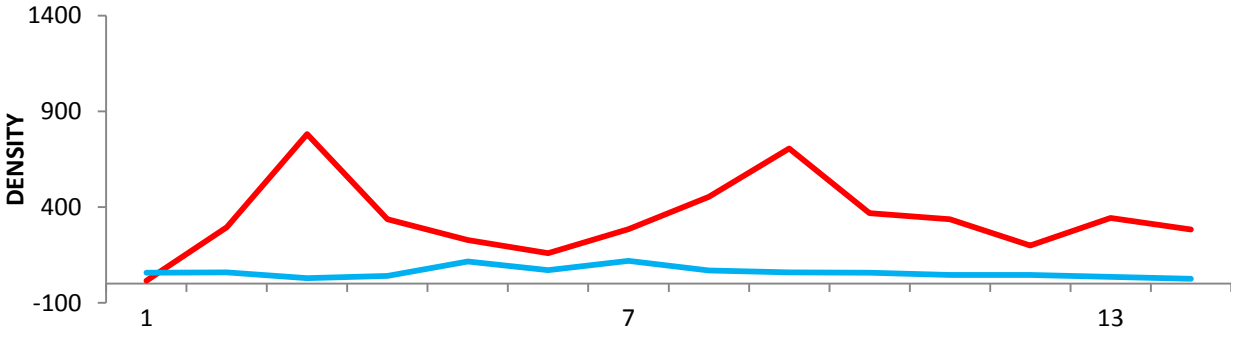
2) Comparison of insects and birds radar data

The time course of number of echoes of birds and insects recorded during a two week period on September 2014. Red line represents insects and the blue one birds echoes. During the insects peak a low MTR of birds has been recorded and also when birds reached their peak we can see a low insects abundance [Note: In **3A** the Y axis represents the number of animals while in **3B** it represents their density.]

3A

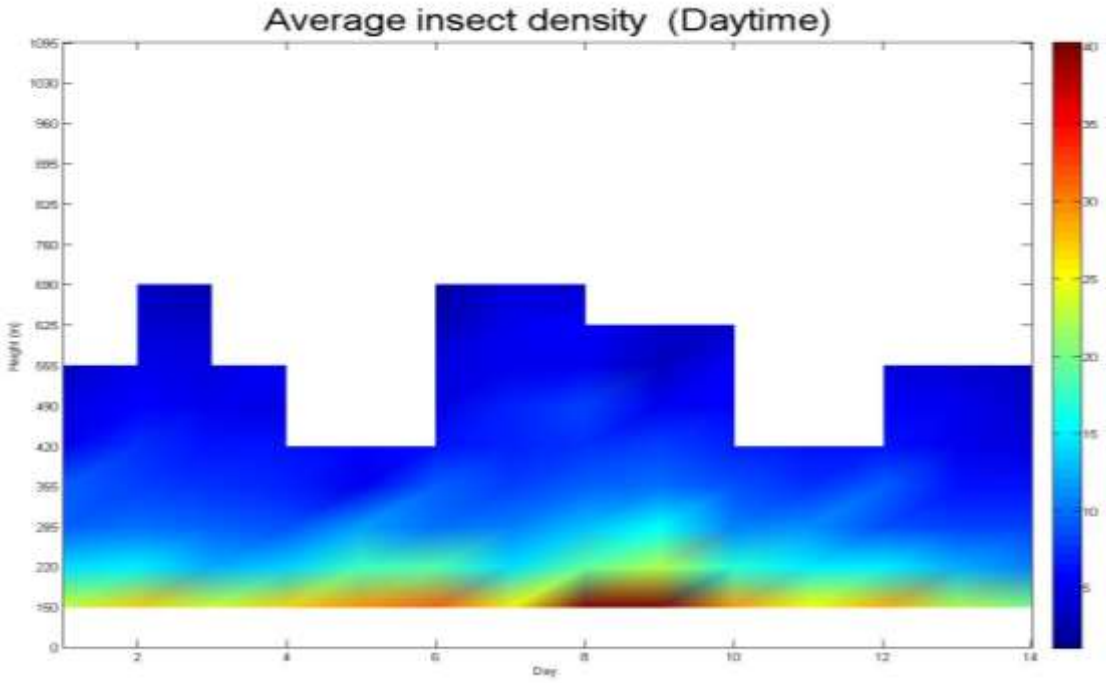


3B

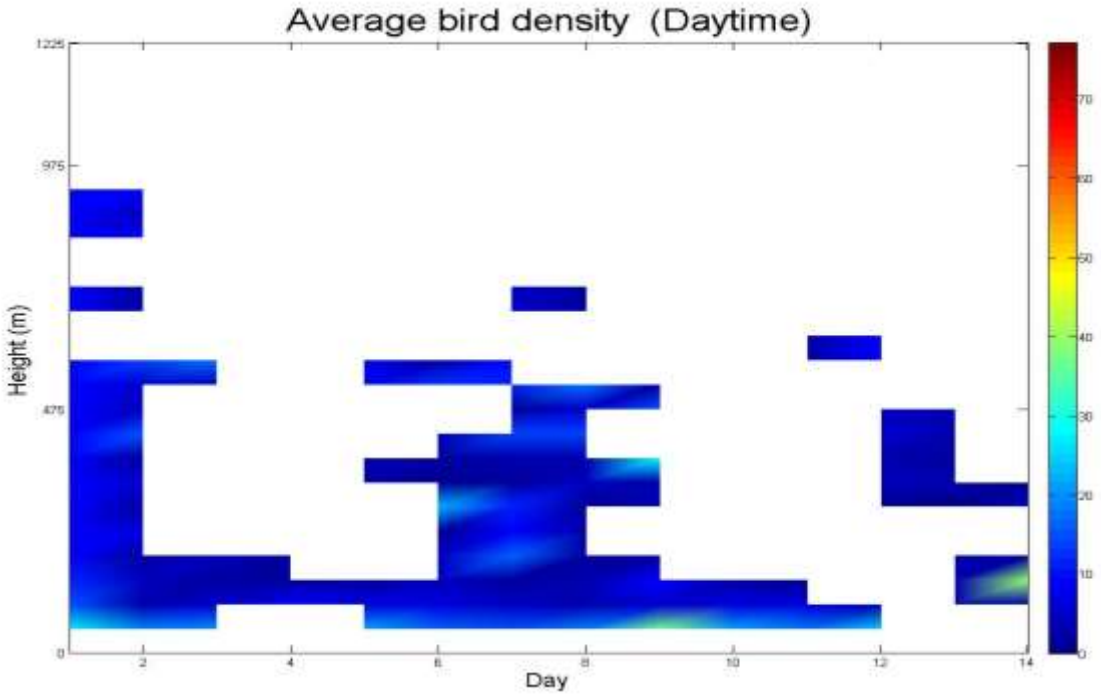


The following four figures show birds and insects MTR during day (**4A, 4B)** and night time (**4C, 4D**) plotted against flight heights. Note the massive presence of insects during day time and the low abundance of birds in the same time period. Also modest heights have been recorded during day time in birds. As expected, bird migration has occurred mainly during night time and it has shown greater flight heights as compared with day time.

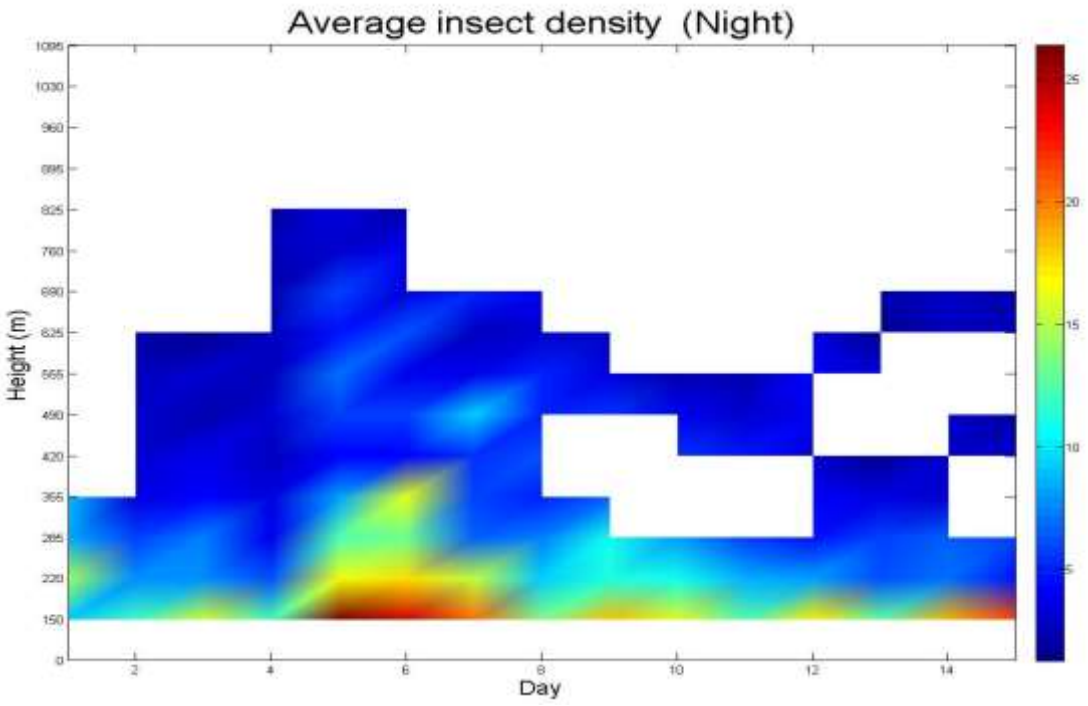
4A



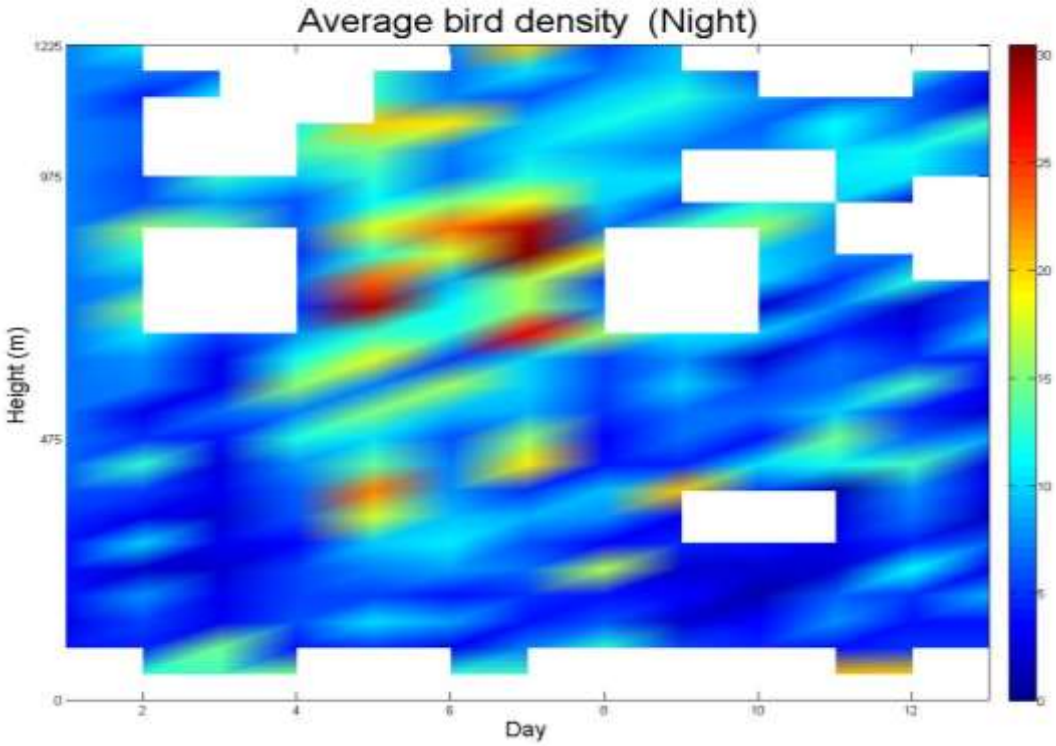
4B



4C

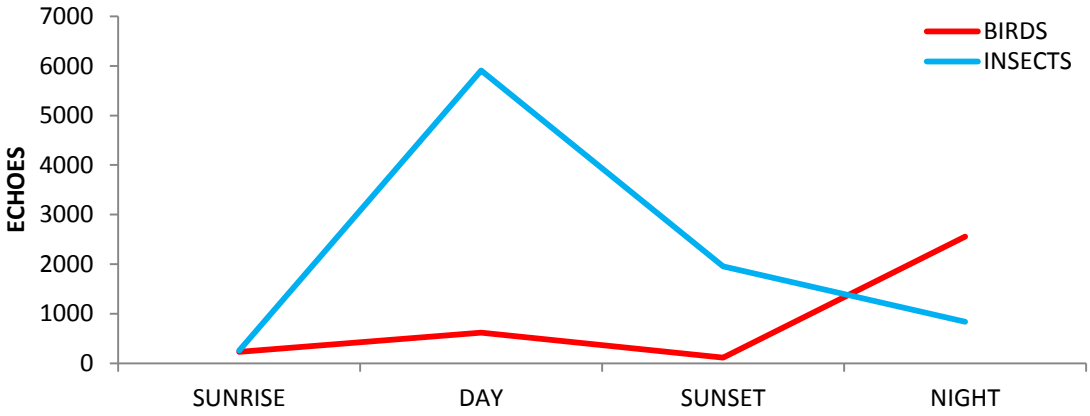

Average insect density (Night)
Height (m)
Day

4D


Average bird density (Night)
Height (m)
Day

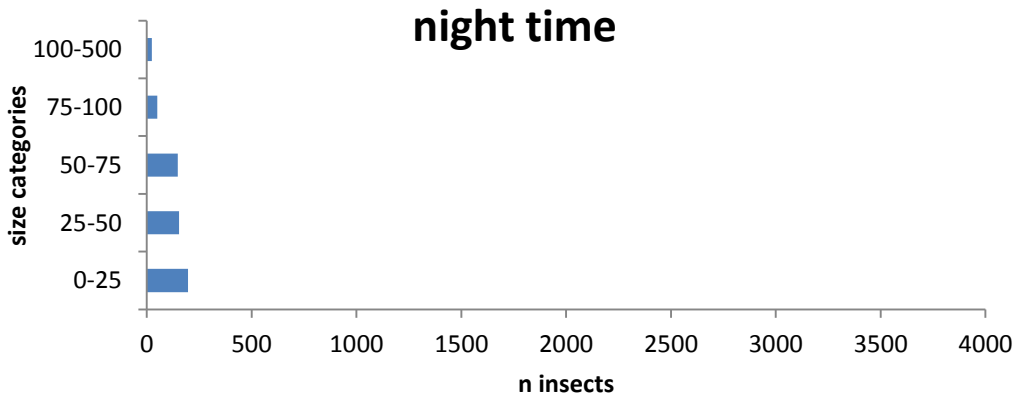
Surprisingly, during sunrise and sunset, the number of echoes has been very low (fig. **6**).

5

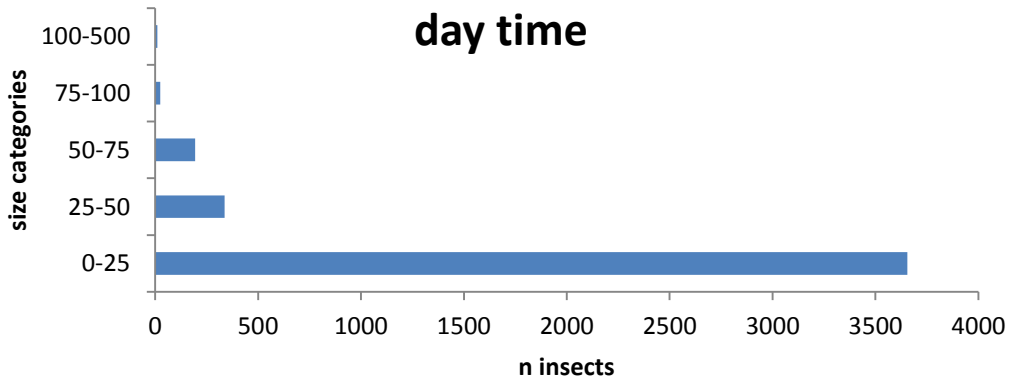


The insects size is different between day and night time. Small insects do not fly over night time while large insects have been recorder to do it (**7A, 7B**).

6A

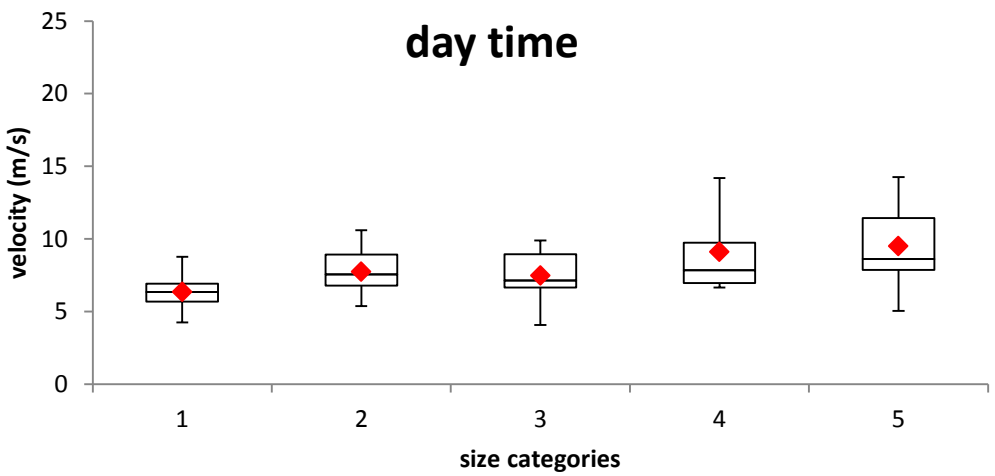


6B

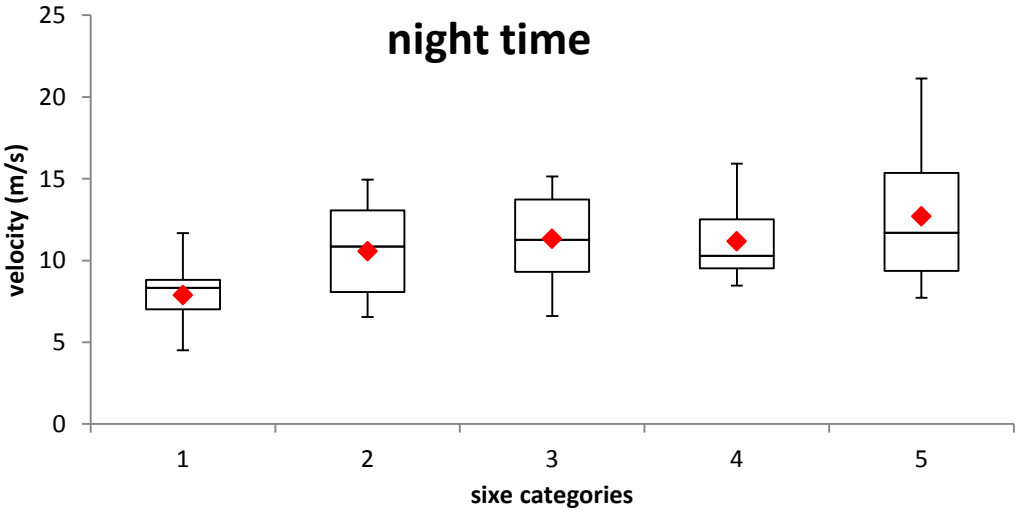


During day (**7A**) and night time (**7B**) it has not been observed a difference in insects velocity in relation to size categories, but it could be a difference between day and night time [1=0-25 mg; 2=25-50 mg; 3=50-75 mg; 4=75-100 mg, 5=100-500 mg].

7A

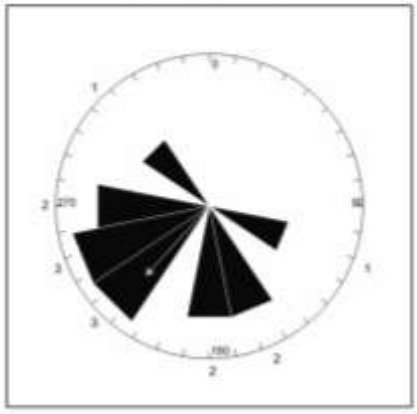


7B

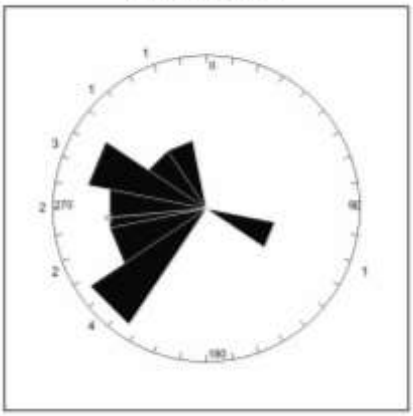


Insect flight direction of day time (**8A**) has occurred in a South/West direction (r= 0.6413 p<0.05) while at night time (8**B**) at West (r=0.7046 p<0.05).

8A



8B



CONCLUSION & FUTURE INVESTIGATIONS

During my STSM I could carry out an initial comparison of birds and insects migration data collected with two different radar systems on adjacent locations.

The preliminary results suggest that during the birds migration peaks there are less insects recorded and vice versa. We found a similarity in the low abundance at sunrise and sunset in both taxa.

The great bird movement at night possibly suggest a passerine migration while the low abundance of birds and the low flight heights during day time could not exclude movements of residential birds. Insects movement during day time is probably a migration of some Diptera and Hymenoptera and this result is in accord with sizes recorded during day time. Unfortunately at the moment we did not have data about velocity, size and flight direction of birds that could have provided more information. Also a consistent rain period has occurred during the bird radar recording, allowing only for a short period comparison. The comparison between the weather data has not be possible because they were not available by the time of this STSM. Further investigations are required and more statistical analysis too. Next step would be to obtain:

- A longer data period for bird migration;
- More parameters for birds (size, velocity, direction);
- Weather radar data.