Electronic recording of bird tracks and bird numbers by tracking radar

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ELECTRONIC RECORDING OF BIRD TRACKS AND BIRD NUMBERS BY TRACKING RADAR

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Summary

The tracking radar "Superfledermaus" can be used in a tracking as well as in a surveillance mode. The flight paths of automatically tracked birds are digitized and recorded at intervals of one second by a personal computer. The same computer also stores a reduced and digitized picture of the PPI, while the pencil-beam of the radar rotates around a vertical axis at selected elevation angles.

Formerly, individual bird tracks detected by tracking radar have been recorded by two-channelled XYY'-plotters. Measuring track directions and calculating headings were done afterwards by hand or by simple computer processing. Numbers of birds were extracted from photo-records of the plan-position indicator or the range-height indicator. The echoes on the photos were digitized and related to the air volumes surveyed in order to get bird density; all these evaluations were very time-consuming. The high speed and large capacity of actually available personal computers offer us new, efficient and relatively cheap recording techniques. The object of this paper is to describe briefly our computerized recording technique, and to highlight some problems of evaluation.

The system is based on an IBM PC (AT). The data which previously went to the XYY'-plotter are now digitized and transferred at intervals of one second to the computer. In addition to the three coordinates, we store the date, time, the running number of the bird within a night, the reference to the magnetic tape on which we record the echo-signature, the bird category and the wing-beat frequency (quickly estimated from the echo-signature). Every four hours we track a pilot balloon to determine the winds at various heights. After a night's observation, we are able to show selected flight paths on the screen and compare them in detail with the echo-signatures. The computer also calculates reduced sets of data:
a) for intervals of 20 seconds the approximate speed, flight direction, heading, height, as well as the correlation coefficient of the approximation;
b) the same approximations for a whole bird track. The last set of data leads to a rough survey for each night, giving the distribution of all the track directions and headings, ground speeds and air speeds at selected height bands. A yet unresolved problem is the separate recording of echo-signatures. In spite of Fourier transformations improving the determination of wing-beat frequencies, we must still visually inspect the complicated pattern of echo-signatures.

The quantitative data previously extracted from PPI- or RHI -photos are now also transferred directly to the PC. The area around the radar is scanned at six elevation angles. A measuring window scans up and down the rotating pencil-beam about four times within each degree of rotation.

The energy level contained in each resolution cell is sampled. In order to reduce the amount of data, only the average of 10 scans is stored. This averaging has the advantage of increasing the signal to noise ratio, but also a disadvantage in that a bird echo will be confined to about 3 to 4 stored scans. The information on the form of the single echoes becomes minimal. If two birds are separated from each other only by 100 to 200 m at larger distances they can only be discriminated if two distinct intensity peaks appear. Another unresolved problem is the exclusion of insect echoes at short ranges. Two further difficulties could be successfully handled in the following way: 1) The ground clutter is excluded by adding all the records of a season for each elevation. As ground clutter appears with a high degree of constancy in certain resolution cells, the latter can easily be defined and excluded by a simple threshold procedure. 2) Electronic detection of weather echoes is more difficult than detection of ground clutter. As our studies are not planned to be fully automatic, we decided to delete cloud and rain returns interactively: the metereological echoes are clearly recognizable on the radar screen (raw video). Thus, it is the task of the operator to indicate with the help of a "mouse" directly on the computer screen the areas to be considered as clutter and to be excluded from further calculations.

The available array gives us the possibility:

1) to describe the flight behaviour of a sample of 100-300 birds per night (according to the selected length of the single tracks),
2) to compare it to the wind situation at different height intervals,
3) to give at least relative numbers of birds per unit volume of air space at different altitudes. Combining the two sets of data leads to a fair estimate of the height distribution of birds and their flight behaviour at different altitudes.

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