## 2. PAPERS PRESENTED AT THE 7TH MEETING

### 2.1. Use of Bird Activity Modulation Waveforms in Radar Identification.

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# USE OF BIRD ACTIVITY MODULATION WAVEFORMS IN RADAR IDENTIFICATION

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SYNOPSIS

It is difficult to obtain the identification of targets using a primary ATC. Modern aircraft move at least ten times faster than birds, and therefore aircraft echoes can quickly be recognised as such on the PPI. Generally the echoes of large scale movements of birds can be separated out from those of weather, sea and ground clutter. The echo patterns of specific bird movements can often be related to visual events as a result of field studies but positive "on-line" identification is not possible.

The wing and body activity of flying animals, such as birds, bats, and insects produce changes in their radar echoing area which results in amplitude modulation of the echo signal. Those wing and body activity modulation waveforms generated by birds (called bird activity modulation BAM waveforms) can be separated out from bats and insects by making use of waveform characteristics, echo intensity, trajectory and velocity characteristics recorded on a tracking radar.

There is an approximate law which relates the physical wingbeat frequencies of flying animals to their weights which has a theoretical basis and has been demonstrated experimentally. The law shows that the slowest wingbeats are produced by the heaviest flying animals.

Although there are many exceptions to the law it can be used to identify species directly, when the BAM waveform characteristics and the flight characteristics of specific birds have been catalogued.

Generally, the BAM waveform generated by aspect changes and wing flapping is a very complex waveform for a bird whose body dimension/radar wavelength ratio is greater than 0.5, and it is necessary to use spectrum analysis techniques to extract the fundamental frequency of the waveform which corresponds to the physical wingbeat frequency.

Other characteristics of the BAM waveform such as harmonic frequencies, periodic changes in modulation depth, number of cycles of wing flapping, and duration of wingbeat pauses or length of glide periods can be valuable aids in bird signature analysis.

The lecture will consider these matters in some detail giving an empirically determined law between measured wingbeat frequency and weight for a number of British and European birds. Some examples of BAM waveforms and spectra will be given to illustrate differences between species. Finally ways of using this information in reducing bird hazards to aircraft will be suggested.