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NOISE EMITTED BY DECIDUOUS TREES BLOWN BY THE WIND

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In the special case when there is no wind or rain, the countryside is very still and the background noise level approaches the human threshold of hearing. However, the general case is that the vegetation (trees, shrubs, grasses and the like) generates noise when moved or struck by wind or rain. The aim of this study was to measure the noise levels and frequency spectrum of rustling leaves and swaying branches, there being considerable lack of data in this area. In a literature survey carried out on the subject only three pertinent references were traced.

The area chosen for the tests was 'Pitt Down', in particular Farley Mount Country Park to the South West of Winchester. This was deemed to be a good site for the following reasons:

1. The nearest main roads, A272 and A3090 were minor 'A' roads with comparatively little traffic flows. Both roads were a minimum distance of 2½ km from the measurement positions reducing traffic noise to insignificant levels.

2. Easy access was afforded to the wooded areas by means of minor 'C' road and farm tracks.

3. A variety of trees and undergrowth was readily available with both sheltered and exposed areas.

4. There was no human habitation within a 1 km radius.

5. There was little air traffic.

A total of seven sites were selected to conduct the tests, which had the following O.S. grid references: 417292, 418794, 419292, 419294, 445292, 452296 and 450298. (Refer to figures 1 to 7). Sites 2 and 4 were approximately 110m above sea level and the remainder between 127 and 137m above sea level. All sites had similar tree types, a mixture of oak, white and downey birch and hawthorn. Ground cover was plentiful, mainly rose hip and brambles. Outside the wooded areas ground cover was meadow grass. Generally the tree diameters varied between 40 and 170mm and the density of trees varied between 1 tree per $5m^2$ and $6m^2$. All the trees were decidious with no coniferous trees present.

From figures 1 to 7 the microphone positions may be clearly seen in relation to wind direction and distance from the source. The wind direction was changeable but generally was North Westerly veering Westerly on some occasions. Speed varied between 0 and 8.5 m/s (0 to 30.6 km/hr) though the most commonly occurring wind speeds were between 1 and 4 m/s (3.6 to 14.4 km/hr). The most frequently recorded wind speed was in the order of 1 m/s. Figure No.8 shows typical scatter, with a greater number of points at the lower wind speeds.

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All measurements were made in dry weather during August and September when the trees were still in full leaf and the daylight hours were long. Measurements were not taken in the rain to avoid possible equipment problems. Temperature varied between 11.8°C and 21.5°C d.b and the humidity between 52% R.H. and 90% R.H. Barometric Pressure was not measured.

The equipment used to measure windspeed and noise levels on site was:-

CEl 193/1 Precision sound level meter. This unit has an output for a tape recorder fed directly from the microphone via a pre-amplifier, by-passing the weighting networks.
B & K ½" microphone type 4133 and closed cell foam windshield type UA 0237.
B & K electronic calibrator type 4230 with ½" adaptor.
Wind Sock for determining wind direction.
Uher 4200 Report reel to reel tape recorder with two channels; channel one was used to record the noise levels generated by the wind in the trees, and channel two to record wind velocities. AKG DZOZEl microphone was used to record the spoken wind speeds into the Uher 4200.
Airflow Developments Vane anemometer was used to measure wind speed.

The equipment used for analysis in the laboratory was:-

Uher 4200 Report tape recorder for playback.
B & K digital frequency analyser type 2131.
B & K level recorder type 2305.

On site the CEC 193/1 S.L.M. was mounted on a tripod and was positioned generally within 5m of the source and typically 1m away. The microphone head was kept at 1500mm above ground level, ground cover usually consisting of grass and/or brambles and other shrubs. A closed cell foam microphone windshield was always used to protect the microphone diaphragm from excessive pressure fluctuations. As the wind speed increased the windshield was less able to protect the microphone and therefore further action was taken to protect it. Two methods were successfully used, sheltering the microphone with vegetation, (i.e. by positioning it within a group of trees)or as on one occasion using the car tail-gate to deflect the wind around the microphone).

When readings were taken at site 6 the microphone was positioned at two heights 1500mm and 150mm above ground level, to determine any noticeable change in frequency response or level owing to ground reflections and the so-called 'ground effect'. No difference was noted in this instance due to the short distance from source to receiver, however it is likely that the type of ground cover would have some effect particularly at greater source receiver separations.

Wind velocity fluctuations across the microphone diaphragm can cause high levels of low frequency sound, so called 'pseudosound'. Cooper(1) has measured such noise generated by the natural wind and the shape and level of the spectra obtained give good reason for using the 'A' weighting network as an effective filter for this unwanted noise. However, recordings were made of linear sound levels and the necessary filtering completed in the laboratory. Nevertheless while a windshield was used and the microphone placed and orientated so that wind disturbance of the diaphragm was reduced to a minimum, pseudosound tended to swamp the system at high windspeeds (> 8 m/s).

Figure 8 shows the average measured levels of the noise emitted from the trees, (i.e. over the seven sites), as a function of wind speed. It requires very little wind to produce appreciable levels of noise, 0.5 m/s giving a measured level of some 59 dB(A) and 7 m/s 79 dB(A). Between 1 and 6 m/s there is a gentle increase of about 1.5 dB(A) for every 1 m/s increase in wind speed. Such results generally confirm the data reported by Miller(2) and Yamada(3).

Figures 9, 10 and 11 show typical data obtained at site 1. Figure 9 is the plot in both linear and a weighted frequency response at 2 meters per second (7.2 km/hr), figure 10, at 3 metres per second, figure 11 the plots of 4 m/s (14.4 km/hr). It is clearly seen that the linear responses are very similar above 200 Hz, varying only in magnitude, and all plots tending to fall off rapidly above 5000 Hz. Below 200 Hz the plots are somewhat erratic which can be put down to the random pressure differences across the microphone diaphragm due to wind on the microphone, Cooper(1). Having obtained the linear plot it was easy to obtain the 'A' weighted ⅓rd octave plots by means of the B & K digital frequency analyser. The plots are almost identical in frequency content but are of course, at different levels. These plots have a reasonably smooth peak between 1000 & 2000 Hz which, incidentally is below the major emphasised vocalisation frequency of most common British passerines.

Miller has produced a series of curves based on the frontal area of a group of trees for a microphone distance of 6m and above. These curves correspond well to figure 8. The main difference between Miller's study and this is that Miller was more concerned with producing a prediction method for determining 'A' weighted sound pressure levels, rather than measurement of actual emitted noise by a group of trees at source. Yamade with his work on the masking effect of vegetation has produced a series of curves of wind speed with respect to sound pressure level in dB'A' for different types of vegetation, which tend to confirm the results quoted here. However, figure 12 is the only known data which attempts to relate "tree noise" in amplitude and frequency response to wind speed.

The frequency curves shown are similar to the broad-band noise introduced into offices for the purpose of masking human speech. It is therefore reasonable to suppose that the masking effect of sound generated by vegetation blown in the wind might be a factor in animal communication.

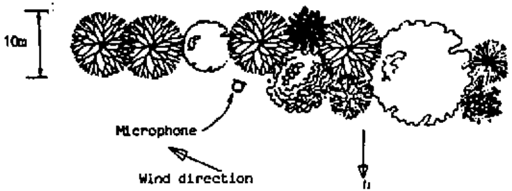
REFERENCES

1. COOPER, G.J. 'The effects of Net and Foam Windscreens on Wind Induced Noise', Polytechnic of the South Bank, MSc Dissertation 1979.

2. MILLER, L.N. 'Sound Levels of Rain and Wind in Trees. Noise Control Engineering 2 (1978) : 101-109.

3. YAMADA, S. Noise Reduction by Vegetation. Proceedings of Internoise Conference on Noise Control Engineering (1977) : B599-B606.

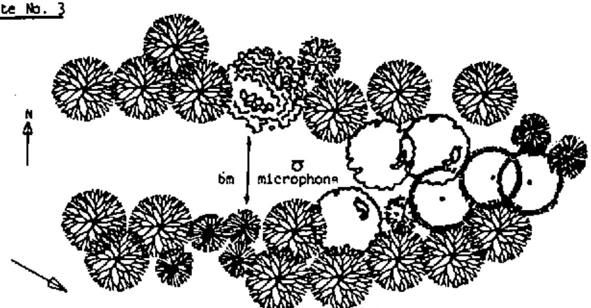
Site No. 1



Average height trees, 5m
Average density , 1:5 sq m
Trunk diameter 40mm to 150mm
Surrounding vegetation:grass

Figure No.1

Site No. 3



Average height trees, 5m
Average density 1:6 sq m
Trunk diameters 35mm to 140mm
Surrounding vegetation: grass

Figure No.3

Site No. 2

Average height trees, 8m
Average density, 1:5 sq m
Trunk diameter 40mm to 175mm
Surrounding vegetation: grass

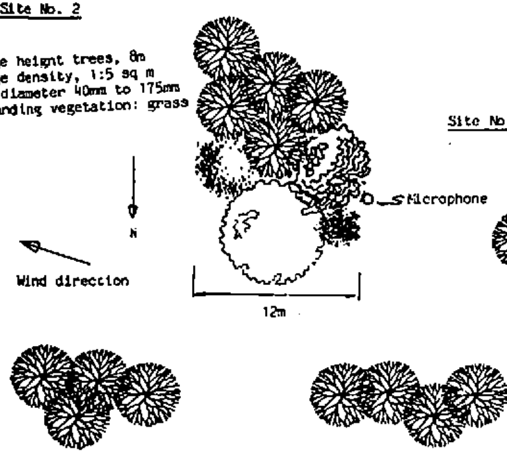
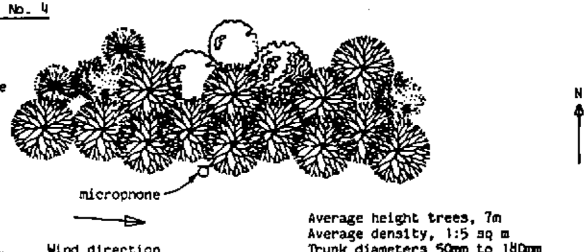


Figure No.2

Site No. 4



Average height trees, 7m
Average density, 1:5 sq m
Trunk diameters 50mm to 180mm
Vegetation to south: grass
" to north
east and west: trees

Figure No.4

Site No. 5

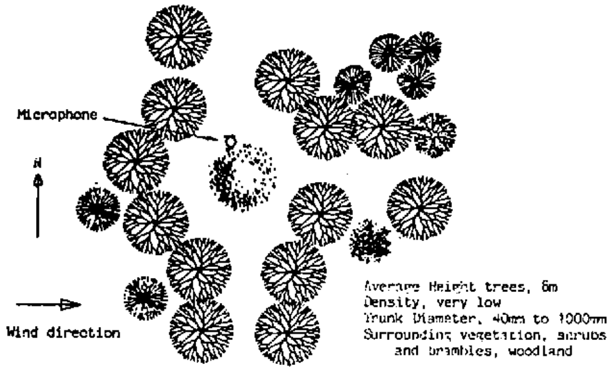


Figure No.5

Site No. 6

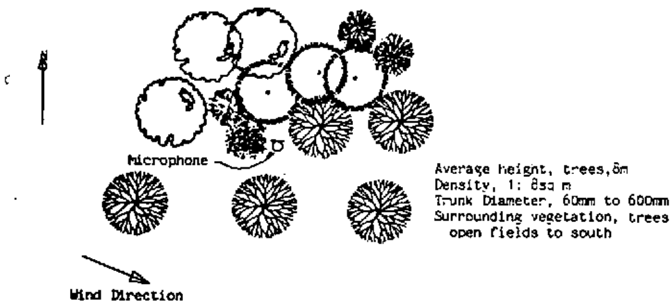


Figure No.6

Site No. 7

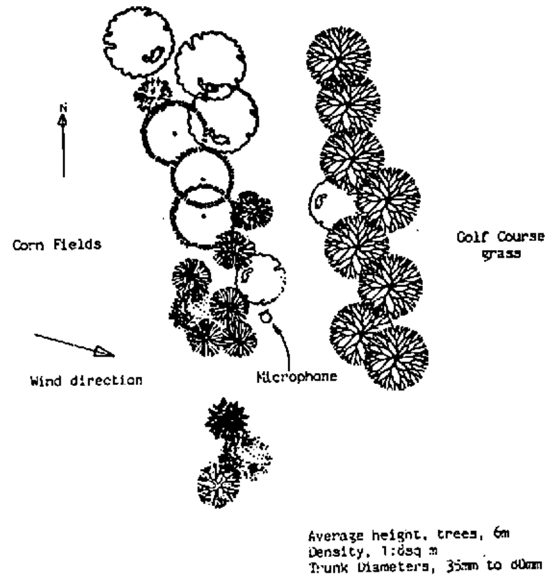


Figure No.7

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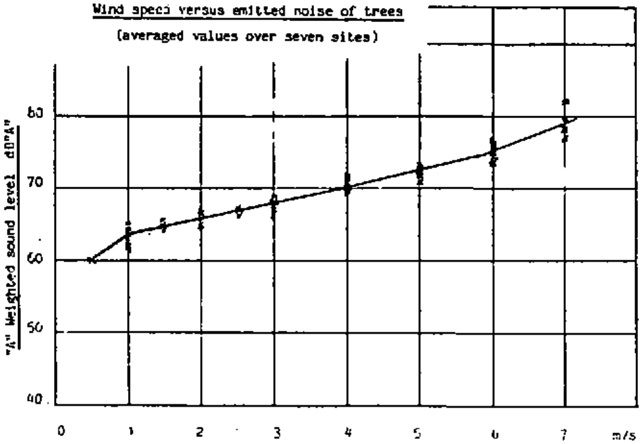

Figure No. 8.

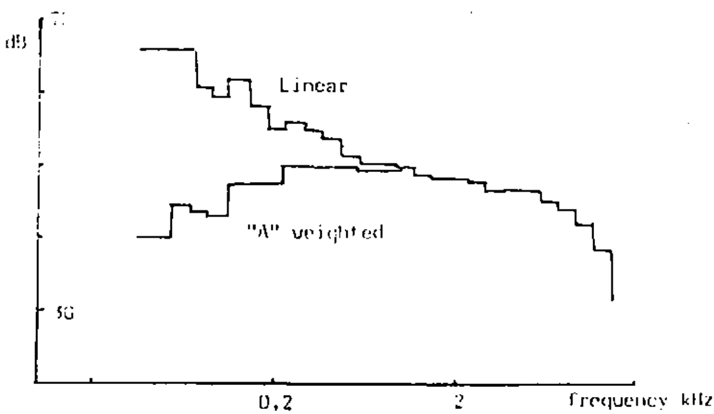

Figure 9 2 m/s windspeed.

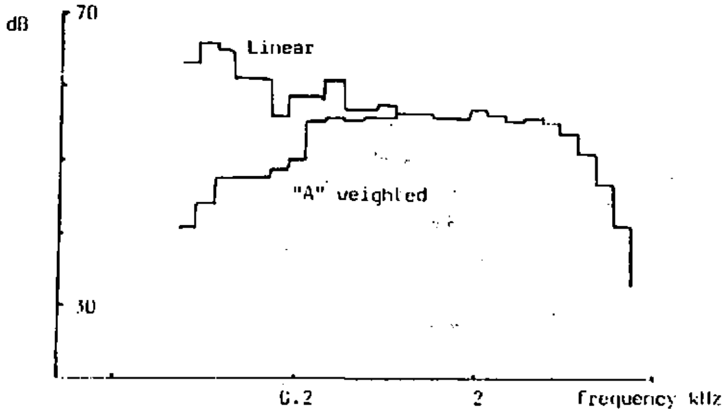

Figure 10 3 m/s windspeed.

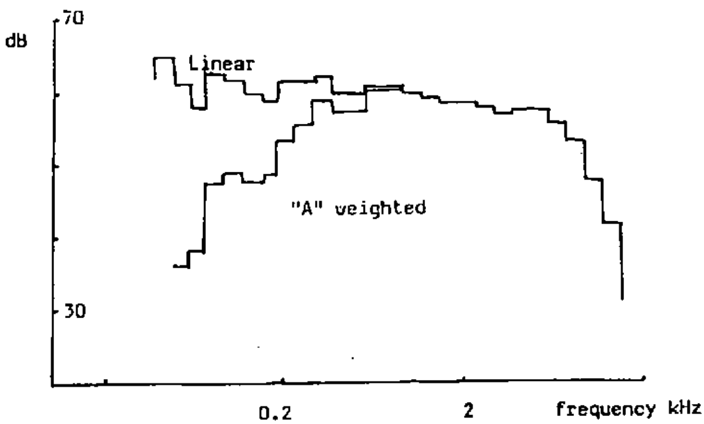

Figure 11 4 m/s windspeed.

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