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# A SIMPLE INSTRUMENT SHELTER FOR USE IN FOREST ECOLOGY STUDIES

by
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# A Simple Instrument Shelter For Use In Forest Ecology Studies

by
J. W. Fraser[1]

Air temperature is one of the important criteria for comparing environments in forest ecology studies. Since a thermometer element exposed freely in the open usually absorbs considerable radiation and may therefore not indicate true air temperature (5, 6), shielding is a major problem. In meteorological practice some form of screen is usually provided that supports the thermometer and shields it from direct radiation from outside sources while allowing free circulation of air around it; the screen also shields the thermometer from precipitation and prevents accidental damage (5). This paper describes the construction and reports on the testing of a simple instrument shelter.

The Meteorological Branch of the federal Department of Transport uses a standardized version of the louvred-box type of shelter known as a Stevenson Screen. This screen (Fig. 1) is described in Manual 20 published by the Department of Transport (3). Designed to minimize the transfer of heat by radiation

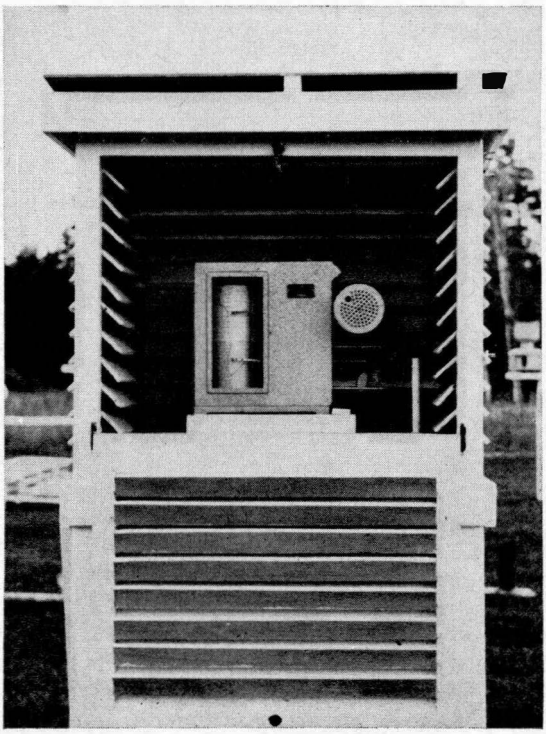

Figure 1. A type 'B' Standard Stevenson Screen with the door open to show the double-louvred construction.

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while allowing a certain amount of ventilation, it is an excellent instrument shelter at permanent, readily accessible locations. However, when it is necessary to set out temperature recording instruments in several temporary locations that are considerable distances apart and which are inaccessible except on foot, Stevenson Screens have certain disadvantages.

Standard type B Stevenson Screens weigh 61 pounds—a marked disadvantage when they must be carried any considerable distance, particularly in heavily wooded country or over mountainous terrain. Hungerford (1) also commented on the weight and bulkiness of the American equivalent of this type of shelter when he reported on a smaller screen that was presumably designed to offset these drawbacks. Installing such heavy shelters at upper trunk or crown levels is an extremely hazardous undertaking.

Standard type B Stevenson Screens list at $55 (2). This may not be a prohibitive cost for an individual shelter, but it might be prohibitive where many instrument stations are contemplated.

These considerations probably explain instances of instruments being used without any shielding and the occasional neglect to take any air temperature measurements.

The objective was a cheap, light-weight shelter that would protect a thermograph or its equivalent against direct short-wave radiation without interfering with ventilation. Construction was to be such that it could be built by unskilled labour, and be installed quickly and easily in any desired location. It was to be comparable to a Stevenson Screen for acquiring comparative data on daily, weekly, and monthly mean air temperatures.

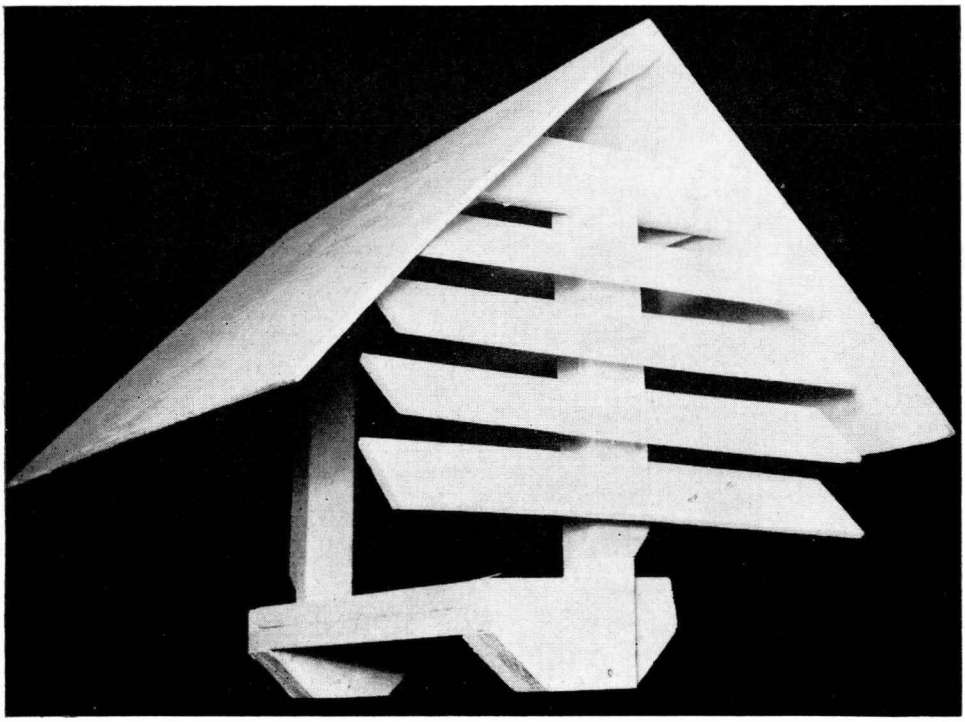

Figure 2. A large size 'Birdhouse' shelter for housing a hygrothermograph.

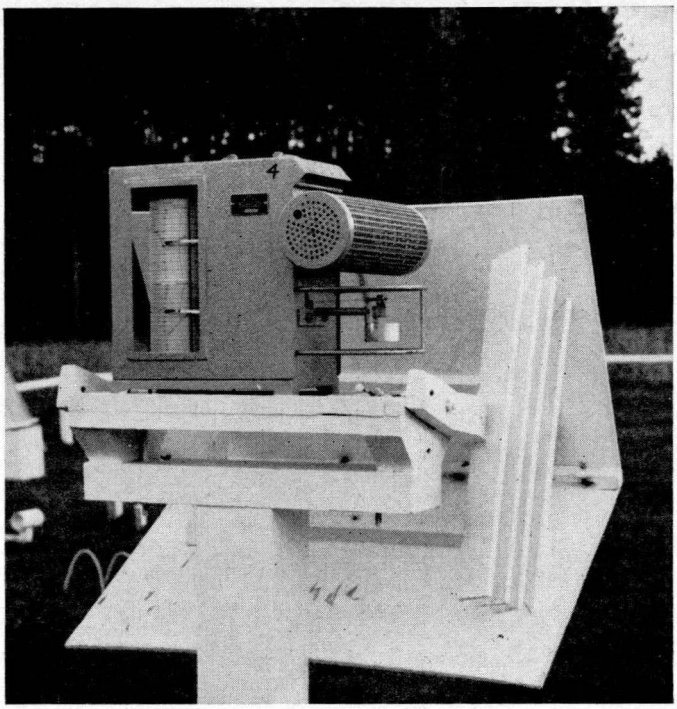

Figure 3. A 'Birdhouse' installation. The roof and end section swings free to facilitate servicing and maintenance.

Figures 2 and 3 show the detail of the shelter, known locally as a 'Birdhouse'. The framework and base are white pine; the roof and louvres are ¼-inch Douglas-fir plywood. Detailed construction plans are available on request.

The cost of the shelter, including materials and labour, is less than $10. The finished shelter (Fig. 2) weighs 10 pounds; a single post provides adequate support (Fig. 3). The T-bar on top of the post is not essential; the shelter may be fastened directly to the top of the post by four 4-inch No. 14 wood screws.

Two Fuess hygrothermographs[2] were standardized in relation to each other[3], and installed in adjacent Stevenson Screen and Birdhouse shelters on the standard weather station at the Petawawa Forest Experiment Station. The sensors of both instruments were 48 inches above the surface. The Stevenson Screen was oriented so that the door opened to the north; the Birdhouse was oriented with the louvres to the west. The data presented in this paper cover the period from January to October, 1960, inclusive.

Daily air temperatures for a sunny day and a cloudy day are presented in Figures 4 and 5, respectively. The patterns are remarkably similar, but the Birdhouse temperature was warmer during the daytime and cooler during the night than that measured in the Stevenson Screen. The period of higher Birdhouse temperature was more protracted on sunny days. Mean daily temperatures based on daily minimum and maximum temperatures were the same for both types of shelter.

[2] The hygrograph mechanisms were not used in these tests and the instruments are referred to hereafter as thermographs.

[3] The two instruments were placed in a constant temperature room and adjusted to read within 1°F of the temperature indicated by a calibrated mercury thermometer.

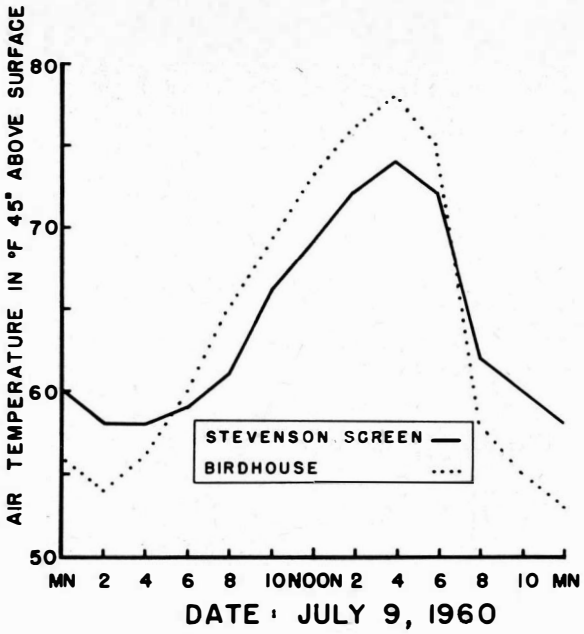


Figure 4. Daily courses of air temperature measured by thermographs on a sunny day. Sunshine ratio (proportion of possible hours of sunshine) .91; average windspeed N-NW 3.5 mph.

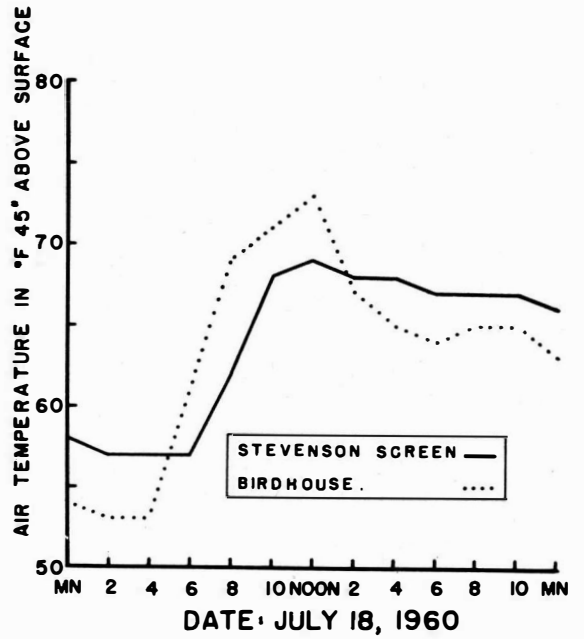


Figure 5. Daily courses of air temperature measured by thermographs on a cloudy day. Sunshine ratio (proportion of possible hours of sunshine) .17; average wind speed SE 5.2 mph.

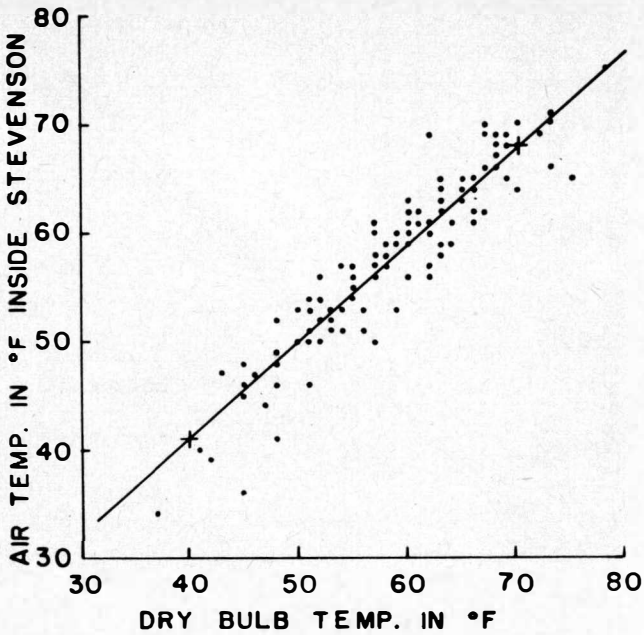


Figure 6. Regression of air temperature measured with a thermograph in a Stevenson Screen on dry bulb temperature obtained with a sling psychrometer at 0800 hours.

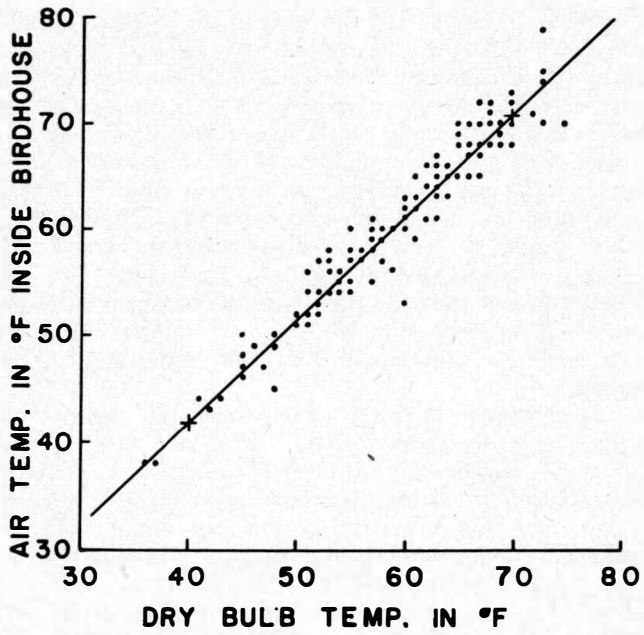


Figure 7. Regression of air temperature measured with a thermograph in a Birdhouse shelter on dry bulb temperature obtained with a sling psychrometer at 0800 hours.

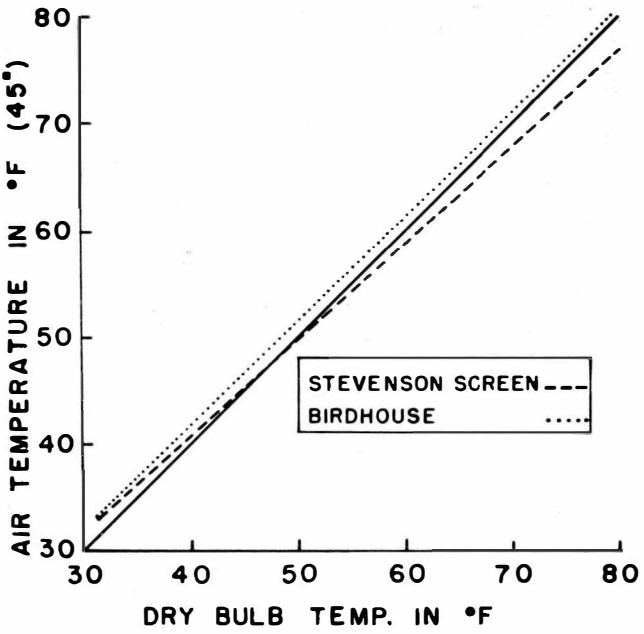


Figure 8. Air temperature regression lines for the Stevenson Screen and the Birdhouse compared with the 45-degree line indicating perfect correlation with dry bulb temperature. Air temperatures in the shelters were measured with thermographs; sling psychrometers were used to obtain dry bulb temperatures.

The relationships between air temperature in the two types of screen and dry-bulb temperature obtained with an M.S.C. Type D sling psychrometer are illustrated in Figures 6, 7, and 8. Regressions of Stevenson Screen and Birdhouse temperatures on dry-bulb temperatures at 0800 hours for the period June to September are given in Figures 6 and 7, respectively. The two regression lines are compared with a 45-degree line indicative of a perfect correlation in Figure 8.

Mean weekly temperatures (Fig. 9) were calculated from chart temperatures at 2-hour intervals. The temperature courses during the 10-month period are very similar. Figure 10 depicts the mean monthly temperatures during the same period. Once again the pattern is almost identical.

The better protection that the Stevenson Screen provides against all radiation is achieved at the expense of interfering with ventilation. The Birdhouse was intentionally designed to eliminate only direct radiation and has a negligible effect on ventilation.

The lower temperature in the Birdhouse than in the Stevenson Screen at night and during cloudy days was probably associated with the better ventilation in this shelter. The higher daytime temperatures may have resulted from greater exposure to indirect, or long-wave radiation. However, since temperatures in a Stevenson Screen only approximate true air temperatures (6), for many purposes Birdhouse temperatures may be an acceptable approximation as suggested by the data presented in Figures 6, 7, and 8.

Although the better ventilation and greater exposure to indirect radiation associated with the Birdhouse may not be truly compensating, one may offset the other sufficiently to provide as close approximations to the mean temperatures of a natural environment as those obtained in a Stevenson Screen.

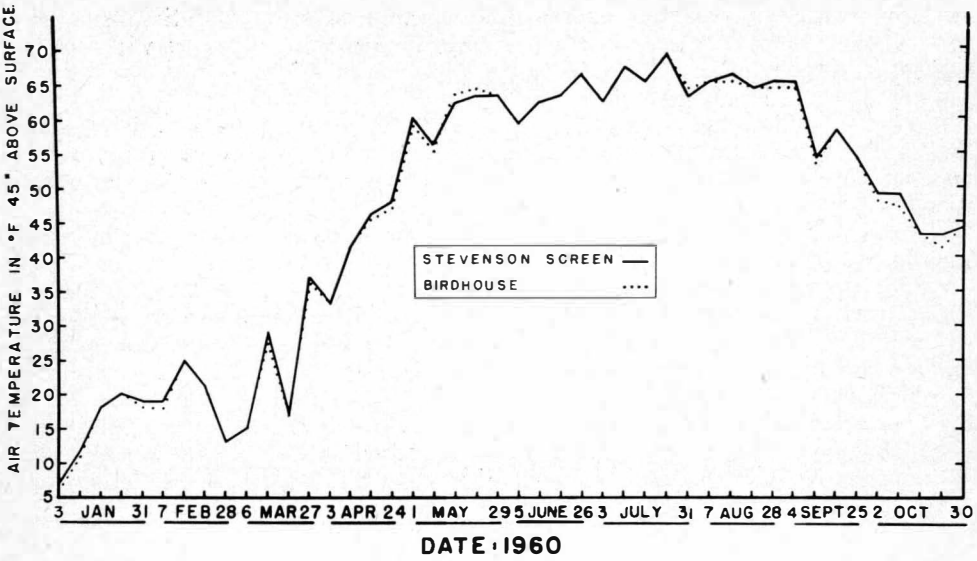


Figure 9. Mean weekly air temperatures based on thermograph measurements from January 3 to October 30, 1960.

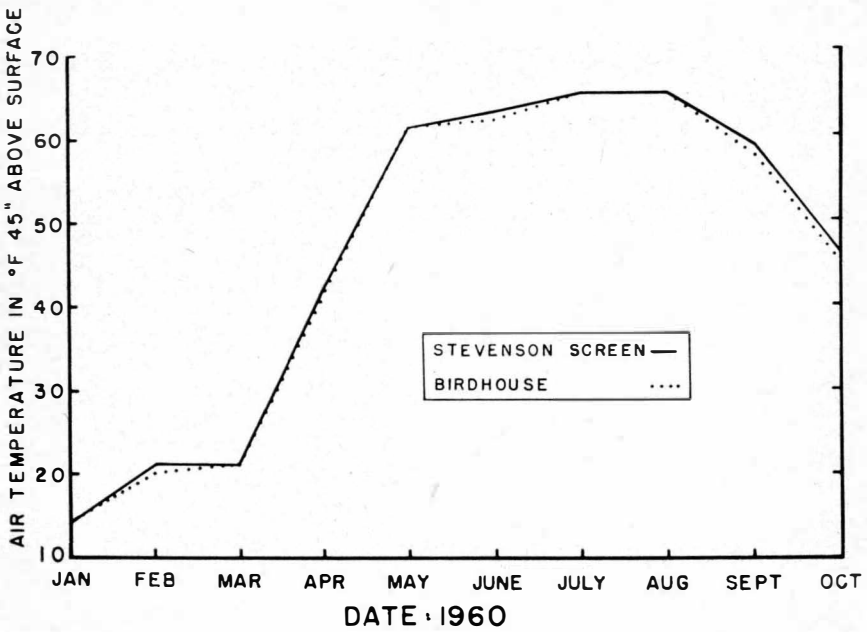


Figure 10. Mean monthly air temperatures based on thermograph measurements from January 3 to October 30, 1960.

Since Birdhouse shelters expose thermographs to some radiation from the ground, temperatures recorded on sunny days in Birdhouses on sites with widely different albedos may not be strictly comparable. In practice, such aberrations are not likely to be important.

Without additional data it would be as difficult to establish which shelter allows the more accurate measurement of air temperature as it would be to account for the differences in individual readings. Nevertheless the measurements do demonstrate that there is little choice between these two shelters for the stated purpose of obtaining comparative data on daily, weekly, and monthly mean air temperature.

The Birdhouse is therefore recommended as a cheap, convenient, and acceptable substitute for the standard shelter for obtaining acceptable approximations of mean air temperature when financial or other considerations such as inaccessibility of study areas preclude the use of standard Stevenson Screens.

Care should be taken to avoid using a Birdhouse shelter on one site and a Stevenson Screen on another in the same study. But it is advisable to maintain parallel installations of both shelters on an acceptable standard weather site to facilitate comparisons between local Birdhouse data and those available from established Stevenson Screen installations.

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