PORTABLE ANIMAL PROTECTION SHELTER AND WIND SCREEN

by

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INTRODUCTION

Shelters built on open rangeland to protect livestock from wind and blowing snow are typically large and stationary. Recently our attention has focused on smaller, movable shelters as temporary protection for individual animals and/or field personnel. Portable barriers would be especially useful for protecting problem animals during calving, when losses in blizzards can be substantial. This paper presents the design and testing of a V-shaped wind screen that can be hauled in a light-duty truck (pickup) and set up by one person in blizzard conditions.

SHELTER DESIGN

Jairell and Tabler (1985) investigated various shapes of animal protection shelters with small-scale models in drifting snow on a frozen lake. Solid-walled semicircular or V-shaped shelters give better protection than straight barriers, especially in winds of variable direction. Both "V" and semicircle deflect snow into similar "wing" deposits that extend downwind approximately 5 times the shelter width D (Fig. 1a), for winds aligned with the centers of the shelters.

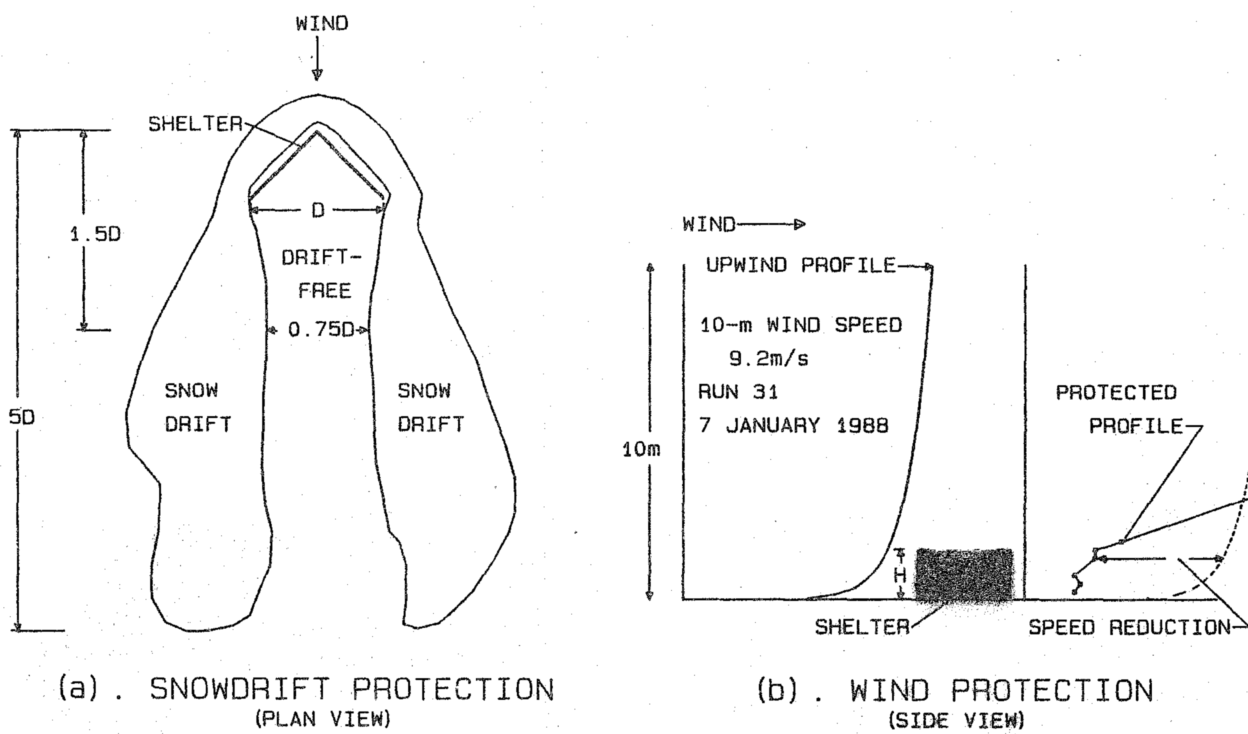

Figure 1. (a). A V-shaped shelter with solid (nonporous) walls deflects snow around the ends, forming "wing" deposits on each side of a drift-free zone downwind of the barrier (Jairell and Tabler 1985). (b). Wind protection is determined as the percentage reduction in ambient wind speed, using measurements of the vertical profile.

Presented at the Western Snow Conference, April 18-21, 1988; Kalispell, Montana.

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Porous snowfences (Tabler 1980) and shrub rows (Peterson and Schmidt 1984) offer greater wind protection over a larger downwind area than a solid barrier of the same height. Porous barriers also collect more snow. An objective in testing the portable device was to learn if a small, V-shaped shelter with a porous fabric face would divert enough drifting snow to give good wind protection without accumulating a snowdrift in the shelter area.

Steel corral panels, 1.5 m tall by 2.4 m long (5 by 8 ft) provide a frame that supports the shelter covering (Fig. 2). These rigid panels, weighing 230 kg (105 lb) each, are made to be pinned together at the ends, with adequate cross members to support a flexible fabric. The cover is cut to fit the frame (5 by 16 ft), with each end sandwiched between two 1-by-6-in boards 1.5 m (5 ft) long. Hinge parts, fabricated to match those on the corral panels, attach to the boards that clamp one end of the fabric, so the fabric may be fastened at one end of the shelter, using the panel pins. Eyebolts are fitted 30 cm (1 ft) from the top and bottom of boards on the other end. The material is rolled around the boards, with the hinge parts out, for storage.

To set up the shelter, two corral panels are held up and pinned together into a "V" pointing into the wind. The rolled covering is pinned to one end of the shelter and unrolled on the upwind side of the shelter (Fig. 2). Shock cords (bongees) from the eyebolts to the cross members of the panel hold the material tight.

SHELTER TESTS

Ease of handling in adverse weather, stability in strong winds, and "quality of the protection" were concerns we explored during field tests. Protection includes not only wind speed reduction and deflection of drifting snow, but also turbulence reduction, which enhances the "feeling" of being sheltered. A study site near the Cooper Cove interchange of Interstate Highway 80, 35 miles west of Laramie in southeast Wyoming, provides consistent west wind during blizzards. In most winters, drifting snow is frequent over this flat, shortgrass rangeland. We installed two corral-panel frameworks at the site on 6 January 1988, to test a solid and a porous design simultaneously (Fig. 3). Reinforced plastic tarp (solid) covered one set of panels, and the other supported plastic snowfence (50% porous).

After learning the procedure, one person could erect a portable shelter on open rangeland in about 5 min, with 15-m s^{-1} (30-mph) winds. If the shelter is hauled in a pickup, pointing the vehicle into the wind and assembling the shelter in the protected wake formed by the truck makes setup possible in much stronger winds.

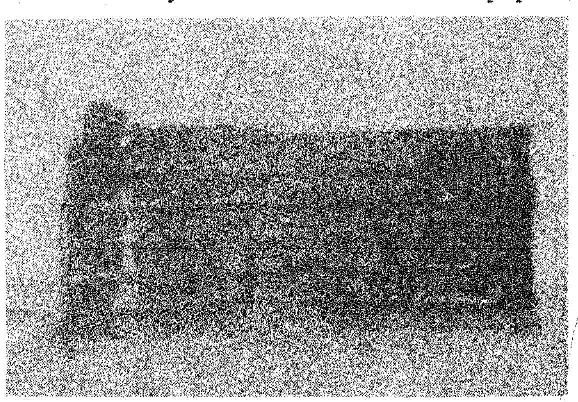

Figure 2. With the covering pinned to one end of the panel frame, unrolling the fabric along the upwindface of the shelter is possible even in strong winds.

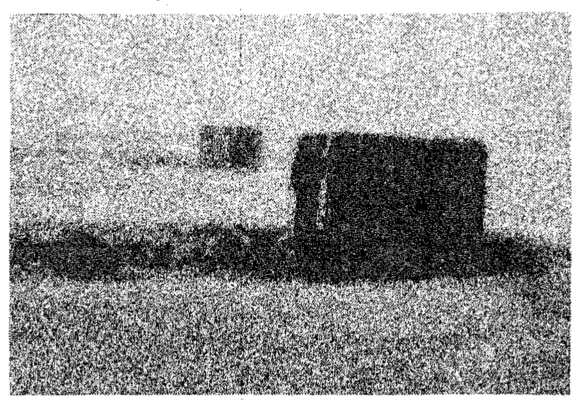

Figure 3. The protection behind solid and 50% porous coverings was compared by measuring wind speed reduction.

To evaluate wind shelter, we measured vertical profiles of horizontal wind speed and temperature with a computer-controlled system housed in a mobile van. Portable 10-m masts (Jairell et al. 1984) located downwind of each shelter supported cup anemometers at 9 levels above the surface (Fig. 1b). A third mast located 45 m upwind of the panels provided measurements of the ambient wind and temperature profiles. A vane tracked wind direction midway between the shelters, which were separated by 24 m perpendicular to the mean wind to avoid interaction.

We measured all data reported here on 7 January 1988. During each 5-min data run, the computer accumulated wind speeds and temperatures from each sensor, then plotted profiles of wind reduction behind each shelter. At the end of a series of 3 to 10 runs, the shelters were moved to a new location upwind of the instrument masts. We obtained wind profile series at 1.9, 3.2, 5.1, and 10 m downwind of the apex. With consistent wind direction, plots of wind speed reduction with height were very similar between runs, even for different ambient wind speeds. We also documented shelter performance with still and video cameras.

Wind shelter, as measured by reduction of the mean wind speed at each level, is greatest for the porous barrier (Fig. 4). This advantage is offset, however, by snowdrift formation in the sheltered region. During 24 hours of drifting in a blizzard with 12-m s^{-1} (25-mph) average wind speed (measured at 10-m height), the deposition behind the porous shelter reached a maximum depth of 25 cm.

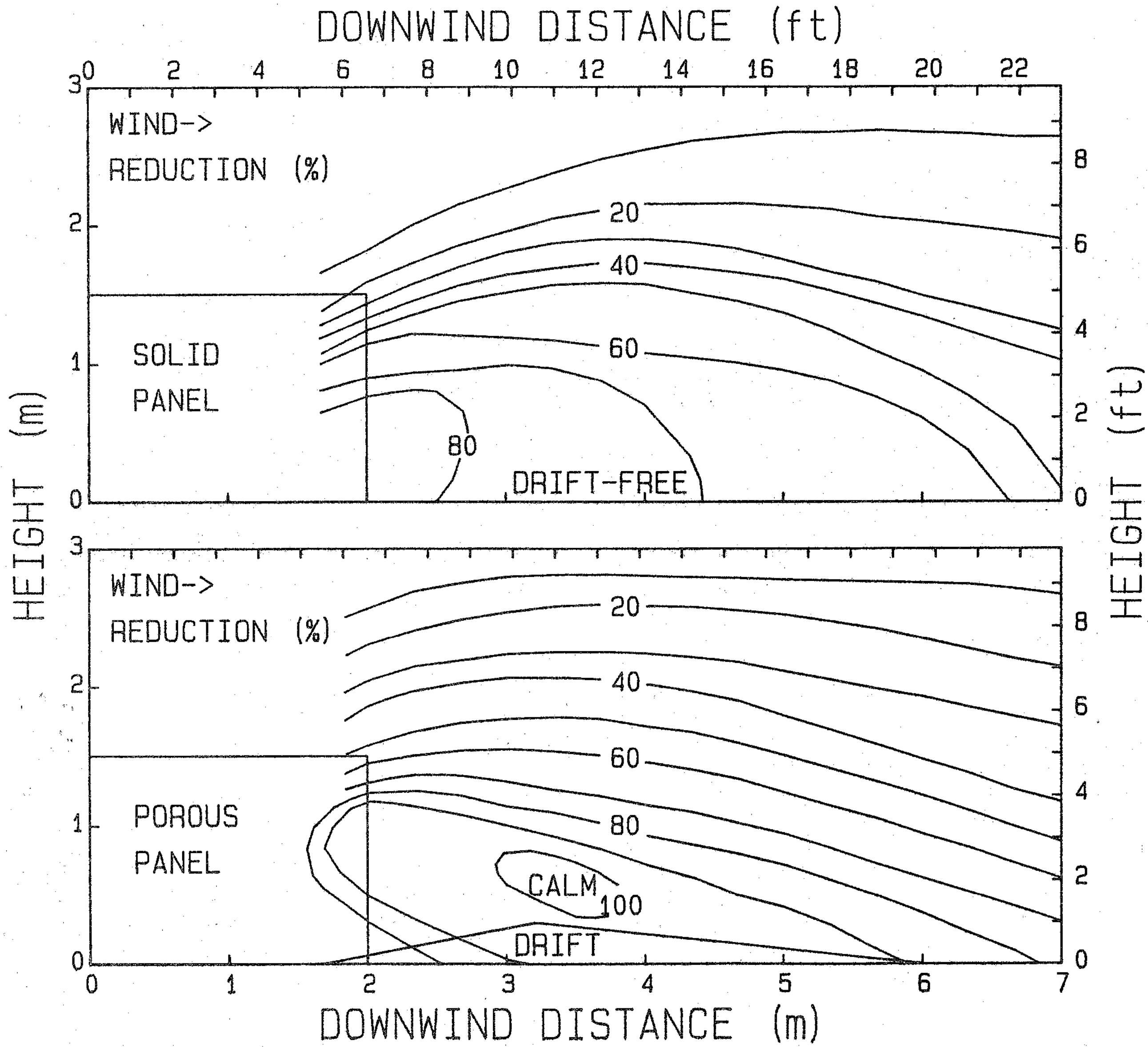

Figure 4. Reduction in mean wind speed is greatest behind the porous covering, but a small snowdrift developed in the protection area.

To measure turbulence, and especially reverse flow behind the two shelters, a propeller anemometer was located 1 m aboveground on each mast. Horizontal velocity fluctuations measured 3.2 m downwind of each shelter apex showed turbulence behind the solid cover was 2 to 4 times stronger, in terms of root-mean-square values (Fig. 5). Periodic flow reversal causes the solid fabric to flap against the support panels.

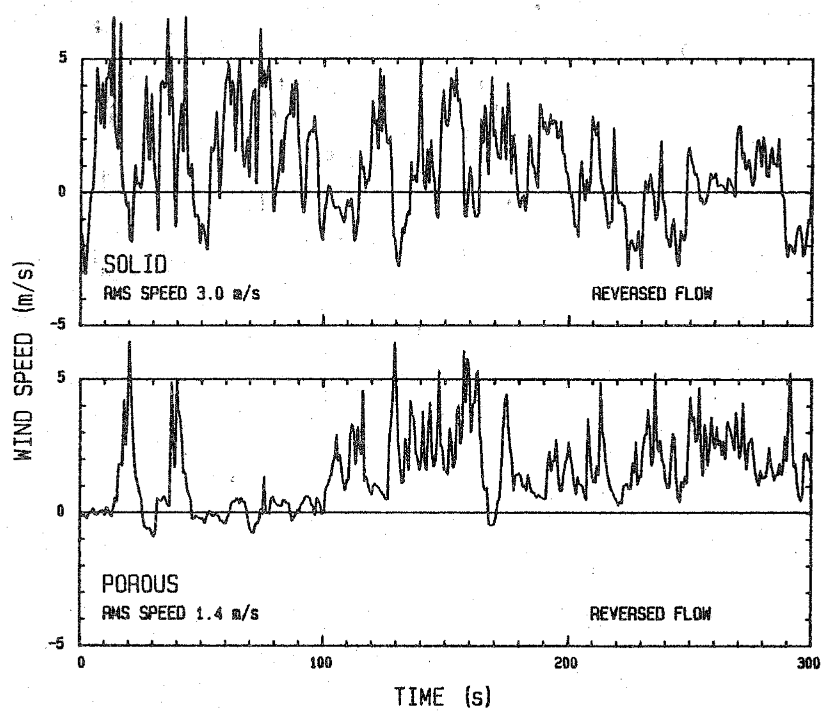

Figure 5. The horizontal component of turbulence, measured with the propeller anemometer 3.2 m behind the panel apex, was 2 to 4 times greater behind the solid panel, where reversed flow was more frequent and stronger.

Wind gusts exceeded 30 m s^{-1} (60 mph) during tests, with no indication of shelter instability. However, if wind enters the "V" from the back, or shelter side, the panel ends "walk" until the barrier becomes straight and falls over. For shelters left overnight, we recommend using guy stakes such as 3/4-in reinforcing rod, and anchoring each corner of the shelter to a stake with a shock cord. For shelter during a few hours in a blizzard, anchoring is usually unnecessary.

CONCLUSIONS

Results of the wind profiles measured in the shelter region behind each barrier showed both shelters were easily set up, and provided effective wind reduction. The greatest wind reduction was behind the porous fabric because flow through the material prevented reverse flow, reducing turbulence. However, the porous material allowed a snowdrift to form in the sheltered area. No snow deposited in the protected area behind the solid fabric. Both shelters were stable in 30-m s^{-1} (60-mph) wind gusts.

For the best protection, the shelter should point into the wind, 5 m (15 ft) upwind of the area to be protected. The porous material gives better wind protection, but the solid fabric is recommended for protection in blizzards, when snow accumulation is undesirable.

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