

LIGHT UNDER A SNOWDRIFT ON LAKE ST. GEORGE

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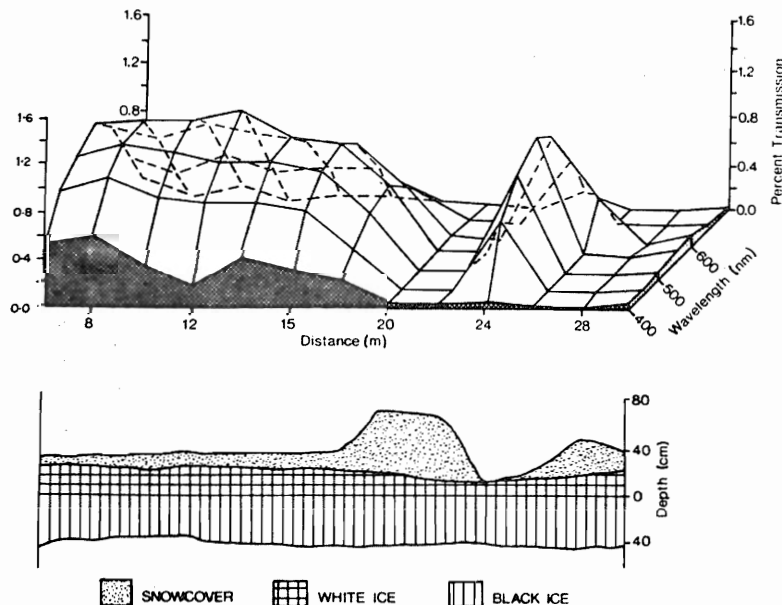
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ABSTRACT

Measurements were made of the quality and quantity of light penetrating a strip of the winter cover of a small temperate lake. Snow and ice along the strip were modified by means of snow fences installed early in the winters concerned. Pronounced variations in the amount of light reaching the unfrozen lake body and in spectral selection of that light were demonstrated. By inference, even greater variations in light occurred across the lake as a whole.

Although wavelength differentiation is of considerable importance in biological processes such as photosynthesis, studies of spectral aspects of light transmission through snow and ice, especially snow and ice on lakes, were not common until recently. Work such as that of Maykut and Grenfell (1975) on sea ice and of Richardson and Salisbury (1977) on land snowpacks have a qualitative value in fresh water, lake situations. However, Adams (W.A. 1978) appears to have been the first to focus on the detail of spectral selection by a fresh water lake cover and to consider spatial aspects of light transmission by ice and snow on lakes.

Figure 1. Spectral distribution of light under a range of snow and ice conditions, generated by a snow fence, 15 February 1979



This note contains the results of part of an experiment (Adams, W.A. et al, 1983) designed to determine the range of light conditions under the ice and snow cover of a small lake in southern Ontario. As an approach to this, a section of the ice cover was modified by means of snow fences erected early in two successive ice seasons. These fences produced an uneven distribution of snow which altered the pattern of ice growth in the section concerned. The idea was to produce a range of cover conditions which approximated the range over the lake as a whole. The changes in both snow and ice affected the light regime of the unfrozen water of the lake.

Lake St. George is 32 km north of Toronto, Ontario. It has a surface area of 10 ha, a mean/maximum depth of 5.8 m/14.3 m and a total volume of  $53 \text{ m}^3 \times 10^4$ . Light measurements were made with a QSM 2500 submersible scanning spectrometer (Tectum Is. Sweden) adapted for low temperatures (Adams, W.A. and Flavelle, 1977). The instrument's wavelength range was 400 nm to 740 nm. Two sensors were used at the same time, one measuring irradiant surface radiation, the other reflectance and transmittance. Under-ice measurements were made by means of a buoyant sled pulled under the test strip on a cable. In 1978 only, after the above measurements were completed, the ice surface was swept free from snow and the light measurements were repeated to isolate the effect of the snowcover. Full details of this procedure and of data reduction are given in Adams, W.A. et al (1983).

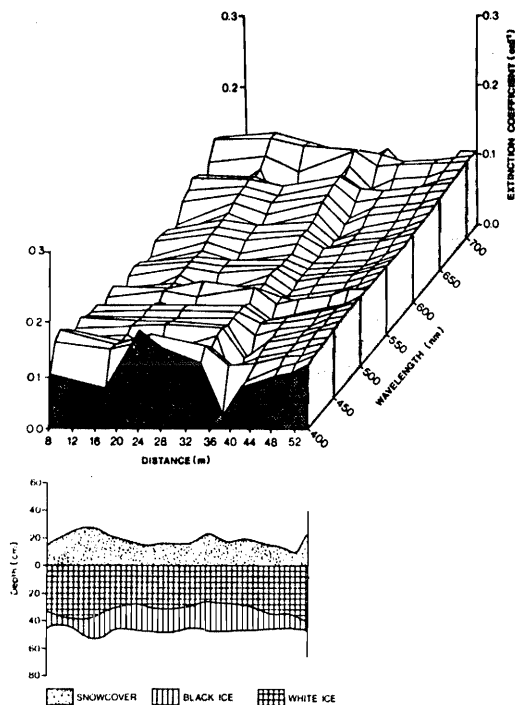


Figure 2. Spectral distribution of light under a range of snow and ice conditions, 26 February 1979, expressed in terms of the extinction coefficient.

Figure 3. The role of snow in the spectral distribution shown in Figure 2.

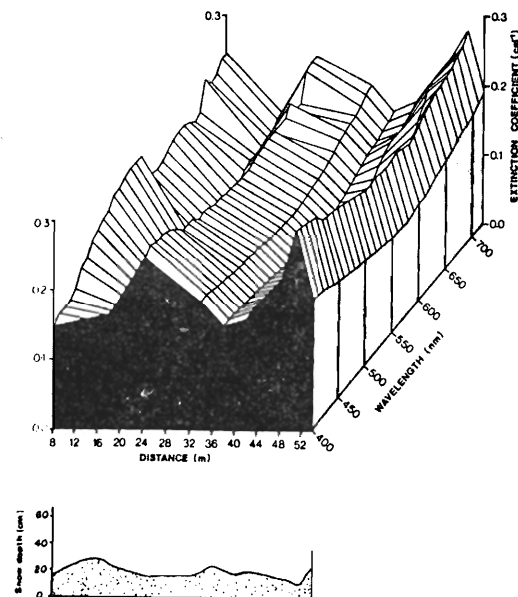


Figure 1. shows the effect of the entire snow and ice cover on light. As depth of white ice is almost constant, the dominant role of snow in light transmission can be seen. Where snow is deepest, transmission is least. Peak spectral transmission is near 550 nm with a normal distribution around that wavelength band.

Figure 2. from the previous year displays the effect of the entire cover on the extinction coefficient. The range of snow conditions here is less striking, but the variability of white ice is more marked. Peak extinction values are approximately 16 m, 34 m and 45 m along the test strip, and appear to be weakly related to sites of average, or below average, snow and least white ice. The 54 m location is an exception in that it has lowest snow and white ice values. The lowest extinction values appear near 8 m, 24 m and 38 m, which had either or both above average snow and white ice. Spectral selection is not pronounced here.

In Figure 3., the effect of snow alone, subsumed in Figure 2., is shown. Peak extinction values appear near 8 m, 22 m and 52 m, all sites are of relatively low snow depth. Extinction coefficients are lowest at 18 m, 38 m and 54 m where snow is relatively thick. The greater magnitude of values in Figure 3., as compared with Figure 2., again illustrates the dominance of snow in light attenuation. However, the spectral selection in the two Figures are similar.

The snow fence procedure used does appear to have a value for studies of the light regime of lakes in winter. The variation in snow and ice produced here along the test strip was relatively small in comparison to that which has been demonstrated to occur naturally across even quite small lakes (Adams and Prowse, 1981, Adams and Roulet, 1980). However, periodic drilling in the vicinity of the artificially created snowdrift, could be used to increase the diversity of the strip. It is apparent from the data presented here that the variation in the quality and quantity of light penetrating a lake cover must both vary greatly at different locations on a lake in winter.

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