Snow Bunting (*Plectrophenax nivalis*) Roosting Sites
A Strategy for Nighttime Survival in Winter?

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ABSTRACT

The snow bunting (*Plectrophenax nivalis*) is a ground nester on the arctic tundra that overwinters in north-temperate latitudes. Snow buntings were studied at Sudbury, Ontario over the course of two winters. The first winter was devoted to studying foraging behaviour and to locating nightly roosting sites. Known foraging sites of the snow buntings were studied from January to March of 1993. Some birds arrived at the feeder before sunrise, whereas others arrived as much as 30 minutes after sunrise. They fed for about one hour. Feeding then diminished until one hour before sunset, after which birds left for their roosting sites. General observations suggest that light plays a role in the feeding activity of the snow bunting.

The roosting sites were located in February 1993 and were monitored for the remainder of the winter and during the winter of 1994. In 1993, the snow buntings roosted within waste rock piles on the floor of a local quarry 2 km NW of the feeding station. However, in 1994, the birds roosted in cracks and crevices within a south-facing rock wall approximately 15 metres in height. Some crevices were used repetitively, although not necessarily by the same bird, and communal roosting did occur. Data collected so far indicates that the sheltered roosts offer protection from wind and predators and provide more favourable temperatures than do open areas.

Key words: snow bunting, roosts, foraging, temperature

INTRODUCTION

For many organisms, winter means enduring the rigors of the season and resisting its stresses (Marchand 1987). It is a time when diurnal birds in regions of north-temperate latitudes are confronted with low air temperatures, short day lengths and diminishing food availability (Buttemer 1985). In order to survive, homeothermic organisms must maintain a body temperature within rather narrow and relatively high limits. Therefore, they must produce enough heat by metabolism of food or fat reserves to offset those lost to the cold surroundings. At a time when mobility is restricted and food resources are scarce, survival in the cold often becomes equated with heat conservation. Staying warm is more difficult for small birds. Because they have a large surface area to volume, their heat loss is greater than those of larger birds (Carey and Marsh 1981). Smaller birds also have less insulation than larger birds because their size limits the thickness of their plumage (Carey and Marsh 1981). Studies suggest that during periods of extreme cold, larger birds can endure fasting for longer periods of time than small birds (Carey and Marsh 1981).

Fortunately, birds can use a combination of two general strategies to cope with the cold. First, birds can use mechanisms that allow for high levels of heat production for long periods of time, such as shivering thermogenesis (Carey and Marsh 1981). Second, they can reduce the amount of heat needed to maintain a high body temperature by fluffing feathers, controlling hypothermia or selecting a more favourable microclimate (Carey and Marsh 1981).

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Although all diurnally active birds save energy by selecting roost-sites that minimize heat losses to the environment, the choice of winter roosts may be more important to small birds (Buttemer 1985). This study focuses on the night-time roosting sites of snow buntings *(Plectrophenax nivalis)* in Sudbury, Ontario. Snow buntings are ground nesters on the arctic tundra and are among the smallest birds that over-winter in north-temperate latitudes. Their primary food is seeds. Snow buntings breed farther north than almost any other land bird. Their North American breeding range includes arctic Canada to the northern limits of land, as well as Alaska and Greenland (Godfrey 1966). During the breeding season, snow buntings seek out terrain such as mountain slopes and rocky shores, where the birds nest in cracks in cliffs or in piles of boulders. Our winter observations indicate that, when foraging, snow buntings seek out areas similar to those they nest in during the breeding season. They particularly favour open countryside. However, it seems highly unlikely that they would roost in the open because of radiation losses to the night sky and because of exposure to wind, freezing rain and potential predators. I wondered whether the Sudbury landscape, which in many respects parallels the open, rocky arctic sites where the birds have been observed nesting, might not offer night time roosting sites that are similar to their summer nesting sites. These night time roosting sites may offer protection from both predators and the elements. Therefore, the place or places that these birds choose to seek shelter is critical to their survival. Answers to the following questions were sought: (1) Where do snow buntings spend the night during the winter? (2) Is there a single roost site that is used repetitively? (3) Do the birds roost singly or communally? (4) What are the microclimatic characteristics of the chosen roosting site(s)? (5) What are the climatic conditions that encourage or impede their foraging? (6) Is light level a single cue to feeding activity?

METHODS

Foraging Site

The behaviour of the snow bunting at one foraging site was studied from mid-December 1992 to April 1993 and from January to March 1994. Two flocks of about 20 birds each were observed at two feeders on the outskirts of Sudbury, Ontario. The feeders were about 100 m apart and were filled with wild bird seed--primarily millet seeds. Foraging behaviour was documented regularly during various weather conditions throughout the study period. The time of arrival in the morning and the time of departure in the evening was also recorded.

Roosting Site

Snow buntings were visually tracked to their nightly roosting area during the study period-February to April 1993 and January to March 1994. The roosting sites were located in a seldom-used quarry adjacent to Kelley Lake, Sudbury, Ontario, and were approximately 2 km northwest of the feeding station.

Roosting sites in the quarry were identified by both the presence of snow buntings in the evening and by the presence of large amounts of bunting guano. During the first winter roosting sites were located within waste rock piles. As these sites were discovered late in the first season, instrumentation of the rock piles with thermocouples could not be implemented until the second season. However, the rock piles were crushed during the summer of 1993 to provide aggregate for the production of ready-mix cement. As a result, during the second winter the snow buntings chose new roost sites, thus demonstrating that they are opportunistic with respect to adequate night time roosts. The new roosts were located on ledges and in crevices on a south-facing rock wall approximately 15 metres above the quarry floor. With the help of a skilled technical rock climber, thermocouples were inserted into two different areas known to be frequent roosts of the snow buntings. One roost was monitored in the first area and two roosts were monitored in the second area. One thermocouple was placed in each roost. The thermocouples were placed as close as possible to where we thought the birds would roost, thus they were sheltered from radiation, wind and precipitation. The leads were then extended to the top of the cliff for attachment to monitoring equipment. The thermocouple in the first area was connected to a Campbell 21X data logger, which recorded hourly data. Other instruments connected to the data logger included a radiometer for measuring solar radiation, a wind vane and a three-cup anemometer for measuring wind direction and wind speed. A separate thermocouple measured air temperature was connected, which would be similar to an open roost. The data logger recorded data at this first area for approximately three months. The other two thermocouples were put into the second area of the rock wall and were monitored periodically with a portable digital thermometer.

RESULTS

Foraging Behaviour

Snow buntings tended to arrive at the feeding station in numbers as small as one to as many as sixty. They began arriving at various times before sunrise and until 15 minutes after sunrise, implying that light is a trigger for feeding activity. During this time, snow buntings were observed to feed intensively while being very cautious of their surroundings. Feeding took place primarily on the snowpack below the feeder. Figure 1 shows the intense feeding activity on a typically cold winter morning. Feeding took place from the time that the birds arrived in the morning until they left the feeder. The number of birds feeding continued to increase until a maximum number of 35 birds was reached. Feeding occurred over an interval of 30 minutes and then diminished abruptly for the rest of the morning.

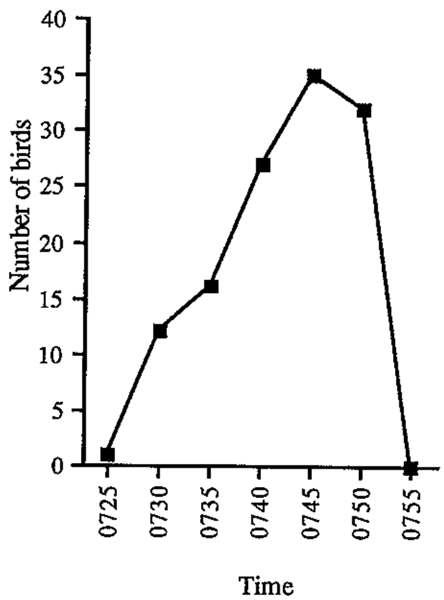

Figure 1. The change in the number of birds feeding at an urban feeder in Sudbury, Ontario, during the morning of February 9, 1994, at an air temperature of -25 °C.

Figure 2 illustrates the feeding activity on a warm morning during the winter. In contrast to the cold morning (Figure 1), fewer birds were feeding. Feeding occurred over a 30 minute interval but the activity was much more sporadic.

Throughout the late morning and early afternoon, feeding activity at the two particular feeders was light. The snow buntings spent most of the afternoon sitting quietly in the trees or flying around the rock quarry exhibiting various types of behaviour. In the late afternoon, approximately one hour before sunset, intensive feeding occurred once more, again suggesting that light plays a role in feeding activity. Figure 3 shows the intense feeding activity on a typically cold afternoon during the winter. Although the air temperature was only -11 °C, the human wind chill factor was -25 °C. There were many birds feeding, as on the cold morning, but in contrast, feeding occurred over one and a half hours, a much longer period of time. As well, there was no abrupt departure as seen on the cold morning (Figure 1). The number of birds decreased more slowly with the last birds leaving just minutes before dark. Although analysis of radiation is still ongoing, general observations imply that the snow buntings are crepuscular, as they begin feeding at first light and stop just before dark.

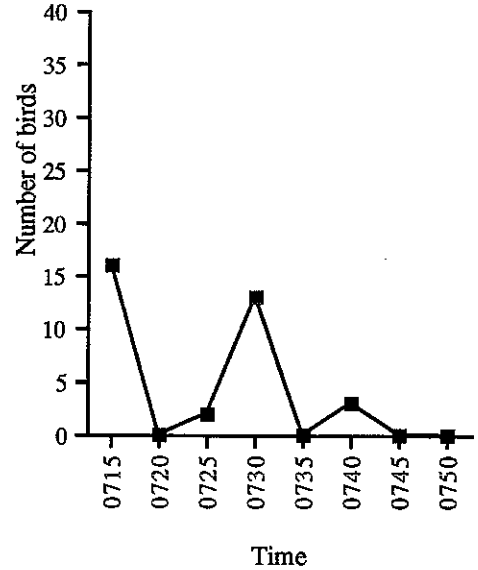

Figure 2. The change in the number of birds feeding at an urban feeder in Sudbury, Ontario, during the morning of February 20, 1994, at an air temperature of +3 °C.

Figure 4 shows the feeding activity on a warm winter afternoon. As on the warm morning, there were less birds feeding than on the cold days, and the activity was sporadic. In contrast to the activity on the cold afternoon, feeding occurred over the course of only 45 minutes. The sporadic feeding activity on the

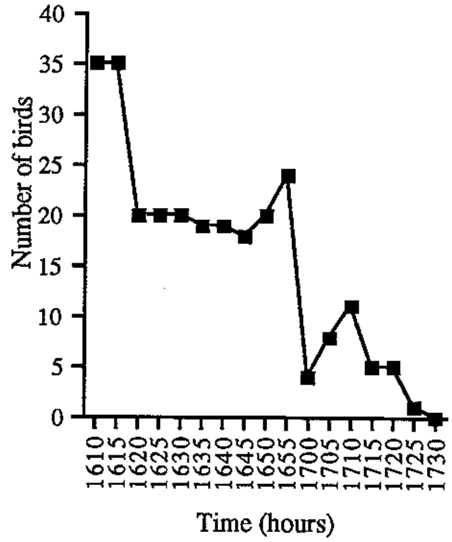

Figure 3. The change in the number of birds feeding at an urban feeder in Sudbury, Ontario, during the afternoon of February 7, 1993, at an air temperature of -11 °C.

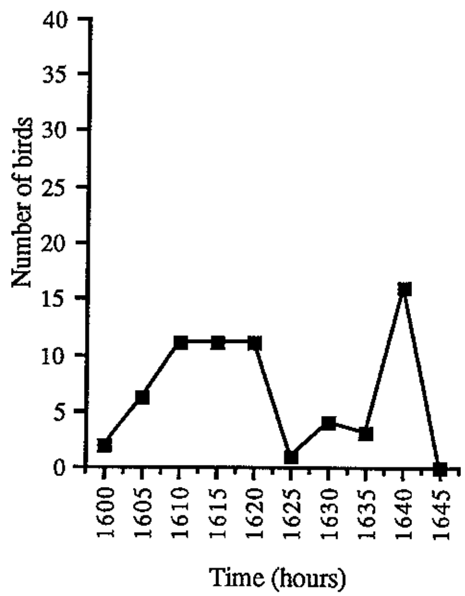

Figure 4. The change in the number of birds feeding at an urban feeder in Sudbury, Ontario, during the morning of January 4, 1993, at an air temperature of +1 °C.

warm days may imply that the birds do not have the need to feed that they do on colder days.

Roosting Behaviour

Snow buntings tended to arrive at the roosting sites at various times before sunset. During the first winter, one of three rock piles had more bird droppings and appeared to be used more often that the others based on the amount of droppings. In addition, within the three rock piles, the cavities located in the middle of the pile seemed to be used the most, because the bird droppings were most abundant in those areas.

During the second winter, many areas of the rock wall were used. Data collected for three months indicates that the roosts in the rock wall offer a more stable microclimate than a roost in the open. Figure 5 shows the change in roost and air temperature on a representative cold winter day from 1600 hours on one day to 1200 hours the next day. It can be seen that the air temperature progressively decreases from -10 °C to a minimum of -24 °C, in the early hours of the morning. In contrast, the roost temperature decreased only 6 degrees from -9 °C to -15 °C, again with the minimum, temperature being reached during the early hours of the morning.

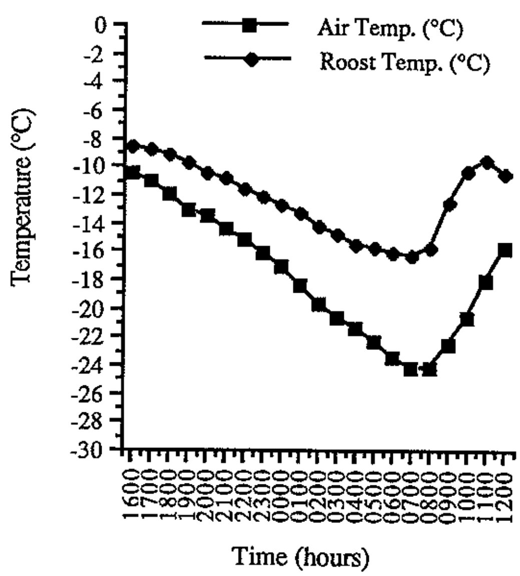

Figure 5. The change in air and roost temperature (°C) from 1600 h on February 25, 1994, to 1200 h on February 26, 1994.

Figure 6 shows the same type of trend on a representative warm winter day. Again, the air temperature decreases progressively from 0 °C to a minimum of -14 °C whereas the roost temperature decreases less from -3 °C to a minimum of -11 °C. Although the temperature difference between the rock and the air is slight, using the roost probably still provides a thermal advantage. In addition, the radiation loss to the night sky is minimized since the bird is protected by at least two rock walls.

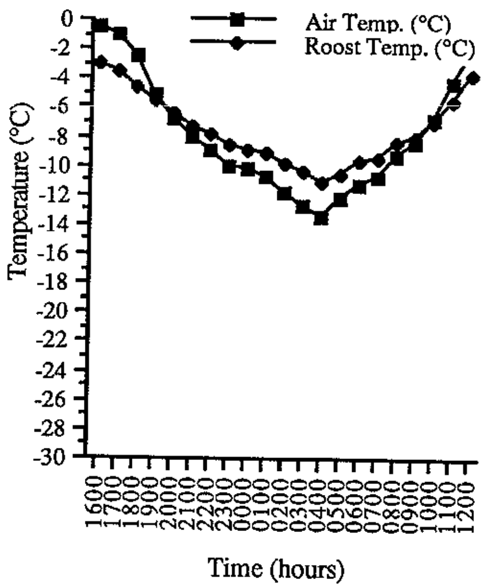

Figure 6. The change in air and roost temperature (°C) from 1600 h on March 1, 1994, to 1200 h on March 2, 1994.

DISCUSSION

The majority of cold-climate birds, such as snow buntings, are diurnal, rather than nocturnal or diel. They have large requirements for food to fuel the costs of heat production (Carey and Marsh 1981). Following a long winter night of fasting, birds must replenish their food reserves in order to make it through the next night. Thus, it makes sense that the foraging area should be close to the roosting area. Buttemer (1985) suggests that the energy cost of roosting is comprised of a bird's metabolic expenditure while occupying the roost, and its costs in travelling to and from feeding areas.Therefore, the amount of energy conserved by roosting in an area that provides this amount of protection, and that is close to the feeding area, may make the difference between survival and death during periods of colder weather. Our observations established that the snow buntings fed intensively in the morning and afternoon during most of the winter. However, certain weather conditions imposed difficulties to feeding. During mornings of very low air temperatures and strong winds, the snow buntings were seen sitting closely together in snow burrows or on rock faces in the lee of the wind while taking turns feeding. This appeared to be a strategy to minimize heat loss while still having the opportunity to feed. The birds conserved more heat energy by sitting still in a sheltered area than by spending extra energy fighting the cold and wind in order to feed. These findings are consistent with Carey and Marsh (1981), who found that black-capped chickadees remained in their roosts for longer periods during the daylight hours and foraged for shorter periods during cold spells than during milder days. This behaviour would reduce the high heat losses incurred by convection during flight and would conserve energy. On such days, although foraging may be reduced, it is important for birds to consume enough food before they leave for the night. Buttemer (1985) suggests that if either excessive snow or ice storms were to prevent goldfinches from feeding for an entire day, most of them would perish. It has been questioned whether birds, including snow buntings, can predict how much food to eat before leaving for the roost site. The weather conditions may change considerably so as to impede their foraging activity the next morning. Lawrence (1958) noted that black-capped chickadees fed voraciously prior to a major temperature drop, apparently in response to a rapid change in barometric pressure. This may also explain why snow buntings fast during cold and windy mornings, but always feed on those same afternoons.

In addition to the roost's proximity to food sources, the physical qualities of the roost sites are also critical to the survival of the snow bunting. On both warm and cold nights, the roost temperature is warmer than the air temperature. The stability of the rock temperature reflects the fact that large rock masses cool down and heat up slowly, and that there is a small but steady geothermal heat flux. Air cools and heats quickly.

The temperature between the air and the roost was greatest during the early morning hours when the energy reserves of the animal are lowest. In addition, most of the roosts used by the snow buntings are sheltered from the wind and predators that frequented the quarry. Buttemer (1985) found that goldfinch roost sites promoted energy savings for all conditions studied, however, the energy benefits derived from their use were greatest during periods of wind. He also suggests that smaller birds may have a greater energy incentive to select wind-protected roosts than larger birds. Swann (1975) also found that wind direction had some effect on the numbers of snow buntings using some roosts, with the birds preferring to roost in the lee of the wind.

During the study period, roosting sites were used repetitively, although not necessarily by the same bird. The snow bunting also roosted communally during colder weather, but only in the larger roosts. If a bird fits a cavity well, or if several birds roosted together and added their body heat, the temperature of the air in the cavity may very well rise appreciably through the night and permit the birds to survive on very cold nights(Moore, 1945).

CONCLUSIONS

Observations of foraging activity of snow buntings showed a distinct pattern of feeding during the mornings and afternoons. Light is suspected to play a major role in the initiation and termination of feeding activity (Sartor unpublished). Foraging activity was interrupted during times of severe winds and very low air temperatures. The roost sites in a local quarry offered protection from wind and predators and provided more favourable air temperatures and radiation losses than open areas. Certain roost sites were used repetitively, although not necessarily by the same bird, and communal roosting occurred during times of colder weather.

ACKNOWLEDGMENTS

I would like to thank the property owner, C. Fielding, for his cooperation in allowing me the use of the quarry, Roel Teunissen for his help in setting the equipment up in the quarry, and Neil Merrifield for his help with the fieldwork and for his patience and support. I gratefully acknowledge G.M. Courtin for his supervision of the research and for his valuable time, criticisms and never-ending support.

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