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Weather Factors Influencing Winter Roosts of American Crows in Central Iowa

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We investigated the effects of season and weather on the winter roosting behavior of American Crows (*Corvus brachyrhynchos*) in central Iowa from January through March 2006. The peak number of birds recorded at a roost in Ames, Story County was 9,000+ in early February, and the number of individuals entering the roost decreased through February and March. Crows tended to enter the roost later in the day as winter neared completion. High wind speed and low light intensity caused individuals to enter the roost earlier in the day. Temperature did not affect arrival time of crows. Wind speed, light intensity, and temperature did not significantly affect total number of individuals entering the roost ($P > 0.05$). However, all three factors were negatively correlated to total number of birds on the roost (−0.20, −0.25, and −0.18 respectively). This research improves our understanding of the roost dynamics of an abundant urban wildlife species, which may eventually be used to manage interactions between humans and wildlife in an urban setting.

INDEX DESCRIPTORS: American Crow, *Corvus brachyrhyncos*, Winter, Roost, Weather, Corvidae.

Communal roosting, defined as the aggregation of individuals at a time of rest, is found in many species and provides benefits that include thermoregulation, predation aversion, and foraging (Beauchamp 1999). Individuals are able to obtain body heat from their roost mates to reduce the amount of energy stores needed to maintain their own temperature (Du Plessis et al. 1994). In addition, a large group of individuals is better able to view a large area for predators, which allows for quick identification and tactics to avoid or defend, and potential health hazards can occur in urban settings from fecal matter and regurgitated pellets (Gorenzel and Salmon 1995). Communal roosting occurs in Acorn Woodpeckers (*Melanerpes formicivorus*; Du Plessis et al. 1994), Sandhill Cranes (*Grus canadensis*; Sparling and Krapu 1994), and Black Vultures (*Coragyps atratus*; Parker et al. 1995) and is also very common within the Family Corvidae (Haase 1963, Stiehl 1981, Wiles 1998, Sonerud et al. 2001, Everding and Jones 2006).

The few studies of the roosting behavior of corvids have found that temperature (Reebs 1985, Everding and Jones 2006), light intensity (Haase 1963, Swingland 1976, Reebs 1985, Everding and Jones 2006), and wind speed (Haase 1963) affect the times at which individuals enter the roost. Haase (1963) studied American Crows in Ohio and found that birds arrived earlier at the roost on days when wind speeds exceeded 15 mph (6.7 m/s^2). In Australia, Everding and Jones (2006) found a positive correlation between the arrival time of Torresian Crows (*Corvus orru*) and temperature. An understanding of these factors is important not only for providing a basic understanding of the roosting behavior of birds, but also may have implications for managing human-wildlife interactions given that these roosts are often located in towns.

The American Crow (*Corvus brachyrhynchos*) is a common permanent resident of Iowa. During winter, the species is known to aggregate in large roosts such as those near Keokuk (Silcock 1993) and Oakville (Silcock 1996). Crow roosts have more individuals when migrant crows enter the area from the north (Personal observation). This normally occurs in November and ends around March (Verbeek and Caffrey 2002). They are also known to use the same roost for 50 years or more (Emlen 1940). However, little is known about the specific wintering habits of these birds (Verbeek and Caffrey 2002), including how factors such as weather and habitat influence roost dynamics. The aim of this study was to understand winter American Crow roosting behavior in central Iowa and to determine how weather and time of day affected American Crow roosting behavior.

METHODS

Study area

We studied the roosting behavior of American Crows on or near the Iowa State University campus in Ames, Story County, Iowa from 19 January to 7 March 2006 (Fig. 1). We began by spending a few evenings in early January locating primary staging and roosting areas on and near campus. We defined the roost as the area where the crows entered in large numbers at or just after sunset. Crows used five main roosts during the study. The primary tree species located at four of these roosts were maples (*Acer* sp., especially Silver Maple (*A. saccharinum*)) and American Sycamore (*Platanus occidentalis*). One roost was dominated by White Pine (*Pinus strobus*); however, this roost was only used on the days with extreme cold. Trees averaged 20–25 m in height and were found in residential areas surrounded by buildings. Three of the roosts were located near a creek or Lake LaVerne and had park-like settings. Staging areas were locations where crows congregated, usually to feed, before traveling to the roost. Crows were seen in these staging areas up to two hours before they traveled to the roost. Once we felt we had located the primary staging and roosting areas, we spent five evenings trying

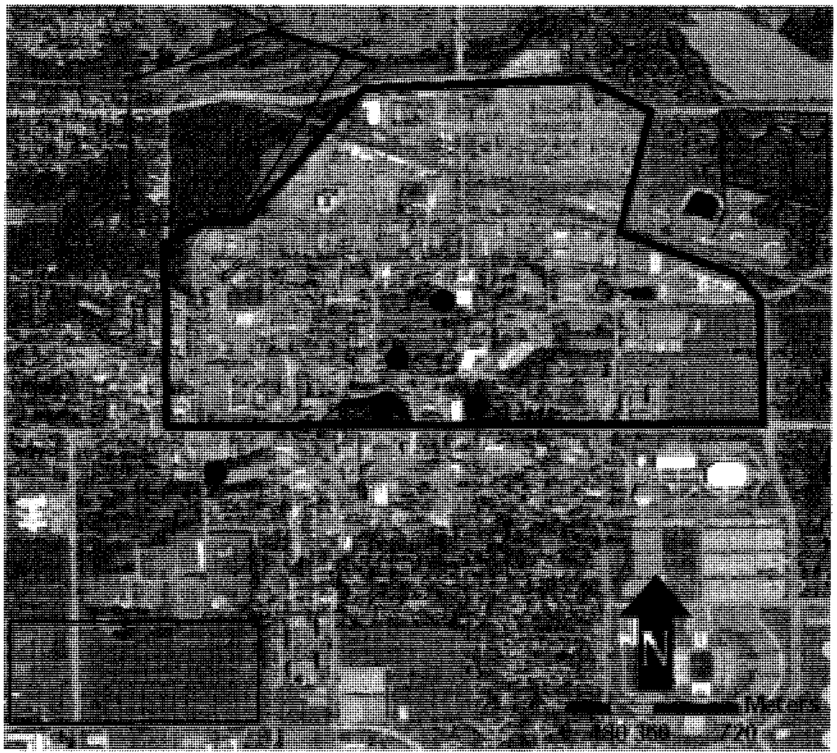

Fig. 1. Map of the roosts (dots) and staging areas (thin outline) used by American Crows on the Iowa State University campus (thick outline) in Ames, Story County, Iowa from 19 Jan to 7 Mar 2006.

different vantage points and practicing counring crows entering the roost.

Counting techniques

For counts, we tried counting birds individually and then in larger increments (by 10s, 25s, and 50s) when it became apparent that we could not accurately count birds at finer resolutions. Typically, the roost began forming by 10 minutes prior to sunset, and we never had birds leave one of these roosts later than 20 minutes after sunset. We counted crows enrering the roost from a vantage point that was usually well above ground level, the top of the Iowa State University Memorial Union parking ramp. If needed, counting poinrs were changed to correspond ro changes in location of the crow roost. All vantage points were chosen such that we had a good view of the flight paths of the birds from multiple staging areas that would maximize the ease and efficiency of counts. Individuals were counted in groups of 10, 25, or 50, depending on the size of the entering flock, with a hand tally counter. Counts were divided into 5-minute intervals beginning around 15 minutes before sunset and ending when the birds stopped entering the roost or were no longer visible due to darkness, which was typically around 25 minutes after sunset. Five-minute intervals were chosen to provide a reasonable level of resolution to larer construct accumulation curves for birds enrering the roost, and not jusr to obtain a total count. Counts did not begin until the first 5-minute interval when we detected >100 individuals. Counts of <100 individuals did not greatly contribute to rhe overall pattern of roosting, reducing our need to arrive at the roost much earlier in the day when the first few individuals arrived to roost.

Srarisrical analyses

Counts of American Crows by date and 5-minute interval, along with corresponding weather data, were summarized for analysis. The range of count dates was separated into four periods ro allow an examination of seasonal patterns: late January (19–31 Jan), early (1–14 Feb) and late (15–28 Feb) February, and early March (1–7 Mar).

Accumulation rates (the cumulative number of crows by 5-minute time interval) at the roost were examined in relation to three weather variables: temperature (°C), wind speed (m/s), and solar radiation (Watts (W)/m^2). Temperature, wind speed, and solar radiation readings were obrained from the Iowa Environmental Network SchoolNet site at Northwoods Elementary in Ames (http://mesonet.agron.iastate.edu/schoolnet/dl/). Solar radiation readings were used to gauge light intensity. We assumed that with high solar radiation, light intensity would be greater due to the greater amount of sunrays entering the area. Weather readings were taken at 30 minutes before sunset for each of the days we counted crows. This time was chosen to best represent the conditions crows were experiencing when they were making decisions on when to enter the roost. To investigate the influence of weather on roost dynamics, we categorized each weather variable for analysis. Categories were chosen arbitrarily and each provided a reasonable contrast in conditions while balancing sample of roost counts across the winter season. Temperature readings were splir into three categories for analyses: <0°C, 0–4°C, and >4°C. Wind speed was defined as either low (<2.2 m/s) or high (>2.2 m/s). Finally, solar radiation was defined as low (<60 W/m^2) or high (>60 W/m^2).

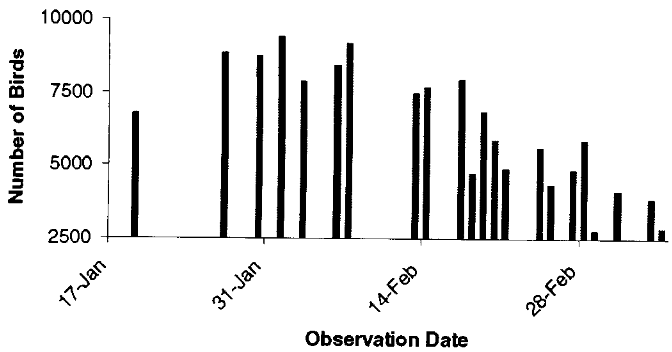

Fig. 2. Number of American Crows counted on or near the campus of Iowa State University in Ames, Story County, Iowa from 19 Jan to 7 Mar 2006.

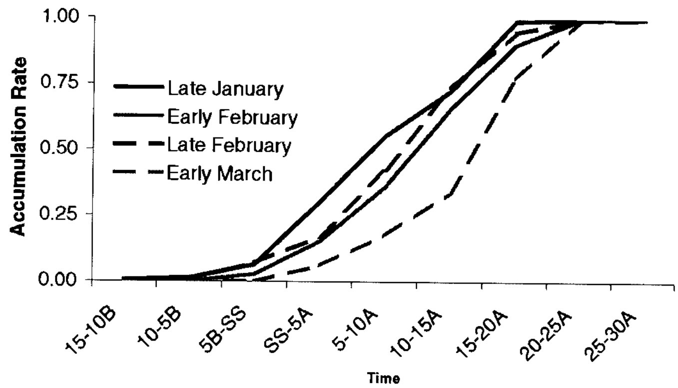

Fig. 3. Seasonal accumulation rates of American Crows entering the roost on or near the campus of Iowa State University in Ames, Story County, Iowa during 19 Jan to 7 Mar 2006. Time periods are designated as number of minutes before (B) or after (A) sunset (SS).

We plotted accumulation curves of crows entering the roost as they related to season and different levels of temperature, wind speed, and light intensity. Then, we further explored the relationship between each of the weather variables and the total number of crows on the roost using linear regression and Pearson product-moment correlation analyses. These last analyses take the total summed count of all crows at the roost on a particular day and relate these counts to the weather variable. The regression analyses used F-tests ($\alpha = 0.05$) to determine the significance of the weather variables' effect on the total number of crows on the roost.

RESULTS

Counts of roosting American Crows ranged from a high of 9,405 birds on 1 Feb to a low of 2,740 on 1 Mar (Fig. 2). The mean count ($\pm$ SD) per day was 6,314 $\pm$ 2,081 birds ($n = 22$ counts). Mean counts ($\pm$ SD) by season were 8,125 $\pm$ 1,192 birds for late Jan ($n = 3$), 8,338 $\pm$ 812 birds for early Feb ($n = 6$), 5,661 $\pm$ 1,164 birds for late Feb ($n = 9$), and 3,388 $\pm$ 694 birds for early Mar ($n = 4$). Crows showed a slight tendency to accumulate on the roost earlier in the day at the beginning of the winter season and later in the day towards the end of the season (Fig. 3). Birds also showed a slight tendency to accumulate on the roost earlier on days with higher wind speeds and lower solar radiation (Figs. 4a and 4b). Temperature did not appear to influence crow roosting behavior (Fig. 4c). Temperature ($F_{1,20} = 0.65$, $P = 0.43$), wind speed ($F_{1,20} = 0.84$, $P = 0.37$), and solar radiation ($F_{1,20} = 1.35$, $P = 0.26$) did not significantly affect the number of crows at the roost, although each showed a weak, non-significant negative correlation (r) (-0.18, -0.20, and -0.25, respectively) to total birds on the roost.

DISCUSSION

Interpretation of results

We encountered several potential problems during our observations of American Crows that may affect interpretation of the results. The main difficulty was darkness, especially on cloudy days, which affected our ability to view distant crows. Also, there were times when birds entered the roost from different directions, presumably from different staging areas. Although we attempted to pick vantage points with good visibility (e.g., increased opportunity to see birds from multiple directions), this was not always possible. We also had to make certain we were not focused on only one entrance path during counts. Counts were more challenging when there were two or more altitudinal levels of individuals entering the roost. In these situations, we may have missed individuals above the lower layer. In each of these scenarios, counts may have been biased. However, this should not have affected our analyses of accumulation curves because the total number of birds entering at that time was not the factor being investigated. Missed individuals would only account for a small percentage of the total number of birds, which would not affect the accumulation curves. For analyses using raw counts, these problems may have biased the counts, although we believe the bias was minimal because in general, roosting crows were easy to view and count in our study.

Our observations were made in an urban setting, and the roost was frequently disturbed. Disturbance resulted in two events that potentially affected our results: 1) the birds left the roost entirely, or 2) the disturbance was short-term and the birds quickly returned to the roost. When birds left the roost entirely, we did not use these counts in our analyses. However, in the second case, there was an increased chance for double-counting birds because the disturbed birds often mixed with newly arriving birds. If the disturbance occurred during the period of peak arrival, this might result in $>$1,000 birds in the air at once, making it difficult to sort out new arrivals from birds already counted. Luckily, disturbed individuals did not stay airborne long and remained underneath newly arriving crows. Thus, we only counted birds in the upper layer of the combined flock during disturbance events.

Seasonal variation of roosting crows

The peak number of birds in this study (Fig. 2) is similar to previous counts in central Iowa (Silcock 1996). However, our counts were lower than counts taken during severe winters (Dinsmore 1999); 2005–06 was an unusually mild winter in central Iowa and probably led to lower than normal numbers using the Ames roost. Of the six months between October 2005 and March 2006, five were above average, with January 2006 being the warmest on record in Iowa (Hillaker, 2007).

Seasonally, the pattern we observed was similar to that found in other studies of roosting corvids (Stiehl 1981, Gorenzel and Salmon 1995). Our counts began in mid-winter, so we did not have an opportunity to observe how birds accumulated at the roost in late fall. However, we did observe a general decline in

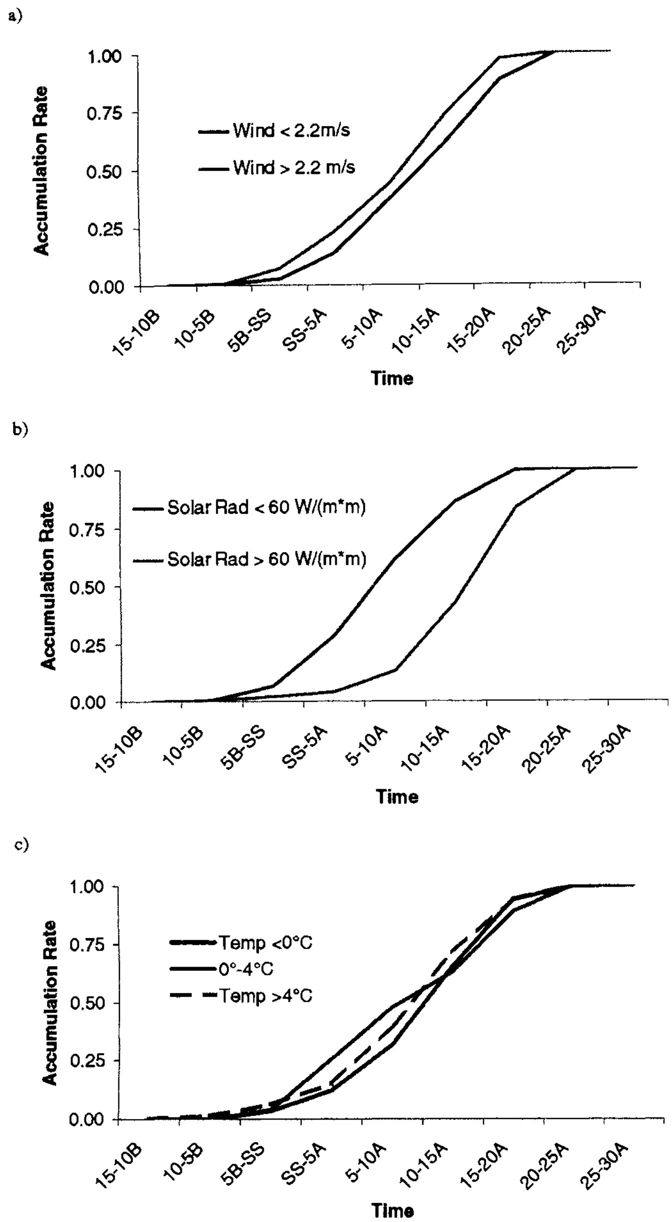

Fig. 4. Accumulation rates of American Crows entering the roost on or near the campus of Iowa State University in Ames, Story County, Iowa during 19 Jan to 7 Mar 2006 on days a) with wind speed less than 2.2 m/s and wind speed greater than or equal to 2.2 m/s, b) with solar radiation less than 60 W/m^2 and solar radiation greater than or equal to 60 W/m^2, and c) with temperatures ≤0°C, 0–4°C, and ≥4°C. Time periods are designated as number of minutes before (B) or after (A) sunset (SS).

numbers at the roost with the onset of warmer weather in spring. Explanations for the decrease in the number of birds later in the season include the onset of spring migration or a shift to other roost sites. Spring migration begins in February in surrounding states (Janssen 1987, Bohlen 1989, Robbins 1991), and this timing would be consistent with the drop in numbers after 18 February. The crows also may have shifted to another, undetermined roost. This could have been caused by an increase in disturbance of the previous roost or a decrease in resources at their previous staging areas.

Crows had a tendency to enter the roost earlier at the beginning of the season (Fig. 3). There are at least three possible explanations for this behavior. First, weather conditions earlier in the season are normally more adverse than later in the season. This might cause individuals to enter the roost earlier simply to conserve energy (Dugan et al. 1981). Second, arrival times may have been influenced by responses to food resources. In early winter, food is abundant and available relatively close to the roost. As winter progresses, food resources near the roost become depleted, causing the birds to make increasingly longer daily foraging flights. As a result, longer flight times are needed to return to the roost, thus delaying their arrival. Lastly, birds may also be taking longer flights, as the amount of daylight later in the season is greater than at the beginning of the season. The greater amount of daylight allows for a greater period of time to seek food sources and possible new roosting areas. However, Janicke and Chakarov (2007) observed Common Ravens (*C. corax*) entering the roost later on days with shorter day length.

Influence of weather on roosting crows

The earlier entrance on days with high wind speeds is consistent with those seen in other studies (Haase 1963, Reebs 1985). Higher wind speeds affect the thermoregulation and energetics of individuals. Dugan et al. (1981) suggest that energy stores would be depleted more rapidly in high wind situations due to increased heat loss from convection. Crows must conserve energy stores in winter to survive the low nighttime temperatures, and any additional loss of energy stores due to increased wind speed could be lethal. Entering the roost earlier in the day also decreases the amount of energy used to forage or travel to another staging area while at the same time allowing an individual to potentially gain heat from roost mates for a longer period.

When solar radiation increases, the amount of sunlight hitting the individual also increases. This raises the temperature of the individual and decreases the need to use energy stores to stay warm on cold days (Huertas and Diaz 2001). Thus, on days with low solar radiation, birds should enter the roost earlier to conserve energy. The black color of many corvids may be an adaptation to take full advantage of energy acquired from solar radiation (Heppner 1970), though some studies have suggested otherwise (Walsberg et al. 1978). It is also possible that the crows are avoiding difficulties associated with traveling in darkness. This has been proposed by Swingland (1976) as a reason for the early roost entrance of Rooks (*Corvus frugilegus*).

Temperature did not appear to affect the roosting time of crows in our study (Fig. 4c), which contradicts previous studies on corvids (Haase 1963, Reebs 1985, Everding and Jones 2006). There are two possible explanations for this: 1) it was an abnormally warm winter, and/or 2) the number of counts was low and didn't span the entire winter season. In our study, we had a small number of roost counts, and many of these were on warmer than normal days. Had we sampled on more days with cold temperatures, we might have seen results consistent with those of previous studies. In addition, the small number of counts encompassed only a portion of the winter season and may have skewed our results. Having more counts earlier in the season may allow us to more thoroughly investigate effects of temperature.

None of the weather variables (wind speed, solar radiation, and temperature) had a significant effect on the total number of crows entering the roost on a given day. We did detect a weak negative correlation between each of these variables and roost timing, and it appeared that the greatest number of individuals occur on days with low temperatures, low wind, and low solar radiation. These conditions are normally seen earlier in the season and correspond with the larger numbers encountered in late January and early February.

Future Considerations

Our results improve our understanding of the behavior of a common, urban animal. However, additional factors such as precipitation should be the subject of future study, as should the broad influence of weather on dawn departure patterns. Knowledge of roosting patterns and seasonal changes can aid the implementation of more efficient control strategies (Gorenzel and Salmon 1995). This may have possible implications for managing roosts relative to potential diseases and nuisance to citizens caused by crows and their fecal matter.

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