Avian Disease and Winter Bird Feeding

The results of a survey of WSO members revealed that four factors were associated with disease outbreaks at feeders: the species using the feeder, the number of birds using the feeder, the habitat around the feeder, and the type of feeder.

by Margaret Clark Brittingham and Stanley A. Temple

Although winter bird-feeders provide birds with a concentrated source of high-energy food during the period of the year when natural food supplies are low and energetic demands are high, there are some potential risks for birds that visit feeders. These include predation by domestic and wild predators attracted to the concentration of prey; accidents, such as flying into windows; and the spread of disease among birds concentrated at an easily contaminated food source. We report on the frequency with which mortality, apparently due to disease, occurs at feeders, and we describe factors that may affect the probability of mortality occurring at feeder-sites.

The principal disease that has been reported as a cause of mortality at bird feeders is salmonellosis (Hudson and Tudor 1957, Wilson and Macdonald 1967, Macdonald et al. 1968, Macdonald and Cornelius 1969, Locke et al. 1973, Hurvell et al. 1974, Nesbitt and White 1974, Fichtel 1978). This disease is caused by the bacteria *Salmonella* spp. and usually results in intestinal infections. Infected birds often have diarrhea and become weak, listless, dehydrated and emaciated. Fecal contamination builds up near the feeder and increases the risk of infection to other susceptible individuals (Macdonald et al. 1968, Macdonald and Cornelius 1969, Fichtel 1978, Terres 1981). Prior to death, sick individuals become extremely weak and may roost near the feeder or even within the feeder.

Other diseases which have been associated with bird feeders or crowded feeding conditions include trichomoniasis (Rosen 1961), coccidiosis (Todd and Hammond 1971), aspergillosis (Terres 1981), avian pox (Bergstrom 1952), and avian mange. Trichomoniasis is caused by a trichomonad parasite that lodges in the throats and lungs primarily of Mourning Doves (*Zenaida macroura*) and Pigeons (*Columba livia*). The disease produces sores in the throat and mouth. Infected individuals often have difficulty swallowing and become emaciated. The disease is spread at feeders when contaminated food drops from the mouth of an infected bird and is picked up by a susceptible individual. Trichomoniasis is observed primarily in spring and summer (Rosen 1961, Greiner and Baxter 1974, Terres 1980).

Coccidiosis is caused by coccidia, an intestinal parasite. Infected individuals often have diarrhea, lose weight, become weak, and occasionally die. It is transmitted from one individual to another in food contaminated by feces (Todd and Hammond 1971).

Aspergillosis is caused by a fungus, *Aspergillus fumigatus*, that grows in damp or wet bird seed. Birds breath in the spores of the fungus while they are feeding, and the spores lodge in their lungs and air sacs causing bronchitis and pneumonia. Infected birds have trouble breathing and become weak and listless. This disease is usually fatal (Terres 1981). It is spread at feeders through the use of moldy seed.

Avian pox is caused by a virus, *Poxvirus avium*, that produces warty lesions on the feet or head of the bird. It is transmitted directly by contact between infected and susceptible individuals and indirectly from perches or other contaminated objects (Terres 1981). The spread of pox may be increased when individuals concentrate at feeders (Bergstrom 1952).

Avian mange is caused primarily by mites and results in a loss of feathers on the head or body (Keymer and Blackmore 1964, Terres 1980). It may be spread at feeders when susceptible and infected individuals feed in close proximity.

Methods

In October 1983, we mailed a questionnaire to 1,145 members of the Wisconsin Society for Ornithology (WSO). These members were distributed throughout Wisconsin and are among the State's most serious amateur ornithologists. The purposes of the questionnaire were to determine the frequency with which mortality due to disease and unknown causes was observed at feeders and to determine whether or not there were correlations between occurrences of mortality and the species of birds using the feeder, the number of birds using the feeder, the type of feeder being used, and the habitat around the feeder. We asked respondents to distinguish among mortalities due to predation, accidents (such as flying into windows), or disease and unknown causes and to report details only of occurrences of mortality due to disease and unknown causes. In analyzing survey responses, we used the following definitions: a feeder-site was one household feeding birds for at least one winter; a feeder-year was one winter of bird feeding at one feeder-site; an occurrence of mortality was at least one bird dying from causes other than predation or accidents at a feeder-site.

To determine the prevalence of mortality at feeder-sites, we calculated both the percentage of feeder-sites at which an occurrence of mortality had been observed and the frequency with which mortality had been observed (total number of occurrences of mortality/total number of feeder-years). The latter calculation gave us the number of occurrences of mortality per feeder-year. We used the same methods to calculate the prevalence of mortality among feeder-sites in different habitat types (urban, suburban, rural) and among feeder-sites with different types of feeders in use (porthole, platform, hopper, suet). If more than one type of feeder was in use, the site was counted more than once. We tested whether or not the probability of observing an occurrence of mortality was higher for feeder-sites in a particular habitat type and for sites with a specific type of feeder in use.

Respondents reported the approximate number of individuals of each species using the feeder on a typical winter day in 1 of 3 categories: 0, 1–20, >20. To make comparisons, we assigned a value of 0 if the number was reported as 0, a value of 10 individuals if the number was reported as 1–20, and a value of 30 if the number was reported as >20, a method described by Wonnacott and Wonnacott (1977). For each feeder-site, we calculated the number of individuals using the feeder and the number of species using the feeder. We tested whether or not the probability of observing an occurrence of mortality was dependent on the number of species present and the number of individuals present.

We tallied the number of occurrences of mortality in which each species was reported dead or dying. For many occurrences of mortality, more than one species was involved. We compared the frequency of occurrences of mortality for individual species, and we tested whether the probability of observing an occurrence of mortality was dependent on the presence of any particular species at the feeder-site.

Results and Discussion

A total of 624 WSO members responded to the questionnaire, a 54% response rate. As a group, these members had been feeding birds for a total of 7,202 feeder-years. We had no follow-up mailings, so we have no information on the non-respondent population. On average, 20% of all households in the United States feed birds during the winter (DeGraaf and Payne 1975). A survey of Wisconsin residents found that 34% of the households in the state regularly feed birds (Cary 1985). From our results, a minimum of 54% of the WSO members fed birds, a percentage well above both the national average and the average for Wisconsin. Therefore, we suspect that many of the members, not responding to our questionnaire, failed to respond because they did not feed birds.

Prevalence of Mortality.—Ninety-eight (16%) of the 624 feeder-sites experienced at least 1 occurrence of mortality due to disease or unknown causes (Table 1). Although most (64%) of the feeder-sites with a history of mortality had experienced only 1 occurrence, 36% of the sites had experienced recurring problems, and 12% had >10 occurrences.

Mortalities due to disease and unknown causes were detected 335 times in 7,202 feeder-years (Table 1). On the average, therefore, there had been one occurrence of mortality for every 21.5 feeder-years. This is probably a low estimate of the actual prevalence of such mortality at feeders. Many birds die and are not detected. Other birds, weakened by disease, starvation or hypothermia, are taken by predators. The deaths of the former go unnoticed, and deaths of the latter are attributed to predation.

Although the probability of any particular feeder-site experiencing an occurrence of mortality due to causes other than predation or accidents is relatively low, the probability of an occurrence within any geographic area may be quite high, depending on the density of feeders in the area. For example, Milwaukee, Wisconsin, had a 1972 population of 442,804 households, and 19.4% of those households regularly fed birds (DeGraaf and Payne 1975). During the winter of

Table 1. Percentage of feeder-sites with reported mortalities and frequency of mortalities at feeder-sites in 3 habitat types in Wisconsin.

Habitat surrounding feeder-site	Number of feeder-sites	Feeder-sites with mortalities[1]	Number of feeder-years	Occurrences of mortality per 1000 feeder-years[2]
Urban	107	18%	1399	24
Suburban	230	19%	2741	50
Rural	270	13%	3017	53
Not reported[3]	17	12%	45	44

[1]Differences were not significant (x^2 = 3.84, $P < 0.10$).
[2]Differences were significant (x^2 = 19.6, $P < 0.01$).
[3]This group was not included in statistical tests.

1972, birds in Milwaukee were, therefore, exposed to 85,904 feeder-years. If an occurrence of mortality happened once in every 21.5 feeder-years, we would have expected 3,995 occurrences of mortality at feeder-sites in the Milwaukee area during the winter of 1972.

Factors Affecting Mortality.—The number of species using a feeder was higher (t = 2.11, P < 0.05) at feeder-sites which had experienced an occurrence of mortality (13.9 ± 0.37 SE) than at those which had never experienced an occurrence of mortality (13.0 ± 0.18 SE). The number of individuals using a feeder was also greater (t = 2.54, P < 0.05) at feeder-sites which had experienced an occurrence of mortality (175.8 ± 6.17 SE) than those which had never experienced an occurrence of mortality (158.3 ± 2.74 SE).

This association could be due simply to chance. As the number of birds using the feeder increases, the probability of detecting birds that die also increases. However, as the number of birds increases, the probability of disease spread by contact between infected and susceptible individuals also increases. In addition, fecal contamination of food, the primary way in which many pathogens are transmitted, increases. Crowded feeding conditions have been implicated in outbreaks of salmonellosis (Hudson and Tudor 1957, Macdonald et al. 1968, Wilson and Macdonald 1967), coccidiosis (Todd and Hammond 1971), trichomoniasis (Rosen 1961), and avian pox (Bergstrom 1952).

There were no differences between habitats in the proportions of feeder-sites at which mortality had occurred (Table 1). There was, however, a difference in the frequency with which occurrences of mortality were reported (Table 1). The frequency of observed mortality was lowest at feeder-sites in urban areas and highest at feeder-sites in rural areas. These differences may have resulted from differences in the numbers of individuals and species using the feeder-sites in the 3 habitat groups. Both the number of individuals and the number of species were lowest at feeder-sites in urban areas and highest at feeder-sites in rural areas (Table 2).

The identities of the species found dead or dying were known for 289 of the 335 occurrences of mortality (Table 3). The House Sparrow (*Passer domesticus*) was the species most frequently involved. House sparrows were 7 times more likely to be found dead or dying

Table 2. Numbers of individual birds and numbers of species using feeder-sites in 3 habitat types in Wisconsin.

Habitat surrounding feeder-site	Average number of birds using feeder-site[1]	Average number of species using feeder-site[2]
Urban	144.1	11.9
Suburban	157.8	13.3
Rural	171.5	13.6

[1]Differences were significant ($F = 7.99$, $P < 0.01$).
[2]Differences were significant ($F = 6.48$, $P < 0.01$).

than the next most frequently involved species, the American Goldfinch (*Spinus tristis*), and at least 10 times more likely to be involved than any other species (Table 3). Five species were associated positively with the probability of an occurrence of mortality at feeder-sites (Table 4). Feeder-sites at which these species were present experienced mortality significantly more often than feeder-sites at which these species were absent.

Most of the species found dead or dying and all of the species associated with an increased risk of mortality at feeder-sites are gregarious during the winter. They roost and feed in large flocks, a behavior which could increase the probability of pathogens being transmitted from an infected individual to a susceptible one. When an infected individual visits a feeder-site, individuals from other non-gregarious species may become infected. Other researchers have noted that gregarious species are most frequently the victims of disease outbreaks at feeders (Hudson and Tudor 1957, Wilson and Macdonald 1967, Macdonald and Cornelius 1969, Taylor 1969, Todd and Hammond 1971, and Locke et al. 1973). It is not known if individuals of these species are more susceptible to certain pathogens or if the increased infection rate is due merely to an increased spread of disease resulting from their gregarious habits.

Only 1 species, the Tufted Titmouse (*Parus bicolor*), was associated negatively with the probability of an occurrence of mortality at a feeder-site. Feeder-sites at which this species was present experi-

Table 3. Frequency of mortality among species reported dead or dying at winter bird feeders in Wisconsin.

Species	Number of mortalities	Mortalities per 1000 feeder-years
House Sparrow[1]	222	37.0
American Goldfinch[1]	33	5.1
Dark-eyed Junco[1]	21	3.2
Mourning Dove[1]	20	3.7
Evening Grosbeak[1]	12	3.3
Common Grackle	10	2.4
Common Redpoll[1]	6	1.7
Purple Finch[1]	4	0.8
Pine Siskin[1]	3	0.7
Others	11	0.4

[1]Species that are particularly gregarious during the winter.

Table 4. Relationship between the presence of certain species and the prevalence of mortality at winter bird feeders in Wisconsin.

	Species present		Species absent	
Species	Number of sites	Percent with history of mortality	Number of sites	Percent with history of mortality
Mourning Dove[1]	421	18	202	11
European Starling[1]	397	18	224	12
House Sparrow[1]	501	18	123	9
American Goldfinch[1]	544	17	79	6
American Tree Sparrow[1]	344	20	278	11

[1]Differences in prevalence between sites with species present or absent were significant.

enced significantly lower mortality than sites where this species was absent. This association probably occurred because titmice occur primarily at feeder-sites in wooded areas where house sparrows, American Goldfinches, European Starlings (*Sturnus vulgaris*), Mourning Doves (*Zenaidura macroura*), and American Tree Sparrows (*Spizella aborea*), which prefer open areas, are relatively rare.

Hopper feeders were present at 73% of all sites, suet feeders at 72%, porthole feeders at 70% and platform feeders at 47% (Table 5). We found no significant relationship between the type of feeder in use and the number of feeder-sites reporting occurrences of mortality (Table 5). There was, however, a difference in the frequency of occurrences (Table 5). Mortality occurred most frequently at feeder-sites where platform feeders were used, and the probability of mortality occurring was higher at sites where platform feeders where in use than at sites where platform feeders were absent ($x^2 = 5.34, P < 0.05$).

The use of platform feeders that allow birds to stand in the food is likely to increase the probability of seeds becoming contaminated with fecal matter. Other researchers have found that occurrences of salmonellosis declined when feeders that birds could not directly contaminate with fecal material were used and when feeders were cleaned and disinfected frequently (Hurvell et al. 1974). No matter what type of feeder is used, seeds often fall to the ground below it, where they may become contaminated and then eaten by birds feeding on the ground. Also, fecal contamination is often abundant on the vegetation near the

Table 5. Effects of type of feeder on the prevalence and rate of mortality among birds at winter feeders in Wisconsin.

Type of feeder	Number of feeder-sites	Feeder-sites with mortalities[1]	Number of feeder-years	Mortalities per 1000 feeder-years[2]
Platform	297	19%	3801	61
Porthole	436	18%	5269	58
Hopper	453	16%	5231	48
Suet	451	17%	5719	49

[1]Differences were not significant ($x^2 = 1.61, P > 0.1$).
[2]Differences were significant ($x^2 = 11.55, P < 0.05$).

feeder where, under optimal conditions, some pathogens may survive for up to 28 months (Petrak 1982).

Although we could not test statistically whether or not mortalities were observed more frequently during periods of severe weather, 12 of the 98 respondents, who observed mortality, reported that they found dead birds primarily during periods of particularly cold temperatures. At very low temperatures the risk of fatal hypothermia increases. Birds are stressed and also have a reduced resistance to disease (Taylor 1969, Steele and Galton 1971). In addition, the number of individuals using the feeder often increases as the temperature drops (Leck 1978). These factors may result in an increased prevalence of mortality during cold spells.

Causes of Mortality.—Only 9 of the 98 individuals who reported observing occurrences of mortality at their feeder-sites obtained a professional diagnosis of the cause. Six occurrences involved salmonellosis, 2 involved avian mange, and 1 involved avian pox.

Since only 9% of the respondents who observed mortalities obtained a professional diagnosis of the cause, we had to classify the majority of mortalities as due to unknown causes which potentially included: disease, starvation, and death due directly to hypothermia. Inasmuch as deaths were observed near feeders, it is doubtful, however, that many were solely the result of starvation. Hypothermia was probably not a major cause of mortality either because most individuals are able to withstand normal winter temperatures if their food supply is adequate. Juncos, which were provided with an abundant supply of food, suffered no adverse affects when exposed to temperatures as low as $-47°$ C (Rowan 1925). Other researchers have observed that high rates of mortality associated with low temperatures affect primarily individuals with an inadequate food supply (Roseberry 1962, Dobinson and Richards 1964).

The probability of mortality occurring at a particular site was associated with both the type of feeder in use and the species composition at the feeder-site. We would not expect to see relationships such as these if the deaths were due primarily to starvation and hypothermia. Therefore, although we can not prove that the majority of the mortalities were due to disease, it appears to be a likely conclusion.

Recommendations

If your feeder-site is in one of the categories associated with a higher risk of disease, or if you want to minimize this risk, we concur with the following recommendations made by others (e.g., Terres 1981 and Dennis 1986):

1. Clean and disinfect the feeder with a weak bleach solution at least once a year. Clean more frequently if a platform feeder is in use. This reduces the risk of all disease.
2. Store seed in a dry place, and do not use it if it becomes moldy. If seed in the feeder becomes moldy, throw the seed out and clean the feeder. This reduces the risk of aspergillosis.
3. Avoid feeding on the ground. This reduces the risk of all diseases.
4. Avoid feeding in the summer if Mourning Doves or Rock Doves are using your feeder. This reduces the risk of trichomoniasis.

If you find birds dead or dying near your feeder, we advise the following:

1. Wearing gloves, pick up all carcasses and either bury them or wrap

them in plastic bags and dispose of them. This is particularly important for occurrences of salmonellosis because both human beings and domestic animals can become infected from the carcasses.

2. Clean and disinfect the feeder.
3. Sweep up and dispose of seeds spilled on the ground.
4. Continue to feed, but move the feeder to a new location in the yard. If you stop feeding completely, infected individuals may move to someone else's feeder and introduce disease there. Moving the feeder to a new location will reduce the probability of birds becoming infected from fecal contamination on the ground and vegetation.

Acknowledgements

This paper duplicates in many ways a paper published in *The Wildlife Society Bulletin* (Brittingham and Temple 1986). We thank The Wildlife Society for allowing us to republish our results in *The Passenger Pigeon* so that WSO members can benefit from the findings. We thank the 624 WSO members who responded to our questionnaire. We thank John R. Cary for assistance in the analysis of these questionnaires, Sherrie Gruder-Adams for assistance in compiling the data, and Thomas M. Yuill, Robert P. Hanson, Fred S. Guthery and three anonymous reviewers for suggestions and advice on earlier drafts of this manuscript. Funding for this project was provided by a grant from the University of Wisconsin, College of Agricultural and Life Sciences, Agricultural Experiment Station.

Literature Cited

Bergstrom, E. A. 1952. Foot pox in passerines. *Bird-Banding* 23:169–171.

Brittingham, M. C. and S. A. Temple. 1986. A survey of avian mortality at winter feeders. *Wildlife Society Bulletin* 14:445–450.

Cary, A. 1985. Evaluation of the 1983 Wisconsin tax checkoff for nongame and endangered resources. Wisconsin Department of Natural Resources Resource Publication 137. 37pp.

DeGraaf, R. M., and B. R. Payne. 1975. Economic values of non-game birds and some urban wildlife resource needs. *Transactions of the North American Wildlife and Natural Resources Conference* 40:281–287.

Dennis, J. V. 1986. A complete guide to bird feeding. Alfred A. Knopf, New York, N.Y. 288pp.

Dobinson, H. M. and A. J. Richards. 1964. The effects of the severewinter of 1962/63 on birds in Britain. *British Birds* 57:373–434.

Fichtel, C. C. 1978 A salmonella outbreak in wild songbirds. *North American Bird Bander* 3:146–148.

Greiner, E. C. and W. L. Baxter. 1974. A localized epizootic of trichomoniasis in Mourning Doves. *Journal of Wildlife Diseases* 10:104–106.

Hudson, C. B. and D. C. Tudor. 1957. *Salmonella typhimurium* infection in feral birds. *Cornell Vet* 47:394.

Hurvell, B., K. Borg, A. Gunnarsson, and J. Jevring. 1974. Studies on *Salmonella typhimurium* infections in passerine birds in Sweden. *International Congress of Game Biologists* 11:493–497.

Keymer, I. F. and D. K. Blackmore. 1964. Diseases of the skin and soft parts of wild birds. *British Birds* 57:175–179.

Leck, C. F. 1978. Temperature and snowfall effects on feeding station activity. *Bird-Banding* 49:283–284.

Locke, L. N., R. Schillinger, and T. Jareed. 1973. Salmonellosis in passerine birds in Maryland and West Virginia. *Journal of Wildlife Diseases* 9:144–145.

Macdonald, J. W. and L. W. Cornelius. 1969. Salmonellosis in wild birds. *British Birds* 62:28–30.

———, M. J. Everett, and M. Maule. 1968. Blackbirds with salmonellosis. *British Birds* 61:85–87.

Nesbitt, S. A., and F. H. White. 1974. A *Salmonella typhimurium* outbreak at a bird feeding station. *Florida Field-naturalist* 2:46–47.

Petrak, M. L. 1982. Diseases of cage and aviary birds. Lea and Febiger, Philadelphia, Pa. 680pp.

Roseberry, J. L. 1962. Avian mortality in southern Illinois resulting from severe weather conditions. *Ecology* 43:739–740.

Rosen, M. 1961. Trichomoniasis or canker in doves. *California Department of Fish and Game Game Management Leaflet* 2. 11pp.

Rowan, W. 1925. On the effect of extreme cold on birds. *British Birds* 18:296–299.

Steele, J., and M. Galton. 1971. Salmonellosis. Pages 51–58 *in* J. W. Davis, R. C. Anderson, L. Karstad, and D. O. Trainer (eds.) Infectious and parasitic diseases of wild birds. Iowa State Univ. Press, Ames.

Taylor, J. 1969. Salmonella in wild animals. Pages 51–73 *in* A. McDiarmid (ed.) Diseases in free-living wild animals. Symposia of the Zoological Society of London No. 24. Academic Press, Orlando, FL.

Terres, J. K. 1980. The audubon society encyclopedia of North American Birds. Alfred A. Knopf, New York, N.Y. 1109 pp.

———. 1981. Diseases of birds - how and why some birds die. *American Birds* 35:255–260.

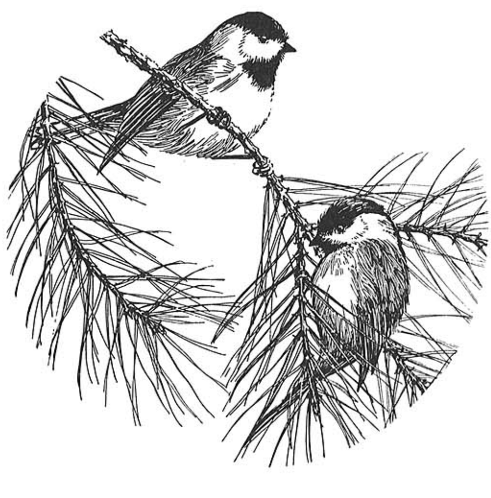
Todd, K. S. and D. M. Hammond. 1971. Coccidia of Anseriformes, Galliformes, and Passeriformes. Pages 234–281 *in* J. W. Davis, R. C. Anderson, L. Karstad, and D. O. Trainer (eds.) Infectious and parasitic diseases of wild birds. Iowa State University Press, Ames.

Wilson, J. E., and J. W. Macdonald. 1967. Salmonella infection in wild birds. *British Veterinary Journal* 123:212–219.

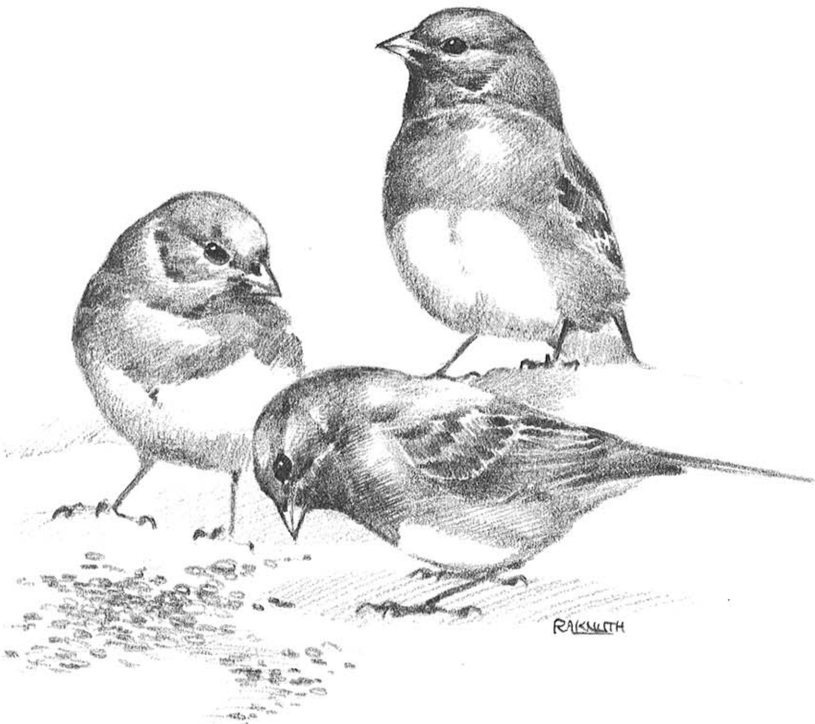
Wonnacott, T. H., and R. J. Wonnacott. 1977. Introductory statistics.John Wiley and Sons, New York, N.Y. 753pp.

Margaret Clark Brittingham
School of Forest Resources
The Pennsylvania State University
University Park, PA 16802

Stanley A. Temple
Department of Wildlife Ecology
University of Wisconsin
Madison, WI 53706



Black-capped Chickadees *by Cary Hunkel*



Feeder scene *by Rockne A. Knuth*