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Factors Influencing the Occurrence of Birds That Use Feeders in Iowa

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Since its inception in 1984, data from the annual Iowa "Winter Bird Feeder Survey" have provided valuable information about birds that use feeders in Iowa such as spatial and temporal population trends. Using data from the 1988 and 1994 Surveys, we examined how the occurrence of bird species that use feeders was influenced by geographic location, the habitat surrounding a house, and the types of seeds offered at a house. Of the 23 species examined, the occurrence of 8 species was influenced by latitude, 22 species were influenced by the habitat surrounding the house, and 22 species were influenced by the presence of water or the types of food available. Two of the more surprising results from this study were that seven species had a positive relationship between occurrence and corn, and only three species had a positive relationship with the presence of mixed seed. Although people interested in feeding birds may not be able to attract all species, results from this study may be used to increase one's likelihood of viewing individual species of interest.

INDEX DESCRIPTORS: backyard birds, bird feeding, feeder survey, Iowa, supplemental feeding.

From 1984 to 1998, the Iowa Department of Natural Resources and the Iowa Ornithologists' Union co-sponsored the "Winter Bird Feeder Survey" (Hollis 1984, Hollis 1986, Horn et al. 1998, Horn et al. 1999). The Winter Bird Feeder Survey was a state-wide survey of the number and species of birds found in residents' yards using bird feeders. The survey was conducted annually since its inception, and at least 800 volunteers participated each year (Horn et al. 1998).

Feeder surveys are an excellent method for gathering basic information about birds that use feeders such as which species most commonly visit feeders (Burtt and Burtt 1979, Brittingham and Temple 1989), spatial and temporal population trends (Burtt and Burtt 1979, Dunn 1986, Wells et al. 1998, Dunn and Tessaglia-Hymes 1999), factors influencing the occurrence of species (Brittingham and Temple 1989, Dunn and Tessaglia-Hymes 1999), and avian mortality (Brittingham and Temple 1986, Dunn 1993, Dunn and Tessaglia 1994). For example, data from Project Feeder Watch, a feeder survey spanning North America, were used to investigate the population cycles of the Varied Thrush, *Ixoreus naevius* (Wells et al. 1996), and a feeder survey in New York was used to track population trends of the Northern Cardinal, *Cardinalis cardinalis* (Burtt and Burtt 1980). The Kansas Winter Bird Feeder Survey has been used to determine the most common visitors to the feeders of that state (Finck 1996).

The Iowa Winter Bird Feeder Survey has provided valuable information about birds that use feeders in Iowa (Hollis 1984, Hollis 1986, Horn et al. 1998, Horn et al. 1999). Previously, we described population trends of birds that use feeders in Iowa from 1985–1994 (Horn et al. 1998) and how those trends compared with Breeding Bird Survey trends in Iowa over the same time period (Horn et al. 1999). In this paper, we describe how factors such as geographic location, habitat surrounding a house, and types of seeds available influence the occurrence of birds. Knowing factors that influence bird occurrence may be beneficial to people interested in attracting (or repelling) particular species.

METHODS

Each year, the Winter Bird Feeder Survey was conducted during a two-day period in the last half of January. During the survey each participant recorded: 1) an estimate of the maximum number of individuals of each species that used feeders in their yard, and 2) information such as where the participants lived, the habitat surrounding their house, and the types of seeds they offered.

We used data from the 1988 and 1994 Winter Bird Feeder Surveys to determine factors that influence the occurrence of birds that use feeders in Iowa. The 1988 data were used because prior to 1987 the survey form was altered annually, and we wanted to use data from a form that was familiar to participants. We did not use information from the 1989–1993 surveys because many of the same birds recorded during the 1988 survey would be expected to visit the same houses during subsequent years; thus, observations would not be independent. Gill (1995) stated that the average life span of a small bird is 2–5 years, so we chose to use data from 1994. Data from the 1995–1998 surveys were unavailable for analysis. A total of 2,212 surveys was used in data analysis, 892 from 1988 and 1,320 from 1994.

We investigated how the occurrence of a bird species in a yard was influenced by 12 explanatory variables. We divided the variables into four major types: 1) year—one variable (i.e., year of the survey), 2) geographic—one variable (i.e., in what region of the state was the house located), 3) house location—four variables (i.e., type of habitat surrounding the house within a two-block circle), and 4) food and water present—six variables (i.e., what types of food and water were offered at the house) (Table 1). The three regions used are a combination of the nine regions used by Hollis (1984, 1986). We did not combine the four house location variables into a single continuous variable, as our house location variables do not represent a continuous gradient of a factor that may influence species occurrence. For example, houses surrounded by farm or timber may have a sim-

Table 1. The 12 explanatory variables used in logistic regression analyses with occurrence of 23 bird species recorded during the 1988 and 1994 Iowa Winter Bird Feeder Surveys to determine the factors that influence the occurrence of birds at feeders in Iowa.

Variable		
Type	Name	Comments; # of Participants
Year	Year	1988 or 1994; 892 and 1,320 participants, respectively
Geographic	Region	State was divided into three regions: north, central, and south; 614, 1,077, and 521 participants, respectively
House Location	Suburbs	Houses in suburbs with shrubs and small trees but few trees wider than 20 inches; 198 participants
	Town	Houses in neighborhoods with many mature shade and street trees; 751 participants
	Timber	Houses surrounded by timber; 216 participants
	Farm	Farmsteads with mature trees and shrubs around house; 472 participants
Food and Water Present	Thistle	Offered by 1,690 participants
	Sunflower	Does not include cracked sunflower; offered by 1,582 participants
	Mixed	Includes any combination of two or more seed types in a single feeder; offered by 1,384 participants
	Suet	Offered by 1,600 participants
	Corn	Whole or cracked corn; offered by 919 participants
	Water	Offered by 661 participants

ilar density of human dwellings in the area. Houses surrounded by farm or suburbs may have similar amounts of trees in the immediate vicinity of the house. We did, however, use habitat variables that were as mutually exclusive as possible and that were used by a large number of survey participants (i.e., at least 7.5% of all participants). Water and each of the five food types used were offered at more than 25% of all participating houses and are among the most popular seeds offered at feeders nationally (Dunn and Tessaglia-Hymes 1999). Other habitat types surrounded houses and other seeds were offered by participants; however, these were not included in the analysis because of small sample size.

The majority of correlation coefficients among the 12 explanatory variables were small. Of the 66 correlation coefficients calculated, 61 were < 0.20, 4 were between 0.20–0.30, and 1 was between 0.30–0.40 (Table 2). The larger correlations were between town and suburbs (−0.22), town and timber (−0.24), town and farm (−0.37), sunflower and mixed (−0.26), and sunflower and suet (0.22). None of the correlations was considered high enough to eliminate a variable from the analyses.

Logistic regression was used to examine the relationship between occurrence of a bird species at feeders in a yard (where a species was either present or absent) and the following explanatory variables: year, region, suburbs, town, timber, farm, thistle, sunflower, mixed, suet, corn, and water. All of the variables were discrete (e.g., timber either surrounded the house or not, mixed seed was either available at a house or not) with the exception of region which was continuous (i.e., north, central, and south). A logistic regression model using all 12 variables determines which variables are significant after adjusting for the effects of the remaining variables in the model. We used this approach, as opposed to a stepwise procedure, because we were interested in determining which variables influenced occurrence as opposed to developing a model that best predicts occurrence (i.e., stepwise procedure). Results were analyzed using the Logistic Procedure of the SAS statistical package (Stokes et al. 1995). Because the same houses may have been used in the 1988 and 1994 surveys (i.e., observations may not have been independent), we considered results significant if $P < 0.005$. For variables that significantly influenced occurrence, frequency of occurrence was calculated when the variable was absent and present at a yard. Only species recorded on the Iowa Winter Bird Feeder Survey that visited $> 10\%$ of participating houses between 1985–1994 were used in data analysis (Horn et al. 1998). The House Finch, *Carpodacus mexicanus,* was also analyzed using 1994 data only. In 1988, the House Finch was not listed on the Winter Bird Feeder Survey form, and few House Finches were reported at feeders.

RESULTS

Of the 23 species examined, 8 were influenced by the region of the state in which a house was located (Tables 3 and 4). Three

Table 2. Correlation coefficients among 12 explanatory variables used in logistic regression analyses with occurrence of 23 bird species recorded during the 1988 and 1994 Iowa Winter Bird Feeder Surveys.

Variable	REG	SUB	TOWN	TIM	FARM	THI	SUN	MIX	SUET	CORN	WATER
Year	0.10	−0.04	−0.05	−0.01	0.03	−0.02	0.03	−0.08	0.03	−0.03	0.09
Region (REG)		−0.06	−0.04	−0.00	0.04	−0.04	0.02	−0.03	−0.04	−0.04	0.04
Suburbs (SUB)			−0.22	−0.10	−0.16	−0.03	−0.04	0.03	−0.05	−0.07	0.04
Town				−0.24	−0.37	0.08	0.01	0.04	0.02	−0.03	0.06
Timber (TIM)					−0.17	−0.08	0.05	−0.06	0.02	−0.02	−0.02
Farm						−0.01	−0.02	0.01	−0.02	0.06	−0.05
Thistle (THI)							0.14	0.05	0.18	0.06	0.14
Sunflower (SUN)								−0.26	0.22	0.10	0.16
Mixed (MIX)									0.01	0.07	−0.01
Suet										0.16	0.13
Corn											0.10

Table 3. Parameters of logistic regression models of occurrence of 23 bird species recorded during the 1988 and 1994 Iowa Winter Bird Feeder Surveys, and 12 explanatory variables: year, region, suburbs, town, timber, farm, thistle, sunflower, mixed, suet, corn, and water. The table lists the parameter estimate, SE, and P for each explanatory variable in the logistic regression model, and the overall R^2[a] of the model. For explanatory variables that significantly influenced the occurrence of a bird species ($P < 0.005$), the frequency of occurrence of species at houses when the variable was absent and present is listed.[bc]

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable			
					Absent		Present	
					Mean	SE	Mean	SE
Mourning Dove (*Zenaida macroura*)								
Intercept	−240.0	36.46	0.0001	0.08				
Year	0.1195	0.0183	0.0001					
Region	0.0971	0.0719	0.1772					
Suburbs	0.1402	0.1911	0.4631					
Town	0.1898	0.1265	0.1337					
Timber	−0.9487	0.2286	0.0001		0.27	0.01	0.13	0.02
Farm	−0.5117	0.1537	0.0009		0.28	0.01	0.19	0.02
Thistle	0.1652	0.1304	0.2051					
Sunflower	0.1881	0.1253	0.1333					
Mixed	0.1583	0.1101	0.1503					
Suet	0.2700	0.1254	0.0313					
Corn	0.3580	0.1042	0.0006		0.23	0.01	0.31	0.02
Water	0.6300	0.1076	0.0001		0.21	0.01	0.38	0.02
Red-headed Woodpecker (*Melanerpes erythrocephalus*)								
Intercept	−97.90	45.51	0.0315	0.05				
Year	0.0480	0.0228	0.0358					
Region	0.2072	0.0918	0.0239					
Suburbs	−0.3926	0.2783	0.1583					
Town	−0.8210	0.1930	0.0001		0.17	0.01	0.06	0.01
Timber	1.0326	0.1945	0.0001		0.11	0.01	0.30	0.03
Farm	0.1695	0.1738	0.3296					
Thistle	−0.1082	0.1517	0.4757					
Sunflower	0.1181	0.1577	0.4542					
Mixed	0.1667	0.1409	0.2368					
Suet	−0.2309	0.1502	0.1243					
Corn	0.4617	0.1340	0.0006		0.11	0.01	0.16	0.01
Water	−0.0821	0.1484	0.5801					
Red-bellied Woodpecker (*Melanerpes carolinus*)								
Intercept	−127.7	32.72	0.0001	0.17				
Year	0.0634	0.0164	0.0001					
Region	0.0857	0.0665	0.1977					
Suburbs	−1.2123	0.2049	0.0001		0.45	0.01	0.19	0.03
Town	−0.9168	0.1219	0.0001		0.51	0.01	0.26	0.02
Timber	1.4123	0.1876	0.0001		0.39	0.01	0.76	0.03
Farm	0.4851	0.1297	0.0002		0.39	0.01	0.57	0.02
Thistle	0.2653	0.1180	0.0246					
Sunflower	0.2157	0.1147	0.0601					
Mixed	−0.2132	0.1018	0.0362					
Suet	0.7776	0.1157	0.0001		0.29	0.02	0.48	0.01
Corn	0.2941	0.0977	0.0026		0.38	0.01	0.49	0.02
Water	0.1815	0.1062	0.0873					
Downy Woodpecker (*Picoides pubescens*)								
Intercept	−11.26	37.75	0.7654	0.20				
Year	0.0056	0.0190	0.7677					
Region	−0.1007	0.0775	0.1934					
Suburbs	−1.1812	0.1994	0.0001		0.76	0.01	0.54	0.04
Town	−0.6638	0.1450	0.0001		0.77	0.01	0.68	0.02
Timber	0.7417	0.2502	0.0030		0.72	0.01	0.88	0.02

Table 3. Continued.

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable: Absent Mean	Absent SE	Present Mean	Present SE
Farm	0.1879	0.1694	0.2673					
Thistle	0.3200	0.1286	0.0128					
Sunflower	0.4320	0.1236	0.0005		0.60	0.02	0.79	0.01
Mixed	−0.4114	0.1240	0.0009		0.79	0.01	0.71	0.01
Suet	1.9153	0.1177	0.0001		0.44	0.02	0.85	0.01
Corn	0.1504	0.1171	0.1991					
Water	0.2165	0.1295	0.0945					
Hairy Woodpecker (*Picoides villosus*)								
Intercept	−78.17	32.81	0.0172	0.15				
Year	0.0387	0.0165	0.0189					
Region	−0.3656	0.0680	0.0001					
Suburbs	−0.8717	0.1991	0.0001		0.39	0.01	0.23	0.03
Town	−0.7441	0.1248	0.0001		0.43	0.01	0.28	0.02
Timber	0.6653	0.1738	0.0001		0.36	0.01	0.57	0.03
Farm	0.2111	0.1334	0.1135					
Thistle	0.2236	0.1202	0.0628					
Sunflower	0.3429	0.1174	0.0035		0.27	0.02	0.42	0.01
Mixed	−0.1000	0.1021	0.3272					
Suet	1.3505	0.1274	0.0001		0.17	0.02	0.46	0.01
Corn	0.2004	0.0975	0.0399					
Water	0.1622	0.1056	0.1247					
Northern Flicker (*Colaptes auratus*)								
Intercept	32.45	36.17	0.3697	0.04				
Year	−0.0175	0.0182	0.3346					
Region	0.3113	0.0751	0.0001					
Suburbs	−0.6446	0.2272	0.0046		0.22	0.01	0.15	0.03
Town	−0.4154	0.1362	0.0023		0.23	0.01	0.19	0.01
Timber	0.0034	0.1878	0.9856					
Farm	−0.2196	0.1491	0.1409					
Thistle	0.2199	0.1352	0.1038					
Sunflower	−0.0884	0.1282	0.4904					
Mixed	0.0391	0.1141	0.7315					
Suet	0.5016	0.1349	0.0002		0.15	0.01	0.24	0.01
Corn	0.2984	0.1081	0.0058					
Water	0.4147	0.1138	0.0003		0.19	0.01	0.28	0.02
Blue Jay (*Cyanocitta cristata*)								
Intercept	79.56	43.43	0.0669	0.06				
Year	−0.0400	0.0218	0.0668					
Region	0.2296	0.0885	0.0094					
Suburbs	−0.4366	0.2195	0.0467					
Town	−0.3126	0.1575	0.0472					
Timber	0.7232	0.2794	0.0096					
Farm	0.4403	0.1981	0.0262					
Thistle	0.2995	0.1418	0.0347					
Sunflower	0.5614	0.1430	0.0001		0.80	0.02	0.87	0.01
Mixed	0.6908	0.1346	0.0001		0.81	0.01	0.88	0.01
Suet	0.0979	0.1381	0.4781					
Corn	0.5345	0.1377	0.0001		0.82	0.01	0.90	0.01
Water	0.5440	0.1562	0.0005		0.83	0.01	0.90	0.01
American Crow (*Corvus brachyrhynchos*)								
Intercept	−131.7	38.14	0.0006	0.05				
Year	0.0655	0.0192	0.0006					
Region	−0.2990	0.0778	0.0001					
Suburbs	−0.1665	0.2010	0.4075					

Table 3. Continued.

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable: Absent Mean	Absent SE	Present Mean	Present SE
Town	−0.3679	0.1359	0.0068					
Timber	−0.8309	0.2258	0.0002		0.21	0.01	0.13	0.02
Farm	−0.5771	0.1592	0.0003		0.21	0.01	0.17	0.02
Thistle	−0.1356	0.1350	0.3152					
Sunflower	0.1672	0.1335	0.2103					
Mixed	0.2917	0.1192	0.0144					
Suet	0.3223	0.1367	0.0184					
Corn	0.4258	0.1109	0.0001		0.17	0.01	0.25	0.01
Water	0.4338	0.1165	0.0002		0.18	0.01	0.27	0.02
Black-capped Chickadee (*Parus atricapillus*)								
Intercept	−92.18	40.42	0.0226	0.08				
Year	0.0469	0.0203	0.0208					
Region	−0.1686	0.0837	0.0440					
Suburbs	−0.7958	0.2094	0.0001		0.84	0.01	0.72	0.03
Town	−0.4724	0.1562	0.0025		0.85	0.01	0.79	0.01
Timber	0.9900	0.3259	0.0024		0.82	0.01	0.94	0.02
Farm	0.0677	0.1832	0.7119					
Thistle	−0.0350	0.1415	0.8046					
Sunflower	0.5826	0.1320	0.0001		0.73	0.02	0.87	0.01
Mixed	−0.2472	0.1357	0.0686					
Suet	1.0468	0.1273	0.0001		0.70	0.02	0.88	0.01
Corn	−0.1692	0.1261	0.1797					
Water	0.2385	0.1423	0.0938					
Tufted Titmouse (*Parus bicolor*)								
Intercept	−117.9	38.93	0.0025	0.17				
Year	0.0578	0.0195	0.0031					
Region	0.7797	0.0813	0.0001					
Suburbs	−1.3277	0.2652	0.0001		0.26	0.01	0.10	0.02
Town	−1.4052	0.1553	0.0001		0.31	0.01	0.10	0.01
Timber	1.1622	0.1745	0.0001		0.21	0.01	0.58	0.03
Farm	−0.2323	0.1436	0.1059					
Thistle	−0.1803	0.1318	0.1711					
Sunflower	0.4916	0.1410	0.0005		0.73	0.02	0.87	0.01
Mixed	−0.4126	0.1156	0.0004		0.31	0.02	0.20	0.01
Suet	0.4234	0.1357	0.0018		0.19	0.02	0.26	0.01
Corn	0.0891	0.1141	0.4349					
Water	0.0536	0.1233	0.6637					
Red-breasted Nuthatch (*Sitta canadensis*)								
Intercept	−775.9	59.50	0.0001	0.15				
Year	0.3885	0.0299	0.0001					
Region	−0.1141	0.0824	0.1660					
Suburbs	0.0109	0.2255	0.9616					
Town	0.0965	0.1445	0.5043					
Timber	−0.2968	0.2220	0.1812					
Farm	−0.6025	0.1761	0.0006		0.22	0.01	0.14	0.02
Thistle	0.2748	0.1501	0.0672					
Sunflower	−0.0036	0.1449	0.9800					
Mixed	−0.3294	0.1228	0.0073					
Suet	0.7919	0.1541	0.0001		0.11	0.01	0.24	0.01
Corn	0.0784	0.1193	0.5109					
Water	0.4014	0.1233	0.0011		0.17	0.01	0.28	0.02
White-breasted Nuthatch (*Sitta carolinensis*)								
Intercept	−36.50	32.57	0.2624	0.11				
Year	0.0186	0.0164	0.2545					

Table 3. Continued.

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable: Absent Mean	Absent SE	Present Mean	Present SE
Region	−0.2640	0.0670	0.0001					
Suburbs	−1.1596	0.1776	0.0001		0.68	0.01	0.42	0.35
Town	−0.4287	0.1225	0.0005		0.68	0.01	0.61	0.02
Timber	1.3328	0.2473	0.0001		0.63	0.01	0.90	0.02
Farm	−0.1065	0.1380	0.4403					
Thistle	0.0101	0.1156	0.9300					
Sunflower	0.3810	0.1099	0.0005		0.55	0.02	0.70	0.01
Mixed	−0.2316	0.1045	0.0267					
Suet	0.6846	0.1070	0.0001		0.52	0.02	0.71	0.01
Corn	0.2327	0.0997	0.0196					
Water	0.2460	0.1094	0.0246					
European Starling (*Sturnus vulgaris*)								
Intercept	42.13	33.10	0.2031	0.19				
Year	−0.0216	0.0166	0.1932					
Region	−0.0326	0.0679	0.6306					
Suburbs	0.7818	0.1953	0.0001		0.57	0.01	0.74	0.03
Town	0.6362	0.1263	0.0001		0.50	0.01	0.74	0.02
Timber	−1.4062	0.1818	0.0001		0.61	0.01	0.29	0.03
Farm	−0.9637	0.1346	0.0001		0.64	0.01	0.38	0.02
Thistle	0.1753	0.1150	0.1274					
Sunflower	0.0300	0.1148	0.7938					
Mixed	0.2720	0.1034	0.0085					
Suet	1.0371	0.1115	0.0001		0.40	0.02	0.65	0.01
Corn	0.5267	0.1011	0.0001		0.53	0.01	0.66	0.02
Water	0.5610	0.1112	0.0001		0.53	0.01	0.70	0.02
Northern Cardinal (*Cardinalis cardinalis*)								
Intercept	−106.0	40.46	0.0088	0.08				
Year	0.0530	0.0203	0.0091					
Region	0.7328	0.0885	0.0001					
Suburbs	−0.3240	0.2225	0.1454					
Town	−0.3097	0.1587	0.0510					
Timber	1.1964	0.3380	0.0004		0.82	0.01	0.95	0.01
Farm	−0.3510	0.1741	0.0438					
Thistle	−0.0290	0.1451	0.8417					
Sunflower	0.6387	0.1359	0.0001		0.76	0.02	0.86	0.01
Mixed	0.2884	0.1318	0.0287					
Suet	0.0877	0.1358	0.5181					
Corn	0.2562	0.1275	0.0445					
Water	0.4994	0.1495	0.0008		0.81	0.01	0.89	0.01
American Tree Sparrow (*Spizella arborea*)								
Intercept	−336.5	33.67	0.0001	0.09				
Year	0.1684	0.0169	0.0001					
Region	−0.0182	0.0662	0.7830					
Suburbs	−0.3257	0.1860	0.0799					
Town	−0.5121	0.1236	0.0001		0.39	0.01	0.27	0.02
Timber	−0.1093	0.1743	0.5303					
Farm	0.2501	0.1313	0.0567					
Thistle	−0.0529	0.1146	0.6442					
Sunflower	0.1348	0.1136	0.2354					
Mixed	0.2510	0.1018	0.0136					
Suet	0.1234	0.1123	0.2715					
Corn	0.3416	0.0967	0.0004		0.31	0.01	0.40	0.02
Water	0.4696	0.1033	0.0001		0.31	0.01	0.43	0.02

Table 3. Continued.

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable: Absent Mean	Absent SE	Present Mean	Present SE
Song Sparrow (*Melospiza melodia*)								
Intercept	−56.04	46.55	0.2286	0.02				
Year	0.0269	0.0234	0.2490					
Region	0.0609	0.0935	0.5148					
Suburbs	−0.5648	0.3085	0.0671					
Town	−0.4372	0.1879	0.0200					
Timber	0.1367	0.2421	0.5724					
Farm	0.5603	0.1750	0.0014		0.10	0.01	0.19	0.02
Thistle	0.0274	0.1629	0.8662					
Sunflower	0.1104	0.1613	0.4937					
Mixed	0.2783	0.1473	0.0589					
Suet	−0.1500	0.1556	0.3350					
Corn	0.0784	0.1382	0.5707					
Water	0.1346	0.1492	0.3670					
Dark-eyed Junco (*Junco hyemalis*)								
Intercept	−87.89	44.12	0.0463	0.04				
Yeat	0.0445	0.0222	0.0448					
Region	0.1807	0.0922	0.0500					
Suburbs	−0.4422	0.2350	0.0599					
Town	−0.4872	0.1686	0.0038		0.89	0.01	0.83	0.01
Timber	1.3679	0.4094	0.0008		0.86	0.01	0.97	0.01
Farm	0.0513	0.2006	0.7982					
Thistle	0.3105	0.1492	0.0374					
Sunflower	0.5586	0.1463	0.0001		0.81	0.02	0.90	0.01
Mixed	0.2344	0.1432	0.1017					
Suet	0.3629	0.1425	0.0109					
Corn	0.0342	0.1379	0.8044					
Water	0.2791	0.1578	0.0770					
Common Grackle (*Quiscalus quiscula*)								
Intercept	63.21	44.51	0.1556	0.04				
Year	−0.0334	0.0224	0.1356					
Region	0.1629	0.0933	0.0808					
Suburbs	0.5725	0.2229	0.0102					
Town	0.2857	0.1623	0.0784					
Timber	−1.4326	0.4065	0.0004		0.14	0.01	0.03	0.01
Farm	−0.5951	0.2179	0.0063					
Thistle	0.2347	0.1762	0.1829					
Sunflower	0.2827	0.1616	0.0802					
Mixed	0.5115	0.1496	0.0006		0.09	0.01	0.15	0.01
Suet	0.0378	0.1595	0.8127					
Corn	0.1958	0.1352	0.1475					
Water	0.3978	0.1394	0.0043		0.11	0.01	0.17	0.01
Purple Finch (*Carpodacus purpureus*)								
Intercept	−39.38	32.72	0.2287	0.07				
Year	0.0186	0.0164	0.2564					
Region	0.5610	0.0682	0.0001					
Suburbs	−0.6901	0.2061	0.0008		0.34	0.01	0.19	0.03
Town	−0.2043	0.1220	0.0940					
Timber	0.5148	0.1675	0.0021		0.31	0.01	0.48	0.03
Farm	−0.3300	0.1375	0.0164					
Thistle	0.1977	0.1181	0.0939					
Sunflower	0.5660	0.1196	0.0001		0.22	0.02	0.36	0.01
Mixed	−0.2528	0.1004	0.0118					
Suet	0.1490	0.1137	0.1902					

Table 3. Continued.

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable: Absent Mean	Absent SE	Present Mean	Present SE
Corn	0.1323	0.0983	0.1781					
Water	−0.2238	0.1071	0.0366					
House Finch (*Carpodacus mexicanus*)								
Intercept	−1.427	0.2886	0.0001	0.13				
Region	0.1285	0.0868	0.1385					
Suburbs	0.6746	0.2308	0.0035		0.37	0.01	0.55	0.05
Town	0.4696	0.1478	0.0015		0.32	0.02	0.53	0.02
Timber	−1.3210	0.2701	0.0001		0.41	0.01	0.16	0.04
Farm	−1.0649	0.1852	0.0001		0.44	0.02	0.91	0.02
Thistle	0.2134	0.1524	0.1615					
Sunflower	0.6198	0.1535	0.0001		0.27	0.02	0.43	0.02
Mixed	−0.2640	0.1293	0.0411					
Suet	0.2827	0.1484	0.0568					
Corn	0.0042	0.1264	0.9735					
Water	0.3023	0.1311	0.0212					
Pine Siskin (*Carduelis pinus*)								
Intercept	72.40	38.86	0.0625	0.05				
Year	−0.0379	0.0195	0.0523					
Region	0.1168	0.0811	0.1498					
Suburbs	−0.1502	0.2322	0.5176					
Town	0.3064	0.1419	0.0309					
Timber	−0.2866	0.2264	0.2057					
Farm	−0.5370	0.1841	0.0035		0.20	0.01	0.11	0.01
Thistle	0.5467	0.1623	0.0008		0.10	0.01	0.20	0.01
Sunflower	0.6271	0.1546	0.0001		0.10	0.01	0.21	0.01
Mixed	−0.0999	0.1207	0.4077					
Suet	0.5140	0.1505	0.0006		0.11	0.01	0.21	0.01
Corn	−0.0297	0.1178	0.8129					
Water	0.2187	0.1224	0.0739					
American Goldfinch (*Carduelis tristis*)								
Intercept	63.89	35.44	0.0714	0.16				
Year	−0.0328	0.0178	0.0651					
Region	0.4957	0.0743	0.0001					
Suburbs	−0.6629	0.1923	0.0006		0.72	0.01	0.59	0.04
Town	−0.7600	0.1355	0.0001		0.74	0.01	0.63	0.02
Timber	0.8709	0.2297	0.0001		0.69	0.01	0.85	0.02
Farm	0.0500	0.1569	0.7499					
Thistle	1.6860	0.1199	0.0001		0.44	0.02	0.78	0.01
Sunflower	0.3710	0.1184	0.0017		0.60	0.02	0.75	0.01
Mixed	−0.1505	0.1129	0.1824					
Suet	0.3967	0.1164	0.0007		0.60	0.02	0.75	0.01
Corn	0.1127	0.1079	0.2964					
Water	−0.0759	0.1174	0.5180					
House Sparrow (*Passer domesticus*)								
Intercept	152.7	37.60	0.0001	0.04				
Year	−0.0766	0.0189	0.0001					
Region	0.0222	0.0750	0.7676					
Suburbs	0.3239	0.2080	0.1195					
Town	0.2414	0.1349	0.0736					
Timber	−0.0588	0.1867	0.7528					
Farm	0.6094	0.1605	0.0001		0.77	0.01	0.84	0.02
Thistle	0.0195	0.1258	0.8770					
Sunflower	0.3824	0.1237	0.0020		0.74	0.02	0.81	0.01

Table 3. Continued.

Species and Variable	Parameter Estimate	SE	P	R^2	Species frequency of occurrence when variable Absent Mean	Absent SE	Present Mean	Present SE
Mixed	0.3300	0.1143	0.0039		0.76	0.01	0.81	0.01
Suet	0.3979	0.1188	0.0008		0.72	0.02	0.81	0.01
Corn	0.1263	0.1122	0.2605					
Water	0.2581	0.1249	0.0388					

[a]R^2 is derived from Stokes et al. (1995)
[b]Frequency of occurrence at houses for species with significant relationships between occurrence and year or region are reported in the text of the results section
[c]For example, the Mourning Dove had a negative relationship between occurrence and timber. This means that the species was less likely to occur at houses that were surrounded by timber than at houses that were not surrounded by timber. Mourning Doves were seen at a frequency of 0.27 at houses that were not surrounded by timber and a frequency of 0.13 at houses that were surrounded by timber

species occurred with decreasing frequency from the north to the south. These species were Hairy Woodpecker (frequency of occurrence at a house in north, central, and south regions was 0.45 [standard error (SE) = 0.02], 0.37 [0.01], and 0.31 [0.02], respectively), American Crow (0.19 [0.02], 0.26 [0.01], and 0.10 [0.01]), and White-breasted Nuthatch (0.70 [0.02], 0.66 [0.01], and 0.61 [0.02]) (scientific names listed in Table 3). Five species occurred with decreasing frequency from the south to the north. These species were Northern Flicker (frequency of occurrence at a house in south, central and north regions was 0.27 [SE = 0.02], 0.22 [0.01], and 0.17 [0.02], respectively), Tufted Titmouse (0.36 [0.02], 0.27 [0.01], and 0.10 [0.01]), Northern Cardinal (0.88 [0.01], 0.90 [0.01], and 0.69 [0.02]), Purple Finch (0.51 [0.02], 0.26 [0.01], and 0.27 [0.02]), and American Goldfinch (0.83 [0.02], 0.67 [0.01], and 0.66 [0.02]).

Twenty-two species were influenced by the habitat which surrounded the house (Tables 3 and 4). The occurrence of 13 species was influenced by whether the house was in town. Two species were more likely to be found at houses in town than at houses not in town, whereas 11 species occurred more frequently at houses not in town. The presence of suburban habitat influenced the occurrence of 11 species with 2 species more likely to be found at houses in suburbs, and 9 species more likely to occur at houses not in suburbs. The occurrence of nine species was influenced by whether the house was in farmland. Three species occurred more frequently at houses surrounded by farmland, and six species occurred more frequently at houses not surrounded by farmland. The most influential habitat was timber. Eleven species were more likely to be found at houses surrounded by timber, whereas five species were more likely to be found at houses not surrounded by timber.

Water and food types available at the house influenced 22 species (Tables 3 and 4). The presence of mixed seed influenced five species. Three species occurred more frequently at houses where mixed seed was present, and two species were more likely to occur at houses where mixed seed was absent. Thirteen species were positively influenced by the presence of sunflower, 12 species were positively influenced by suet, 9 species were positively influenced by water, 7 species were positively influenced by corn, and 2 species were positively influenced by thistle.

Year of the survey influenced seven species (Tables 3 and 4). Mourning Dove (frequency of occurrence at a house in 1988 and 1994 was 0.18 [SE = 0.01] and 0.31 [0.01], respectively), Red-bellied Woodpecker (0.37 [0.02] and 0.47 [0.01]), American Crow (0.17 [0.01] and 0.23 [0.01]), Tufted Titmouse (0.19 [0.01] and 0.28 [0.01]), Red-breasted Nuthatch (0.04 [0.01] and 0.31 [0.01]), and American Tree Sparrow (0.22 [0.01] and 0.44 [0.01]) had a higher occurrence at feeders in 1994 than 1988. The House Sparrow (0.83 [0.01] and 0.76 [0.01]) had a higher occurrence at feeders in 1988.

DISCUSSION

Brittingham and Temple (1989) found 16 of 21 bird species that use feeders (76%) differed significantly in occurrence between the north and south regions of Wisconsin. Nine species were more likely to be observed in the northern region of the state, and seven were more likely to be viewed in the southern region. In Iowa, we found only eight species (35%) to be influenced by the latitudinal region of the state in which a house was located. One reason that latitudinal location was not as important a factor in Iowa as it was in Wisconsin may be that our analysis of the north, central, and south regions did not correspond with the natural regions of Iowa (Prior 1991). The south region used in our analysis corresponded well with the Southern Iowa Drift Plain. However, the north and central regions we used were a combination of several natural regions including: Northwest Iowa Plains, Des Moines Lobe, Iowan Surface, Paleozoic Plateau, and Southern Iowa Drift Plain. The distribution of several species we studied may be influenced more by natural regions than by latitude, thereby affecting the number of species influenced by geographic location. For example, both Tufted Titmouse and Northern Cardinal were more likely to be observed in the south region than the north. This result may be because both species are less abundant and nest less frequently in the northwest part of the state than in the northeast (Hollis 1984, Jackson et al. 1996, Kent and Dinsmore 1996).

The type of habitat surrounding a house is an important factor influencing the occurrence of birds (Dunn and Tessaglia-Hymes 1999). For example, Brittingham and Temple (1986) found a greater number of birds and species at houses in Wisconsin in rural areas compared to suburban and urban areas, and Hollis (1986) observed 20 species in central Iowa be more abundant at rural feeders than at urban feeders. Brittingham and Temple (1989) reported that 16 of 21 bird species that use feeders in Wisconsin (76%) had significant differences in occurrence among houses in urban, suburban, and rural areas. Two species were more likely to occur at suburban houses than urban or rural houses, 4 species were more likely to occur at urban houses, and 10 species were more likely to occur at rural houses.

Table 4. Explanatory variables that significantly influenced the occurrence of 23 bird species recorded during the 1988 and 1994 Iowa Winter Bird Feeder Surveys, and whether the variable positively (+) or negatively (−) influenced species occurrence.

	Explanatory Variable											
Species	Year[a]	Region[b]	Suburbs	Town	Timber	Farm	Thistle	Sun-flower	Mixed	Suet	Corn	Water
Mourning Dove	+				−	−					+	+
Red-headed Woodpecker				−	+						+	
Red-bellied Woodpecker	+		−	−	+	+				+	+	
Downy Woodpecker			−	−	+			+	−	+		
Hairy Woodpecker		−	−	−	+			+		+		
Northern Flicker		+	−	−						+		+
Blue Jay								+	+		+	+
American Crow	+	−			−	−					+	+
Black-capped Chickadee			−	−	+			+		+		
Tufted Titmouse	+	+	−	−	+			+	−	+		
Red-breasted Nuthatch	+					−				+		+
White-breasted Nuthatch		−	−	−	+			+		+		
European Starling			+	+	−	−				+	+	+
Northern Cardinal		+			+			+				+
American Tree Sparrow	+			−							+	+
Song Sparrow						+						
Dark-eyed Junco				−	+			+				
Common Grackle					−				+			+
Purple Finch		+	−		+			+				
House Finch			+	+	−	−		+				
Pine Siskin						−	+	+		+		
American Goldfinch		+	−	−	+		+	+		+		
House Sparrow	−					+		+	+	+		

[a]If year +, species had a higher occurrence at feeders in 1994 than 1988. If year −, species had a higher occurrence at feeders in 1988
[b]If region +, species occurred with decreasing frequency from the south to the north. If region −, species occurred with decreasing frequency from the north to the south

Similarly, in Iowa 22 of 23 species (96%) were influenced by the habitat surrounding a house (Blue Jay was the exception).

Cavity-nesting species, as a group, were the most sensitive to the habitat surrounding a house. Red-headed Woodpecker, Red-bellied Woodpecker, Downy Woodpecker, Hairy Woodpecker, Northern Flicker, Black-capped Chickadee, Tufted Titmouse, and White-breasted Nuthatch were less likely to be found at houses in town or in the suburbs, and, with the exception of the Northern Flicker, were more likely to occur at houses surrounded by timber. The one exception was European Starling, which was more likely to be found at houses in town or in suburbs, and occurred less frequently at houses surrounded by farmland or timber. Presumably, this is because starlings build their nests in buildings, and there are more buildings in town or suburbs. These results are comparable to those reported by Dunn and Tessaglia-Hymes (1999) who stated that the occurrence, abundance, or flock size of Red-bellied Woodpecker, Hairy Woodpecker, Black-capped Chickadee, and Tufted Titmouse was greater at houses at rural sites compared to urban sites.

Sparrows in the Family Emberizidae were also less likely to occur at houses in urban areas compared to rural areas. We observed that American Tree Sparrow and Dark-eyed Junco were less likely to occur at houses in town. Dark-eyed Junco occurred more often at houses surrounded by timber, while Song Sparrow were more likely to occur at houses surrounded by farmland. Dunn and Tessaglia-Hymes (1999) found the occurrence, abundance, or flock size of these species to be lower at urban sites compared to rural sites.

Twenty-two of 23 species (96%) were influenced by the presence of water or at least one food type (Song Sparrow was the exception). Two surprising results were the large number of species positively influenced by the presence of corn, and the few species that were positively influenced by mixed seed.

In Maryland, Geis (1980) stated that cracked corn was readily consumed by three species that had a positive relationship to corn in our study: Mourning Dove, Red-bellied Woodpecker, and American Tree Sparrow. Geis also observed White-throated Sparrow and Dark-eyed Junco feeding on cracked corn regularly. However, Geis did not find cracked corn to be particularly attractive to Blue Jay or American Crow, two species for which we report a positive relationship between occurrence and the presence of corn. Dunn and Tessaglia-Hymes (1999) noted that Mourning Dove, Blue Jay, American Crow, European Starling, American Tree Sparrow, Dark-eyed Junco, Common Grackle, and House Sparrow consumed corn on more than a third of their visits to feeders, whereas we found no relationship between the occurrence of Dark-eyed Junco, Common Grackle, and House Sparrow and the presence of corn. The discrepancy among these three studies suggests that further investigation is needed into the attractiveness of corn to birds, and that bird species have regional differences in seed preferences (Dunn and Tessaglia-Hymes 1999).

Horn (1999) reported an increase in the occurrence or abundance of Red-bellied Woodpecker, Blue Jay, American Crow, European Starling, Northern Cardinal, and House Sparrow when mixed seed was offered. We observed two of those species, Blue Jay and House Sparrow, more often at houses where mixed seed was present. One reason for the discrepancy between studies in the number of species positively influenced by mixed seed may be the composition of mixed seed used. Horn (1999) used a mixed seed containing hulled sun-

flower (about 50% of contents), hulled peanuts (25%), hulled millet (15%), and hulled "tree" nuts (10%), whereas for the Feeder Survey, mixed seed could be any combination of two or more seed types. Thus, mixed seed could have consisted of two seed types that birds do not frequently consume.

Horn (1999) did not find any species to be negatively influenced by mixed seed, whereas we found two species to have a lower occurrence at houses where mixed seed was available. One reason for the negative relationships may be that several of the species that feed on mixed seed, such as Common Grackle, are aggressive species (Ambuel and Temple 1983) that may exclude other species from feeding.

Although thistle seed was offered at 76% of the houses participating in the Iowa Winter Bird Feeder Survey during 1988 and 1994, thistle seed does not appear to be a major factor influencing the occurrence of species. Only two species, Pine Siskin and American Goldfinch, were influenced by the occurrence of thistle seed. Of the 22 species examined in our study that were also examined by Dunn and Tessaglia-Hymes (1999), only three species, House Finch, Pine Siskin, and American Goldfinch consumed thistle at greater than 33% of visits to feeders. Horn (1999) observed only one species to have a positive relationship between occurrence and presence of thistle. Thus, results from studies performed at the local (Horn 1999), state (this study), and national level (Dunn and Tessaglia-Hymes 1999) indicate that thistle seed may not be as important as other foods in attracting birds.

There are many confounding factors in this study that may make some of our results difficult to interpret. First, the presence of supplementary food has been known to alter the habitat preferences of species (Wilson 1994). Thus, species may actually switch habitats based on whether food from bird feeders is available. Second, the houses of participants were surrounded by more types of habitats and offered additional seed types than the ones analyzed in this study. We did not analyze these additional variables due to their small sample size. Next, the location of the feeder (Cowie and Simmons 1991, Dunn and Hussell 1991) and the type of feeder (Horn 1995) influence both the number and composition of birds that visit (Geis and Pomeroy 1993). These variables were not recorded by participants, and thus, we were unable to account for them in the analyses. For the previous two reasons, the amount of variation explained by our analyses is low. Finally, due to the large number of statistical tests run, there may be several tests that found a statistically significant difference, but were biologically false. For example, we found positive relationships between Pine Siskin, American Goldfinch, and House Sparrow occurrence and suet, even though suet is an infrequent food choice for these species (Dunn and Tessaglia-Hymes 1999).

Geographic region, the habitat surrounding a house, and the seeds available are important factors influencing the occurrence of bird species that use feeders in Iowa (Dunn and Tessaglia-Hymes 1999). However, there is not one scenario that will attract all of the species that use feeders to a given yard. Different species prefer different habitats and different seeds, and moreover, different species are more likely to occur in different regions of the state. Results of this study, however, can be used to increase chances of attracting those species that feeder owners would like to see.

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