

BOSTON PUBLIC LIBRARY



3 9999 06317 788 3

233

**RELATIVE ATTRACTIVENESS OF DIFFERENT
FOODS AT WILD BIRD FEEDERS**

**UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Special Scientific Report—Wildlife No. 233**

Library of Congress Cataloging in Publication Data

Geis, Aelred D. 1929-
Relative attractiveness of different foods at wild bird feeders.

(Special scientific report—wildlife ; no. 233)

Supt. of docs.: I49.15/3:233

1. Birdseed. I. Title. II. Series.

SK361.A256 no. 233 [QL676.5] 639.9'79'0973s [664'.764] 80-607831

RELATIVE ATTRACTIVENESS OF DIFFERENT FOODS AT WILD BIRD FEEDERS

By Aelred D. Geis



UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

Special Scientific Report—Wildlife No. 233

Washington, D.C. • 1980

Relative Attractiveness of Different Foods at Wild Bird Feeders

by

Aelred D. Geis

U.S. Fish and Wildlife Service
Patuxent Wildlife Research Center
Laurel, Maryland 20811

Abstract

The relative attractiveness of various seeds used to feed wild birds was measured. This information, with data on consumption rates and costs, provides a basis for determining the most efficient materials for use in bird feeders in residential areas. Many common bird foods, such as fine cracked corn, wheat, sorghum, hulled oats, and rice, were found to be relatively unattractive. Seeds of the small black oil-type sunflower were superior to those of black striped and gray striped sunflowers. White proso millet was the best seed for use in attracting the small seed-eating species. Feeding preferences among various species of birds are strikingly different; consequently it is difficult to formulate a mixture of seeds that would be efficient at all locations and at all times.

The feeding of wild birds at people's homes is one of the most popular ways of enjoying wildlife in the United States. Payne and DeGraaf (1975) estimated that one-fifth of all households purchased wild bird seed, spending about \$170 million annually. In New England, the practice is even more popular; an estimated 33% of the homes in Maine (Cross 1973) and Massachusetts (Massachusetts Audubon Society 1974) participate. However, few data have been reported on the most efficient foods for use in feeding stations. The most extensive study (Grey 1979) demonstrated that there were striking differences in the attractiveness of various food materials and that some commonly used foods are relatively unattractive to birds.

The objective of the present study was to determine the best materials for use in feeding birds. A data collection program was developed to measure the relative attractiveness of various materials and the amount consumed; with this information and knowledge of the cost of the various foods, the most efficient materials for use as bird feed could be derived.

Procedures

Data were gathered between November 1977 and July 1979 by volunteers who systematically recorded over 179,000 bird visits and food consumption at experimental feeders near their homes. Information on the relative attractiveness of various foods was ob-

tained by presenting two, three, or four different foods simultaneously. In most instances, these were presented on experimental tables (122 x 122 cm) divided into four equal 61- x 61-cm compartments (Fig. 1). A wooden barrier, 37 mm high, rimmed the outside edge of the table and 15.2-cm plexiglass partitions separated the compartments. A lantern-type feeder (Rubbermaid Incorporated, Wooster, Ohio 44691) was placed at the center of each compartment (Fig. 1). In a few instances, lantern feeders were placed on posts or hung from wires with no tables to catch spilled seed; in these experiments, relative attractiveness could be determined but data on the amount of spill could not be obtained. Materials routinely used to feed birds in Maryland were tested, as were some seeds used in planting food plots.

A standard for comparing the attractiveness of various food materials was provided by using black striped sunflower (BSS), or white proso millet (WPM), or both in each experiment. The attractiveness of food is presented quantitatively as the ratio of the number of visits made to the candidate food material compared with those made during the same test to the WPM or the BSS. These two materials were selected because they are both commonly used and all bird species found one or the other relatively attractive.

The location of each food material was rotated to a new position on the table after several days to avoid any possibility of a location bias in the observations. When positions were changed, all spilled material was

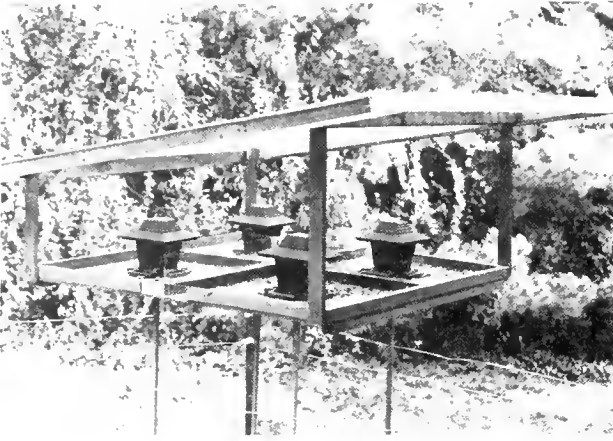


Fig. 1. Experimental Feeding Table

removed from each compartment and sorted, by using screens and a blower, so that the amount of sound seed could be measured. This amount was subtracted from the amount added to the feeders during the experiment to obtain a more accurate measure of the food actually taken by the birds. Such an adjustment was important because some foods were much more easily spilled from feeders than others, thus yielding exaggerated consumption values if only the amounts of food passing through the feeder were recorded.

Bird visits to each compartment were recorded during 30-second intervals throughout the day at the discretion of the observer. In a few instances, a schedule was followed relative to sunrise and sunset to evaluate the effects of adjacent food sources on visitation rates at the feeding tables. Only birds attracted to the compartment to feed were recorded. Because no seasonal differences in relative attractiveness of different foods were detected, the seasonal information was pooled for presentation.

Results

Foods Preferred by Each Bird Species

American Goldfinch (*Carduelis tristis*)

Hulled sunflower seeds (in the form of pieces or entire kernels), thistle seed, and oil-type sunflower seed were all much more attractive to the American goldfinch than BSS (Table 1). Goldfinches found the WPM unattractive; however, comparisons with this standard identified the same three preferred materials (Table 2).

Blue Jay (*Cyanocitta cristata*)

Whole peanut kernels were the most attractive food,

followed by BSS and gray striped sunflower seeds (Table 1). No other food approached these three in their attractiveness to this species. The fourth-ranked material, oil-type sunflower seed, was less than one-fifth as appealing as the BSS. These data strongly suggest that peanut kernels should be omitted from feeders by people who do not wish to attract blue jays. (Peanut kernels are commonly found in commercial mixes.) Also, to discourage blue jays, the small oil-type sunflower seed should be substituted for the larger BSS and gray striped sunflower seeds. Blue jays found WPM so unattractive that better information on feeding preferences came from comparisons with BSS.

Brown-headed Cowbird (*Molothrus ater*)

The preferred food of the brown-headed cowbird was WPM (Table 1). In comparison with the BSS, most of the foods offered were more attractive. In the comparisons with WPM (Table 2), which are perhaps more meaningful for this species, red proso millet was about two-thirds as attractive as WPM and German millet about half as attractive, closely followed by canary seed. All other foods were much less preferred than these millets and canary seed.

Cardinal (*Cardinalis cardinalis*)

Oil-type sunflower seed was the most attractive food to cardinals; BSS ranked second (Tables 1 and 2). Gray striped sunflower seed was about two-thirds as attractive to cardinals as BSS and half as attractive as the oil-type seed (Table 1). To a lesser degree, cardinals fed on a wide variety of other foods (Table 1).

Carolina Chickadee (*Parus carolinensis*)

Carolina chickadees highly preferred oil-type sunflower seed to other foods (Table 1). Oil-type sunflower seeds were 3.5 times more attractive than BSS seeds. Other foods that were at least one-fifth as attractive as BSS seed were hulled sunflower pieces and gray striped sunflower. The large attractiveness ratio of sunflower kernels is based on small samples. Peanut kernels attracted this species in the spring, and casual observations support the attractiveness of this material. Chickadees were uninterested in WPM and other small seeds in our experiments.

Dark-eyed Junco (*Junco hyemalis*)

Dark-eyed juncos clearly preferred red proso millet and WPM, followed by canary seed and fine cracked corn (Tables 1 and 2). In the sunflower seed comparisons (Table 1) juncos showed a strong preference for oil-type sunflower over BSS and gray striped sunflower seeds. None of the sunflowers, however, was nearly as attractive as the small seeds.

Table 1. Attractiveness of various foods compared with that of black striped sunflower (BSS), for different species of birds: number of visits to candidate food per visit to BSS and (in italics) number of visits to BSS while it and candidate food were equally available.

Candidate food	Species																		
	AG ^a	BJ	BHC	CA	CC	DEJ	EG	HF	HS	MD	PF	RBW	SS	ST	TS	TT	WCS	WTS	
Buckwheat	—	—	1.76	0.01	—	—	—	—	0.46	1.74	—	—	—	—	—	—	—	—	—
	—	—	17	101	—	—	—	—	119	38	—	—	—	—	—	—	—	—	—
Canary seed	0.02	T ^b	1.05	T	0.02	4.62	0.00	0.01	1.50	1.51	0.08	0.00	—	—	1.40	0.00	0.07	0.65	—
	1944	369	111	2325	133	73	104	173	360	245	162	54	—	—	25	72	121	1186	—
Cracked corn	—	—	—	0.06	0.00	4.62	—	—	—	—	—	—	—	—	30.00	—	—	0.55	—
Fine	—	—	—	227	37	13	—	—	—	—	—	—	—	—	1	—	—	100	—
Coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Flax	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Flax	—	0.00	—	0.00	—	—	—	—	0.00	0.11	—	—	—	—	—	—	—	0.00	—
	—	81	—	198	—	—	104	—	54	35	—	—	—	—	—	—	—	152	—
Millets	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
German	—	0.00	5.59	0.06	—	—	—	—	2.72	0.31	—	—	—	—	—	—	—	—	—
	—	23	27	51	—	—	—	—	99	32	—	—	—	—	—	—	—	—	—
White proso (WPM)	0.05	0.04	7.61	0.20	0.02	5.54	0.02	0.06	4.81	4.24	0.18	0.02	8.75	6.80	30.33	0.02	1.01	1.28	—
	1928	1016	707	7924	412	277	388	332	3778	862	173	99	16	15	24	163	167	3193	—
Red proso	0.03	0.01	6.89	0.14	T	7.17	0.00	0.25	3.49	3.72	0.20	0.00	4.17	0.41	36.50	0.01	0.75	0.97	—
	2658	586	153	4679	258	162	74	48	681	259	127	102	6	22	28	159	139	2718	—
Japanese	—	—	—	0.00	0.00	0.38	—	—	—	—	—	—	—	—	—	—	—	0.04	—
	—	—	—	112	30	24	—	—	—	—	—	—	—	—	—	—	—	86	—
Milo	T	0.12	1.86	0.12	0.04	0.87	0.01	0.00	0.96	2.07	—	—	—	7.40	—	0.00	—	0.33	—
	602	128	49	660	100	39	93	126	334	42	—	—	—	5	—	24	—	209	—
Oats	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hulled	0.00	—	0.84	0.01	—	0.31	—	0.00	0.81	1.04	—	—	—	67.00	—	—	—	0.20	—
	193	—	237	595	—	52	—	26	364	97	—	—	—	1	—	—	—	327	—
Whole	0.00	—	—	0.00	—	0.20	—	—	—	—	—	—	—	4.40	—	—	—	0.12	—
	468	—	—	228	—	30	—	—	—	—	—	—	—	5	—	—	—	136	—
Peanuts	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hearts	0.02	0.06	0.19	0.04	0.17	0.67	0.00	T	0.08	0.14	0.00	—	—	94.20	—	—	0.14	0.32	—
	1634	123	111	1049	24	57	92	230	388	244	122	—	—	5	—	—	35	469	—
Kernels	0.00	1.46	0.14	0.07	0.37	—	0.04	0.00	0.27	0.04	—	—	—	—	—	5.40	—	1.25	—
	22	385	108	1517	95	—	24	115	1875	198	—	—	—	—	—	10	—	59	—
Rape seed	0.00	0.00	—	0.00	—	—	0.00	0.00	0.00	—	0.00	—	—	—	—	—	—	0.00	—
	51	163	—	219	—	—	161	61	36	—	30	—	—	—	—	—	—	80	—
Rice	0.01	0.10	0.38	T	0.00	0.21	—	—	0.10	0.64	—	—	—	—	—	0.00	—	0.02	—
	304	29	53	975	30	101	—	—	143	47	—	—	—	—	—	34	—	763	—

Table 1. Continued

Candidate food	Species																		
	AG ^a	BJ	BHC	CA	CC	DEJ	EG	HF	HS	MD	PF	RBW	SS	ST	TS	TT	WCS	WTS	
Sunflower seeds																			
Black striped (BSS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Gray striped	0.17	0.75	0.61	0.67	0.22	0.70	1.10	0.31	0.55	0.46	0.64	—	—	—	—	0.75	—	—	0.54
	86	439	85	2829	73	140	184	229	1307	777	39	—	—	—	—	44	—	—	642
Hulled pieces and kernels	20.38	0.02	1.91	0.37	0.56	—	—	1.88	2.43	1.84	—	—	—	—	—	0.00	—	—	2.17
	71	232	103	2476	72	—	—	41	1103	753	—	—	—	—	—	25	—	—	116
Oil-type	4.06	0.19	1.03	1.14	3.53	2.99	1.48	2.26	1.27	4.49	4.05	0.13	3.22	—	—	0.53	1.61	1.67	1.67
	1797	1692	643	7000	350	160	969	2913	4340	1426	172	30	23	—	—	536	23	1623	1623
Wheat																			
New	—	0.00	4.22	0.11	—	—	0.00	—	1.72	2.28	—	—	—	—	—	—	—	—	—
	—	26	23	257	—	—	93	—	403	57	—	—	—	—	—	—	—	—	—
Old	0.00	0.08	1.41	0.07	0.05	—	0.00	0.03	1.20	1.25	—	—	—	—	—	—	—	—	0.12
	60	139	107	1470	37	—	—	36	1770	209	—	—	—	—	—	—	—	—	83
Thistle	6.28	T	0.55	0.02	0.02	1.55	0.02	0.20	0.12	2.67	0.25	0.00	2.25	—	—	0.00	0.09	0.26	0.26
	851	934	51	4648	236	328	227	213	1161	270	194	43	12	—	—	161	46	2320	2320

^aAG—American goldfinch; BJ—Blue jay; BHC—Brown-headed cowbird; CA—Cardinal; CC—Carolina chickadee; DEJ—Dark-eyed junco; EE—Evening grosbeak; HF—House finch; HS—House sparrow; MD—Mourning dove; PF—Purple finch; RBW—Red-bellied woodpecker; SS—Song sparrow; ST—Starling; TS—Tree sparrow; TT—Tufted titmouse; WCS—White-crested sparrow; WTS—White-throated sparrow.
^bLess than 0.01.

Table 2. Attractiveness of various foods compared to white proso millet (WPM) for individual bird species^a

Candidate food	Species											
	AG	BHC	CA	DEJ	CG	HS	MD	PF	SS	ST	TS	WTS
Buckwheat	—	0.08	—	—	—	0.04	0.22	—	—	—	—	—
	—	393	—	—	—	2044	353	—	—	—	—	—
Canary seed	0.43	0.44	0.05	0.36	—	0.29	0.58	0.38	0.14	—	0.12	0.42
	77	469	289	409	—	2637	707	24	21	—	244	909
Cracked corn	—	0.04	0.37	0.33	57.80	0.18	0.31	—	0.06	—	0.23	0.39
Fine	—	1021	54	181	5	1453	321	—	35	—	132	176
Coarse	—	0.01	—	—	23.60	0.03	0.15	—	—	—	—	—
	—	555	—	—	5	955	140	—	—	—	—	—
Flax	—	—	0.00	—	—	0.00	0.08	—	—	—	—	0.00
	—	—	65	—	—	773	52	—	—	—	—	180
Millets	—	—	—	—	—	—	—	—	—	—	—	—
German	—	0.51	0.56	—	—	0.58	0.72	—	—	—	—	—
	—	629	50	—	—	1602	191	—	—	—	—	—
White proso	1.00	1.00	1.00	1.00	1.00	1.00	0.95	—	0.54	—	1.19	0.66
Red proso	2.32	0.67	0.60	0.84	1.62	0.48	0.95	—	55	—	546	2739
	25	1391	903	1008	16	5827	1110	—	—	—	0.02	0.02
Japanese	—	—	0.00	0.05	—	0.02	—	—	—	—	40	156
	—	—	26	172	—	143	—	—	—	—	—	0.18
Milo	—	0.07	0.98	—	—	0.14	0.25	—	—	—	—	—
	—	1865	154	—	—	3031	912	—	—	—	—	131
Oats	—	—	—	—	—	—	—	—	—	—	—	—
Hulled	—	0.15	0.07	0.14	—	0.13	0.22	—	—	6.09	0.00	0.15
	—	1328	146	111	—	2470	506	—	—	11	20	421
Whole	—	—	—	—	—	—	—	—	—	—	—	—
Peanuts	—	—	—	—	—	—	—	—	—	—	—	—
Hearts	0.27	0.03	0.42	0.03	—	0.01	0.04	—	—	—	—	0.14
	52	774	36	100	—	983	582	—	—	—	—	148
Kernels	—	0.04	0.91	—	—	0.05	0.01	—	—	—	—	1.73
	—	419	215	—	—	6261	805	—	—	—	—	82
Rape seed	—	—	0.00	—	—	0.00	0.00	—	—	—	—	0.00
	—	—	56	—	—	438	26	—	—	—	—	77
Rice	—	0.12	0.01	0.11	—	0.02	0.12	—	—	0.22	0.00	0.02
	—	250	354	194	—	1569	322	—	—	81	76	777
Sunflower seeds	—	—	—	—	—	—	—	—	—	—	—	—
Black striped	21.91	0.13	4.91	0.18	—	0.21	0.24	5.58	0.11	0.15	0.03	0.78
	88	5379	1614	1535	—	18,159	3659	31	140	102	728	4100

Candidate food	Species											
	AG	BHC	CA	DEJ	CG	HS	MD	PF	SS	ST	TS	WTS
Gray striped	—	—	—	—	—	—	—	—	—	—	—	—
Hulled pieces and kernels	258.00	0.08	2.21	—	—	0.40	0.25	—	—	—	—	—
Oil-type	631.25	0.09	7.40	0.15	17.35	0.16	1.24	14.17	0.38	—	—	0.46
Wheat	4	5845	550	61	20	13,671	2611	6	21	—	—	591
New	—	—	—	—	—	—	—	—	—	—	—	—
Old	—	0.13	0.78	—	—	0.32	0.31	—	—	—	—	0.19
Thistle	367.40	0.02	0.06	0.20	—	0.02	0.22	—	0.04	0.00	0.01	108
	5	1300	662	803	—	2713	665	—	85	89	377	1900

^aAG—American goldfinch; BHC—Brown-headed cowbird; CA—Cardinal; DEJ—Dark-eyed junco; CG—Common grackle; HS—House sparrow; MD—Mourning dove; PF—Purple finch; SS—Song sparrow; ST—Tree sparrow; TS—Starling; WTS—White-throated sparrow.

Common Grackle (*Quiscalus quiscula*)

Relatively limited observations on common grackles (Table 2) suggested that hulled sunflower seeds and cracked corn were the most attractive foods for this species.

Evening Grosbeak (*Hesperiphona vespertina*)

The most attractive food (Table 1) for the evening grosbeak was oil-type sunflower seed to which 48% more visits were made than to BSS. Gray striped sunflower was about as attractive as BSS. All other foods ranked much lower than the three sunflower types in their appeal. Small seeds, such as various millets, canary seed, wheat, and milo, were rarely, if ever, eaten.

House Finch (*Carpodacus mexicanus*)

In tests of substantial sample size, oil-type sunflower was the food most attractive to house finches, receiving more than twice as many visits as BSS (Table 1). Hulled sunflowers (kernels or pieces) also ranked high. Gray striped sunflower, red proso millet, and thistle were eaten only 20–30% as often as BSS.

House Sparrow (*Passer domesticus*)

House sparrows preferred WPM to a variety of other foods that were also readily eaten. Both WPM and BSS year-round comparisons (Tables 1 and 2) showed essentially the same order of attractiveness. In summer tests, however, German millet attracted more house sparrows than red proso millet. House sparrows ate almost everything except flax and rape seed. In general, small seeds were preferred to sunflower seeds; the millets ranged from 2.7 to 4.8 times more attractive than BSS.

Mourning Dove (*Zenaidura macroura*)

Mourning doves found the small black oil-type sunflower seeds the most attractive food offered (Tables 1 and 2). This finding is especially significant because other types of sunflowers tended to be unattractive; BSS received less than one-fourth as many visits as did oil-type sunflower. The second most attractive food was WPM, closely followed by red proso millet. Both BSS and WPM comparisons reflected the general superiority of the oil-type sunflower seed and the WPM in attracting mourning doves. Other foods attractive to this species were thistle, wheat, milo, hulled sunflowers, buckwheat, canary seed, hulled oats, and fine cracked corn.

Purple Finch (*Carpodacus purpureus*)

Oil-type sunflower seed was clearly the most attractive food to purple finches (Tables 1 and 2). These birds

visited the oil-type seed 4 times more than the second-ranked BSS (Table 1). The next preferred food, gray striped sunflower, was 64% as attractive as the BSS seed. Thistle, red proso, and WPM also received a significant number of visits.

Red-bellied Woodpecker (*Melanerpes carolinus*)

The red-bellied woodpecker seldom visited the feeders. Those that did greatly preferred BSS (Table 1). Casual observations (in earlier years) suggested that red-bellied woodpeckers also eat cracked corn.

Song Sparrow (*Melospiza melodia*)

The preferred food of the song sparrow was WPM (Tables 1 and 2). Red proso, which ranked second, was about half as attractive as the WPM. The oil-type sunflower seed also received significant use by this rather infrequent visitor that usually feeds on small seeds.

Starling (*Sturnus vulgaris*)

Starlings took few foods, but showed a striking preference for peanut hearts and hulled oats (Tables 1 and 2).

Tree Sparrow (*Spizella arborea*)

Tree sparrows preferred red proso, WPM, and fine cracked corn to other foods (Tables 1 and 2). This species is one of the few that showed a slight preference for red proso millet over WPM. Canary seed also was attractive to tree sparrows.

Tufted Titmouse (*Parus bicolor*)

The tufted titmouse found WPM so unattractive that better information on feeding preferences came from comparisons with BSS (Table 1). Peanut kernels were the most attractive food; BSS, gray striped, and oil-type sunflower seeds also attracted this species, in the order listed.

White-crowned Sparrow (*Zonotrichia leucophrys*)

The white-crowned sparrow, an infrequent visitor to the feeding tables, preferred oil-type sunflower seeds and WPM followed by BSS and red proso millet (Table 1). Other foods received few visits by this species.

White-throated Sparrow (*Zonotrichia albicollis*)

Among the materials tested extensively, oil-type sunflower, WPM, and BSS ranked highest for the white-throated sparrow (Tables 1 and 2); in some small samples, hulled sunflower kernels and pieces and peanut kernels ranked highest. Other foods receiving substantial use were red proso millet, canary seed, fine cracked corn, and gray striped sunflower.

Characteristics of Food Materials

Buckwheat (*Fagopyrum esculentum*)

Brown-headed cowbirds and mourning doves showed some interest in buckwheat during the summer and fall (Tables 1 and 2) but other food materials were far more attractive to all bird species.

Canary Seed (*Phalaris canariensis*)

Canary seed was most heavily used by the same species (various sparrows and doves) that used WPM, and, to a limited extent, by finches, but no species found it nearly as attractive as the WPM (Tables 1 and 2). Canary seed is used in small quantities in mixes. Since it costs about 70% more than WPM, little advantage accrues from adding this seed to mixes and certainly none in presenting it alone.

Cracked Corn (*Zea mays*)

Although the reputation of cracked corn is good and it was used to a significant extent by such species as white-throated sparrows, dark-eyed juncos, cardinals, mourning doves, and tree sparrows (Tables 2 and 3), it was eaten only about one-third as often as WPM. The fine cracked corn (sometimes called chick corn) was eaten more by all species than the coarse cracked corn; when corn is offered, the fine cracked corn should be the type used.

Flax (*Linum berlandieri*)

Flax was almost completely ignored by all species (Tables 1 and 2). Although mourning doves fed on it sparingly, they ate much less flax than WPM or even BSS.

German Millet (*Setaria itabia* var. *stramineofructa*)

Often called golden millet, German millet was tested only in summer and appealed to some extent to brown-headed cowbirds, mourning doves, house sparrows, and cardinals (Tables 1 and 2). In no instance was it as attractive as WPM, but it was superior to BSS in attracting brown-headed cowbirds and house sparrows.

White Proso Millet (*Panicum miliaceum*)

Like BSS, WPM can be judged only by comparison with a variety of other foods. Among the bird species preferring small seeds to sunflower products, WPM was clearly the preferred food; no other small seed had its general attractiveness. It certainly should be the food of choice in any feeding program to attract dark-eyed juncos, mourning doves, and all species of sparrows. In a comparison of the performance of WPM with BSS, the species that preferred the small seeds to sunflower products were, in descending order of pref-

Table 3. *Relative attractiveness (visits), consumption, and cost of various foods compared with black striped sunflower.*

Food	Visits	Consumption	Cost
White proso millet	2.616	2.974	0.6
German millet	1.880	1.110	0.9
Oil-type sunflower	1.691	1.834	1.0
Red proso millet	1.431	1.856	0.6
Hulled sunflower pieces	1.346	1.031	1.7
Wheat	0.903	1.006	0.5
Canary seed	0.894	1.662	1.0
Thistle	0.846	0.316	4.5
Peanut kernels	0.630	1.813	1.9
Gray striped sunflower	0.610	0.487	1.8
Buckwheat	0.551	0.319	0.8
Milo	0.515	0.941	0.5
Rice	0.221	0.139	0.8
Peanut hearts	0.079	0.242	1.5
Hulled oats	0.010	0.051	0.7
Rape seed	0.007	0.003	1.4
Flax	0.006	0.000	1.6

erence, tree sparrow, song sparrow, brown-headed cowbird, dark-eyed junco, house sparrow, mourning dove, and white-throated sparrow. The general availability of WPM, its relatively low cost, and high attractiveness make it an excellent food for use in bird feeders.

Red Proso Millet (*Panicum miliaceum*)

Red proso millet has about the same characteristics as WPM. American goldfinches and common grackles visited red proso more often than WPM but both species greatly preferred other foods to the millets. The large ratios of visits to red proso vs. BSS by some species were due more to a lack of attraction to sunflower than a strong preference for red proso. American goldfinches and grackles found WPM even more appealing than the red proso. Red proso millet can be used as a substitute for WPM although it is apparently somewhat less attractive.

Japanese Millet (*Echinochloa crus-galli* var. *frumentacea*)

Although Japanese millet has frequently been planted in Maryland food plots to attract birds, it was much less attractive on the feeding tables than WPM or BSS. Dark-eyed juncos demonstrated more interest in Japanese millet than did other bird species.

Milo (*Sorghum vulgare*)

Milo was more attractive to starlings, mourning doves, and brown-headed cowbirds than BSS. No

species found milo as attractive as WPM; however, cardinals were attracted equally to both foods. Although milo is a common ingredient in wild bird food mixes, in view of its general unattractiveness it probably should not be used. The milo available for the tests reported here was the dark, brownish-red "combine" variety. Possibly the white-seeded varieties may be more attractive, judging from food plot observations where the *hegari* variety with white seeds was consumed before the dark-seed varieties.

Oats (*Avena sativa*)

Hulled oats.—Hulled oats, sometimes called oat groats, appear occasionally in bird food mixes. The present experiment indicates that the inclusion of hulled oats is ill-advised because the only species finding them strongly attractive was starlings.

Whole oats.—Limited tests indicated that whole oats were attractive only to starlings.

Peanuts (*Arachis hypogaea*)

Peanut hearts.—Peanut hearts were extremely attractive to starlings and somewhat attractive to a number of small birds that typically feed on WPM. A comparison of peanut hearts and WPM, however, clearly indicates that small birds can effectively be attracted to WPM without the negative effect of attracting starlings.

Peanut kernels.—In view of their large size, whole peanut kernels were remarkably attractive. Tufted titmice, blue jays, Carolina chickadees, and white-throated sparrows readily took this food. The peanuts used in these tests were the large "Virginia" type. The attractiveness of small, round Spanish peanuts may be different.

Rape Seed (*Brassica napus*)

Rape seed was unusual in that it received no visits by any bird species in two winter tests. This food material occasionally appears in mixes and is a major ingredient in domestic canary feed. However, as far as wild birds are concerned, it was the least attractive food in this study.

Rice (*Oryza sativa*)

Rice was not nearly as attractive to any bird species as BSS or WPM.

Sunflower Products (*Helianthus annuus*)

Black striped sunflower seeds.—Carolina chickadees, evening grosbeaks, tufted titmice, blue jays, American goldfinches, house finches, purple finches, and cardinals much preferred BSS to WPM. In contrast, the sparrows and mourning doves found BSS

unattractive. Among the usual sunflower eaters, only tufted titmice and blue jays preferred BSS to other sunflower products.

Gray striped sunflower seeds.—Although this large sunflower seed imported from South Africa is visually appealing to those who stock bird feeders, very few species of birds preferred gray-striped sunflower seeds. Only evening grosbeaks found gray striped sunflower seeds as attractive as BSS. In winter tests, the gray striped variety was as attractive as BSS to blue jays and tufted titmice. All species that liked sunflower seeds ate the gray striped seed but they usually consumed much less of the gray striped than the oil-type sunflower or BSS seeds.

Hulled sunflower pieces and sunflower kernels.—Whole or broken kernels of hulled sunflowers were very attractive to a number of species, especially American goldfinches, house sparrows, and white-throated sparrows. These foods are discussed collectively because the hulled sunflowers used in our tests were variable, ranging from whole kernels to kernel pieces of different sizes. They are desirable food materials, especially if one wishes to attract finches and eliminate the accumulation of husks that results when whole sunflower seeds are fed.

Oil-type sunflower seeds.—Oil-type sunflower seed was superior to other foods, including BSS, for most bird species. Among the common visitors to feeding tables, only the tufted titmouse and blue jay did not demonstrate a strong preference for the oil-type sunflower seed. Some of the birds ordinarily regarded as small seed eaters found oil-type sunflower attractive; for example, white-throated sparrows, song sparrows, house sparrows, and dark-eyed juncos all made significant use of oil-type sunflower seeds, even when WPM was available. Apparently, the smaller size of the oil-type sunflower seed not only makes it attractive to more species but also causes it to last longer in the feeder than other sunflower seeds because it has 3 to 4 times the number of seeds per unit weight.

Wheat (*Triticum aestivum*)

Data were segregated into new and old wheat to determine whether freshly harvested wheat was more attractive than wheat that had been in storage and had a drier, more broken appearance. The tests indicated that the two types of wheat were about equally attractive except possibly for brown-headed cowbirds and mourning doves, which showed some preference for the new wheat. Of the species that used wheat, all used either BSS or WPM to a much greater extent.

Thistle (*Guizotia abyssinica*)

Thistle (niger), a small black seed imported from

Africa and Asia, demonstrated excellence as a goldfinch food. It also was eaten to a significant extent by house finches, purple finches, mourning doves, song sparrows, white-throated sparrows, and dark-eyed juncos.

Discussion

Decisions concerning the best bird food materials to use will depend on the attractiveness of foods to the desired bird species in relation to the cost of the foods. To gain insight into costs, the amount of a food that was consumed must be related to the number of visits received. In the summaries of the relative attractiveness, consumption, and cost of each food offered in comparison to BSS and WPM (Tables 3 and 4), visits are based on all species and seasons combined for those tests where complete consumption data were available. The pooling of species was necessary because consumption data could not be segregated by species. Reported relative costs are based on wholesale prices in Maryland at the time of the study.

A comparison of relative attractiveness with consumption and cost information yielded the following general conclusions. With a few exceptions, consumption is generally proportional to relative attractiveness. Peanut kernels were taken at a much greater rate than the number of visits would suggest, apparently because of the large size and heavy weight of the kernels, which resulted in a substantial reduction every time a bird carried a kernel away. In contrast, thistle seed had more than twice as many visits as would have been expected from the amount consumed. Thus, thistle seed was a relatively efficient food. Small German millet seeds tended to have the same characteristics as thistle, in that they were consumed at a lesser rate than would have been expected from the number of visits recorded. Hulled sunflower pieces also produced abundant visits in relation to the amount consumed. The consumption rate of the small oil-type sunflower seeds in relation to BSS and WPM seemed high, but this may have been caused by mourning doves that filled their large crops with this highly preferred food, taking a large quantity in few visits.

I found that oil-type sunflower seed and WPM are the best foods for use under Maryland conditions. Although the BSS that has traditionally been used is an excellent bird food, the oil-type sunflower seed is more attractive and no more expensive. Many of the ingredients routinely included in wild bird mixes are generally unattractive, to the extent that even with their lower cost they do not provide the bird visits per unit cost afforded by WPM. Commonly used but essentially unattractive foods are wheat, milo, peanut hearts, hulled oats, and rice.

Table 4. *Relative attractiveness (visits), consumption, and cost of various foods compared with white proso millet.*

Food	Visits	Consumption	Cost
German millet	0.576	0.442	1.5
Red proso millet	0.558	0.667	1.0
Oil-type sunflower	0.512	0.678	1.6
Canary seed	0.482	0.463	1.7
Hulled sunflower pieces	0.466	0.197	2.8
Black striped sunflower	0.382	0.336	1.6
Peanut kernels	0.289	0.897	3.1
Wheat	0.259	0.182	0.8
Milo	0.156	0.232	0.8
Fine cracked corn	0.150	0.110	0.7
Thistle	0.122	0.056	7.5
Buckwheat	0.064	0.029	1.4
Rice	0.050	0.021	1.3
Peanut hearts	0.042	0.074	2.5
Flax	0.004	0.000	1.7
Hulled oats	0.002	0.033	1.2
Rape seed	0.000	0.006	1.9

Bird species demonstrated striking differences in feeding preferences. Also, because the species composition at the feeding tables varied greatly within the year and between years, it would be very difficult to produce an ideal mix of seeds. The most practical way to proceed would be to make BSS or oil-type sunflower seeds and WPM available as appropriate for the bird species present at the bird-feeding station. In special situations, and to attract specific bird species, hulled sunflower pieces and niger thistle seed might be used. The relative attractiveness patterns of food should be determined for other geographic areas, and other foods should be tested. It seems clear from the available data that the efficiency with which wild birds are fed could be improved by recognizing the striking differences in the attractiveness of foods.

Acknowledgments

Most of the data for this report were collected by L. M. Geis, near Clarksville, Maryland. Other observations were made in the Washington-Baltimore area by H. Barroll III, J. Doeller, S. Filson, A. Smith, and the author. R. Hissey separated spilled seed and summarized, organized, and entered data for computer analyses. Experimental feeding tables were provided by the Maryland Wildlife Administration and modified by the Urban Wildlife Research Center, Inc. T. Grunwald wrote the programs for this study using the data management capabilities of Statistical Analysis System (Barr et al. 1979).

References

- Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig. 1979. A user's guide to SAS. SAS (Statistical Analysis System) Institute Inc., Raleigh, N.C.
- Cross, P. 1973. Bird seed is big business. *Maine Fish and Game* 15:10-11.
- Grey, E. 1979. Bird foods: who likes what. *Pa. Game News*, Feb. 1979.
- Massachusetts Audubon Society. 1974. Results of the 1974 bird feeding survey. Lincoln, Mass. 15 pp.
- Payne, B. R., and R. M. DeGraaf. 1975. Economic values and recreational trends associated with human enjoyment of nongame birds. Pages 6-10 *in* Proceedings of the symposium on management of forest and range habitats for nongame birds. U.S. For. Serv. Gen. Tech. Rep. WO-1.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
EDITORIAL OFFICE
AYLESWORTH HALL, CSU
FORT COLLINS, COLORADO 80523

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR
INT 423



NOTE: Mailing lists are computerized. Please return address label with change of address.