CRC HANDBOOK OF AVIAN BODY MASSES

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INTRODUCTION

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Many studies in avian biology require estimates of body size for the species being investigated. Ecological and physiological studies, for instance, often report measures of body size as baseline descriptive statistics when a large number of species are being compared. For this purpose, adult body mass is often the best single estimator of avian body size (Rising and Somers 1989). Body masses are also necessary for allometric scaling of metabolic processes (Calder 1984), and for some community structure analyses, such as calculating the total biomass of consumers supported by local resources (Schluter and Repasky 1991, Wiens and Dyer 1975). For many other types of avian research, masses are extremely useful statistics (Clark 1979).

In spite of their utility, body masses are often difficult to locate even for relatively common species, however (Dunning 1984, 1985). Gleaning the relevant data from varied and sometimes obscure publications is time-consuming. Weights are routinely recorded in banding operations and during museum assession of specimens, however, gathering data from these unpublished sources is also a difficult process.

This handbook is a compilation of data on body masses for 6283 species of birds, and is intended to alleviate the difficulty with which avian masses can be found. The handbook includes the largest and most complete sample of body masses located for each species from published or unpublished sources. Taxonomy and sequence of the handbook follow the fifth edition of Clements' (1991) checklist of birds of the world.

SOURCES OF DATA

The data presented here were gathered primarily by searching the published literature. Clark's unpublished bibliography of body mass references and Brough's (1983) compilation were of great value in this effort. Because mass data were irregularly reported in papers published prior to 1960, I searched systematically for articles reporting mass data in the volumes of the major bird journals published from 1960 to 1990. Journals searched systematically included *Ibis, Auk, Wilson Bulletin, Condor, Emu, Corella, Notornis, Journal of Field Ornithology,* and a number of smaller journals devoted primarily to bird banding. I also searched for individual articles published in these journals prior to 1960 when I encountered a citation that suggested that mass data might be found in a specific article. A wide variety of other journals were searched less systematically. Coverage of English-language literature published in the Western Hemisphere was more complete than coverage of Eastern Hemisphere journals, or journals published in French, German, or other languages. This bias reflects my access to the relevant literature, but probably does not reflect the distribution of published data. Mass data were located in articles covering a wide number of topics, including breeding biology, morphological variation, community structure, and physiology.

In addition, I surveyed regional handbooks and compilations such as Ali and Ripley (1968–1974) for India, Cramp and Simmons (1977–1988) and Baver and Glutz (1966) for Western Europe and North Africa, Brown et al. (1982) and subsequent volumes for Africa, and Clench and Leberman (1978) for eastern North America. Faunal surveys that focused on particular groups of birds provided extensive data for those groups, including Isler and Isler (1987) for tanagers, Turner and Rose (1989) for swallows, and Palmer (1976, 1988) for North American waterfowl and hawks, respectively. Finally, Brough's (1983) list of masses for over 2000

species worldwide provided both data and an extensive list of references, especially for Eurasian and African species.

Unpublished data were requested when possible from museum collections, banding operations, and researchers. I visited the collections of several research museums to record data from specimen labels, especially the collections at the University of Arizona, Louisiana State University, and the Philadelphia Academy of Natural Sciences. Numerous other museums responded to requests for information (see Acknowledgments). Unpublished banding data were solicited primarily for North American species. Much of this data was reported in Dunning (1984). A few unpublished dissertations were consulted, especially for Latin American species (e.g., Binford 1968, Weske 1972).

DATA COLLECTION

As in Dunning (1984), I included the "best available sample" that I located for each species. The best available sample was defined as the data from the single source that had (1) the largest available sample size, or (2) the most complete descriptive statistics, if sample size from several sources were equivalent. I avoided combining data from different sources if possible because data taken in different seasons, at different locations, or using different techniques increases the heterogeneity of variance found within the sample, reducing the value of the composite mean (Sokal and Rohlf 1973). I did not follow this rule when all samples were very small. If no source provided masses of at least ten individuals, I lumped data from several sources to increase the overall sample size. I considered the increased heterogeneity that might result from this practice preferable to reporting means based on the mass of only one or two individuals.

I preferred data from breeding birds, however, the lack of published information for many species required the liberal use of data from other seasons. If ages were reported in the original source, I only used masses of adult birds. I present separate means for males and females for sexually dimorphic species. Dimorphism was assessed by testing for significant differences between sexes with a Student's t test when this was possible. A statistical test was not possible in many cases due to incomplete statistical information in the original source. In these instances I report separate means for males and females if the means differ by more than 10%. A single mean is presented for species that were not judged to be sexually dimorphic by these criteria, and for species in which the sex of the weighed individuals was not indicated in the original source.

Many species of birds vary in size across their geographic range. My ability to express this geographic variation is limited by the lack of adequate data for most species. However, I have reported several means when suitable samples were available from different locations throughout the range of geographically variable species. Such samples are identified by the collecting location, or the subspecific identity of the samples, whichever were reported by the original source. I did not assign samples to subspecies if the original source did not do so, since subspecies' ranges and validity are poorly studied in most birds.

DEFINITIONS

The table was compiled using as much of the following information as was available in the selected source(s): sample size, mean, standard deviation, range, sex, collecting season, and location. Species names and order follow Clements (1991), which is based on Sibley and Monroe (1990), except in the treatment of some orders and families (e.g., Parulidae). Scientific names were modified in a few cases to reflect recent taxonomic suggestions (e.g., Robbins

and Ridgely 1991). Species are numbered in the table using a numbering system following Clements (1991). Thus gaps in the species numbers in the table indicate species in Clements' list for which no data were found.

All means and ranges are given in grams. Standard deviation, when available, is given for samples that include masses of ten or more individuals. When necessary, standard deviation was calculated from standard error.

The following codes are used to describe the sex of the samples: M = male, F = female, B = data for both sexes lumped into a single mean, U = sex of weighed individuals not given in original source. To describe the collecting season, I used the following codes: B = breeding, PB = postbreeding, S = spring migration, F = fall migration, M = spring and fall migration combined, W = winter, Y = year round. In many sources, the data were not collected during a time period that fit neatly into any of the above categories (i.e., April through November). No collecting season is indicated in the table for these species.

All sources are numbered in the Literature Cited section, including sources of unpublished data such as banding programs and museum collections. Data in the table are referenced to the original source by citing the relevant numbers from the Literature Cited section.

LIMITATIONS AND USES OF MASS DATA

A variety of topics in avian research require a measure of a bird's size. Size can be measured most accurately through multivariate analysis of several mensural characteristics (Freeman and Jackson 1990), however, the data for such an approach are rarely available, especially when a large number of species are being studied. In recent comparative studies, body mass has been shown to be the single most accurate univariate measure of size in birds. Rising and Somers (1989) determined that body mass correlated more strongly with overall body size (as estimated by multivariate analysis) than did body length, wing chord, or other commonly-measured linear characteristic. Freeman and Jackson (1990) showed that body mass and tarsal length were the two best univariate measures of overall body size. Tarsal length is a less desirable measure, at least in part because its measurement is less standardized and can be more subject to measurement error than are other linear measurements of birds (Lougheed et al. 1991). In addition, tarsal lengths are published for even fewer bird species than body masses.

Body mass is a measure of the overall size of an organism, including both the organism's structural framework and its nutrient reserves (Clark 1979, Piersma and Davidson 1991). The structural size of an organism is the relatively invariant mass associated with skeletal elements and internal organs; while the nutrient reserves are the protein and fat stores that vary with an organism's condition. Studies of structural size can be done most accurately using multivariate approaches to estimate the size of skeletal elements (Freeman and Jackson 1990, Piersma and Davidson 1991) or using skeletal volume (Moser and Rusch 1988). Both techniques require sacrifice of the study organisms, however, and therefore cannot be used in long-term studies of live birds. Representative samples of skeletal masses, linear measurements, or volumes are even less available in the published literature than are body masses for most birds.

Although body mass can be a useful measure of overall body size, the use of large number of masses collected from a variety of sources, such as those presented here, may not be justified in all comparative studies. The body mass of birds varies according to time of day, season, sex, and throughout many species' geographic range (Clark 1979). Such variation may reduce the validity of comparing mass samples collected from different sources. Researchers contemplating using the data in this handbook are urged to consider the effect of such variation on their study. When questions arise, the original source of the data should be consulted.

PART II

BODY MASSES AND COMPOSITION OF MIGRANT BIRDS IN THE EASTERN UNITED STATES

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
dry	39	3.50	1.15	2.33	6.11
fat-free	39	5.82	0.34	5.03	6.56
ash-free	39	5.60	0.32	4.85	6.31
All individuals					
wet	304	7.60	1.25	5.51	11.17
dry	304	3.56	1.17	2.11	7.07
fat-free	304	5.93	0.49	4.40	7.24
ash-free	236	5.82	0.43	4.20	6.96
Dendroica pensylvanica					
Male HY					
wet	11	13.22	0.71	12.08	13.99
dry	11	7.85	0.65	6.65	8.69
fat-free	11	8.03	0.39	7.30	8.53
Male AHY					
wet	11	12.92	1.40	9.21	14.46
dry	11	7.17	1.30	3.69	8.89
fat-free	11	8.33	0.40	7.41	8.78
Female HY					
wet	20	12.17	1.20	9.23	13.72
dry	20	6.89	1.27	3.44	8.36
fat-free	20	7.84	0.43	6.97	8.44
Female AHY					
wet	26	13.04	0.92	11.16	15.31
dry	26	7.61	0.74	6.01	9.41
fat-free	26	7.97	0.42	7.17	9.01
All individuals					
wet	73	12.79	1.22	9.05	15.57
dry	73	7.35	1.16	3.16	9.41
fat-free	73	8.01	0.45	6.97	9.07
Dendroica magnolia					
Male HY					
wet	21	9.68	1.55	7.43	12.51
dry	21	4.88	1.51	2.89	7.22
fat-free	21	6.95	0.47	6.00	7.70
ash-free	19	6.74	0.42	6.07	7.42
Male AHY					
wet	2	9.31		8.30	10.32
dry	2	4.38		3.04	5.72
fat-free	2	7.06		6.66	7.45
ash-free	2	6.80		6.40	7.20
Female HY					
wet	9	9.56	1.37	7.49	11.25
dry	9	5.02	1.38	2.78	6.33
fat-free	9	6.68	0.35	6.31	7.44
ash-free	6	6.38	0.22	6.07	6.54
Female AHY					
wet	3	9.69		9.30	10.04
dry	3	4.92		4.58	5.19
fat-free	3	7.35		6.84	8.32
All individuals					
wet	35	9.63	1.39	7.43	12.51
dry	35	4.89	1.39	2.78	7.22
fat-free	35	6.92	0.49	6.00	8.32
ash-free	27	6.67	0.41	6.07	7.42

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
Dendroica coronata					
Male HY					
wet	25	11.75	0.89	10.16	13.77
dry	25	4.38	0.43	3.67	5.34
fat-free	25	10.56	0.82	9.18	12.13
Male AHY					
wet	1	14.59			
dry	1	7.37			
fat-free	1	10.43			
ash-free	1	10.10			
Female HY					
wet	91	11.97	1.35	8.63	14.99
dry	91	5.16	1.04	3.54	8.08
fat-free	91	10.00	0.84	6.99	12.32
All individuals					
wet	120	11.94	1.28	8.63	14.99
dry	120	5.00	1.01	3.54	8.08
fat-free	120	10.13	0.86	6.99	12.32
ash-free	1	10.10			
Dendroica fusca					
Male HY					
wet	6	14.01	0.86	12.83	15.16
dry	6	8.33	0.49	7.84	9.08
fat-free	6	8.34	0.70	7.45	9.46
ash-free	6	8.01	0.68	7.12	9.08
Male AHY					
wet	12	13.31	1.61	10.35	16.41
dry	12	7.91	1.60	4.42	10.34
fat-free	12	7.86	0.41	7.37	8.72
ash-free	12	7.56	0.39	7.08	8.37
Female HY					
wet	17	12.46	1.25	10.19	14.66
dry	17	7.50	1.22	5.66	10.69
fat-free	17	7.30	0.47	6.47	8.08
ash-free	17	7.02	0.46	6.16	7.76
Female AHY					
wet	9	13.03	0.62	11.88	13.90
dry	9	7.82	0.38	7.16	8.27
fat-free	9	7.60	0.63	6.83	8.37
ash-free	9	7.31	0.61	6.55	8.07
All individuals					
wet	52	12.98	1.28	10.19	16.41
dry	52	7.81	1.13	4.42	10.69
fat-free	52	7.58	0.61	6.47	9.46
ash-free	51	7.30	0.59	6.16	9.08
Dendroica dominica					
Male HY					
wet	4	9.71		9.31	10.27
dry	4	3.98		3.58	4.36
fat-free	4	8.20		7.88	8.47
ash-free	4	7.86		7.57	8.10
Female HY					
wet	9	9.16	0.69	7.96	10.12
dry	9	3.68	0.45	3.05	4.37
fat-free	9	7.93	0.44	7.18	8.37

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
ash-free	9	7.61	0.41	6.87	7.98
Female AHY					
wet	1	15.26			
dry	1	8.79			
fat-free	1	9.37			
All individuals					
wet	14	9.76	1.70	7.96	15.26
dry	14	4.13	1.41	3.05	8.79
fat-free	14	8.11	0.53	7.18	9.37
ash-free	13	7.69	0.38	6.87	8.10
Dendroica palmarum					
Male HY					
wet	30	10.43	1.23	8.27	12.51
dry	30	4.60	1.19	3.25	7.02
fat-free	30	8.69	0.47	7.46	9.65
ash-free	29	8.36	0.46	7.19	9.29
Male AHY					
wet	14	11.34	1.09	9.68	13.60
dry	14	5.48	1.02	4.16	7.62
fat-free	14	8.73	0.43	7.88	9.67
ash-free	14	8.42	0.42	7.55	9.32
Female HY					
wet	34	9.76	1.37	7.75	12.90
dry	34	4.24	1.27	2.70	6.91
fat-free	34	8.13	0.54	7.29	9.36
ash-free	34	7.84	0.52	7.00	9.01
Female AHY					
wet	4	9.53	0.64	8.78	10.22
dry	4	4.23	0.65	3.55	5.11
fat-free	4	7.92	0.21	7.71	8.19
ash-free	4	7.64	0.23	7.43	7.94
All individuals					
wet	100	10.25	1.29	7.75	13.60
dry	100	4.62	1.18	2.70	7.62
fat-free	100	8.38	0.58	7.10	9.67
ash-free	99	8.07	0.56	6.82	9.32
Dendroica castanea					
Male HY					
wet	2	14.52		12.99	16.04
dry	2	8.44		6.78	10.11
fat-free	2	9.56		9.42	9.69
Male AHY					
wet	3	16.84		16.50	17.46
dry	3	8.87		7.55	10.19
fat-free	3	11.24		10.90	11.79
Female HY					
wet	2	14.89		14.56	15.22
dry	2	8.09		7.77	8.41
fat-free	2	9.92		9.81	10.03
Female AHY					
wet	6	14.60	1.16	12.80	16.10
dry	6	7.71	0.96	6.28	8.95
fat-free	6	10.10	0.63	9.24	10.96
All individuals					
wet	14	14.99	1.47	12.80	17.46

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
dry	14	8.15	1.13	6.28	10.19
fat-free	14	10.17	0.79	9.03	11.79
Dendroica striata					
Male HY					
wet	6	16.20	3.85	11.13	19.97
dry	6	8.73	4.02	3.87	12.21
fat-free	6	10.77	0.89	9.29	11.84
ash-free	5	10.66	0.54	9.96	11.38
Male AHY					
wet	7	13.90	5.33	9.34	24.08
dry	7	6.88	4.79	3.22	15.87
fat-free	7	10.11	0.90	8.82	11.80
ash-free	5	9.66	0.29	9.19	9.95
Female HY					
wet	3	15.98		11.92	18.14
dry	3	8.81		4.66	11.07
fat-free	3	10.36		10.20	10.52
ash-free	3	9.93		9.66	10.14
Female AHY					
wet	3	11.30		10.96	11.59
dry	3	4.30		4.04	4.67
fat-free	3	9.99		9.71	10.25
ash-free	3	9.64		9.36	9.91
All individuals					
wet	19	14.54	4.26	9.34	24.08
dry	19	7.36	4.03	3.22	15.87
fat-free	19	10.34	0.78	8.82	11.84
ash-free	16	10.02	0.57	9.19	11.38
Setophaga ruticilla					
Male HY					
wet	23	9.89	1.19	7.11	11.83
dry	23	5.41	0.91	3.03	6.64
fat-free	23	6.66	0.53	5.50	7.94
ash-free	23	6.42	0.52	5.19	7.67
Male AHY					
wet	27	8.81	1.20	6.99	11.42
dry	27	4.30	1.26	2.51	6.95
fat-free	27	6.62	0.37	5.93	7.35
ash-free	26	6.39	0.37	5.71	7.10
Female HY					
wet	18	8.93	1.50	6.69	10.85
dry	18	4.57	1.37	2.52	6.34
fat-free	18	6.39	0.33	5.59	7.00
ash-free	18	6.15	0.31	5.37	6.75
Female AHY					
wet	15	8.91	1.08	7.00	10.79
dry	15	4.54	1.10	2.64	6.47
fat-free	15	6.38	0.23	6.07	6.90
ash-free	15	6.16	0.22	5.85	6.68
All individuals					
wet	102	9.11	1.30	6.60	11.83
dry	102	4.71	1.22	2.48	6.95
fat-free	102	6.49	0.42	5.50	7.94
ash-free	101	6.26	0.41	5.19	7.67

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
Protonotaria citrea					
Male HY					
wet	47	13.62	1.31	11.90	18.64
dry	47	6.21	1.16	4.86	11.56
fat-free	47	11.12	0.67	10.04	12.75
ash-free	46	10.65	0.65	9.61	12.24
Male AHY					
wet	2	17.66		17.09	18.23
dry	2	10.6		8.96	11.17
fat-free	2	11.36		10.64	12.07
ash-free	2	10.92		10.23	11.61
Female HY					
wet	20	13.77	1.35	11.39	16.78
dry	20	6.57	1.32	4.63	9.90
fat-free	20	10.68	0.52	9.68	11.86
ash-free	19	10.25	0.50	9.27	11.40
Female AHY					
wet	3	17.61		17.12	18.13
dry	3	10.19		9.46	11.45
fat-free	3	11.10		10.23	11.63
ash-free	3	10.66		9.78	11.22
All individuals					
wet	72	13.94	1.62	11.39	18.64
dry	72	6.58	1.55	4.63	11.56
fat-free	72	11.01	0.66	9.68	12.75
ash-free	70	10.55	0.64	9.27	12.24
Helmitheros vermivorus					
Male HY					
wet	6	16.71	2.65	11.38	18.30
dry	6	9.30	2.49	4.40	10.85
fat-free	6	11.16	0.67	10.25	12.03
ash-free	3	10.27		9.80	10.97
Female HY					
wet	6	16.43	2.51	11.62	18.47
dry	6	9.00	2.11	4.99	10.78
fat-free	6	11.10	0.62	10.17	11.89
ash-free	5	10.47	0.54	9.71	11.11
Female AHY					
wet	6	15.57	2.54	11.13	18.22
dry	6	8.60	2.24	4.98	10.55
fat-free	6	10.58	0.73	9.58	11.54
ash-free	5	9.98	0.69	9.15	11.05
All individuals					
wet	28	15.63	2.40	11.01	18.47
dry	28	8.47	2.18	4.40	10.85
fat-free	28	10.79	0.78	9.58	12.46
ash-free	20	10.11	0.62	9.15	11.11
Seiurus aurocapillus					
Male HY					
wet	10	23.92	2.08	20.94	26.68
dry	10	13.12	1.41	10.68	14.81
fat-free	10	15.78	0.96	14.65	17.21
ash-free	8	15.33	0.93	14.04	16.54

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
Male AHY					
wet	2	22.86		22.50	23.23
dry	2	11.96		11.66	12.27
fat-free	2	15.72		15.62	15.82
ash-free	2	15.12		15.04	15.19
Female HY					
wet	9	21.90	1.38	20.74	24.85
dry	9	11.31	0.95	10.61	13.50
fat-free	9	15.57	0.69	14.98	16.45
ash-free	4	15.41		14.48	15.82
Female AHY					
wet	11	22.05	0.59	20.82	22.99
dry	11	11.72	0.47	11.09	12.51
fat-free	11	15.05	0.77	13.89	16.43
ash-free	2	13.91		13.30	14.53
All individuals					
wet	33	22.68	1.63	20.74	26.68
dry	33	12.04	1.19	10.61	14.81
fat-free	33	15.52	0.87	13.89	17.21
ash-free	17	15.23	0.92	13.30	16.57
Seiurus noveboracensis					
Male HY					
wet	7	17.17	4.13	13.22	25.69
dry	7	8.55	3.23	6.04	15.39
fat-free	7	12.94	1.71	9.94	14.95
ash-free	5	12.09	1.95	9.41	14.38
Male AHY					
wet	7	21.86	3.91	14.06	25.49
dry	7	11.53	2.93	5.80	14.13
fat-free	7	14.91	1.41	12.24	16.55
ash-free	6	14.37	1.53	11.69	15.94
Female HY					
wet	15	20.30	3.72	13.17	24.25
dry	15	11.17	2.90	6.12	14.32
fat-free	15	13.67	1.72	8.76	15.80
ash-free	15	13.12	1.69	8.27	14.18
Female AHY					
wet	33	20.77	2.34	14.92	24.56
dry	33	11.55	2.37	5.44	14.72
fat-free	33	13.61	1.11	11.71	17.00
ash-free	31	13.07	1.12	11.18	16.43
All individuals					
wet	89	20.37	3.41	13.17	25.69
dry	89	11.13	2.96	4.94	15.49
fat-free	89	13.68	1.30	8.76	17.00
ash-free	82	13.14	1.32	8.27	16.43
Oporornis formosus					
Male HY					
wet	69	16.69	2.64	10.89	20.31
dry	69	8.95	2.70	4.21	16.28
fat-free	69	11.52	1.16	5.29	13.43
ash-free	65	11.11	1.13	4.76	12.89
Male AHY					
wet	10	15.68	2.71	12.12	19.84
dry	10	7.77	2.70	4.52	11.62

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
fat-free	10	11.48	0.51	10.66	12.27
ash-free	10	11.04	0.52	10.21	11.88
Female HY					
wet	48	16.24	2.42	11.82	19.77
dry	48	8.60	2.37	4.25	11.91
fat-free	48	11.16	0.82	9.19	12.84
ash-free	48	10.72	0.80	8.77	12.31
Female AHY					
wet	10	16.58	2.60	12.00	19.30
dry	10	8.76	2.41	4.34	10.80
fat-free	10	11.38	0.52	10.46	12.26
ash-free	10	10.91	0.50	9.99	11.68
All individuals					
wet	156	16.46	2.54	10.83	20.31
dry	156	8.76	2.53	4.21	16.28
fat-free	156	11.36	0.96	5.29	13.43
ash-free	151	10.93	0.93	4.76	12.89
Geothlypis trichas					
Male HY					
wet	9	11.41	1.37	9.98	13.67
dry	9	5.35	1.35	3.75	6.90
fat-free	9	8.67	0.54	7.90	9.46
Male AHY					
wet	8	9.94	0.30	9.61	10.35
dry	8	4.34	0.31	3.98	4.68
fat-free	8	8.07	0.42	7.55	8.65
All individuals					
wet	19	10.78	1.19	9.61	13.67
dry	19	4.95	1.06	3.75	6.90
fat-free	19	8.36	0.54	7.55	9.46
Wilsonia citrina					
Male HY					
wet	74	10.59	1.99	8.17	14.99
dry	74	4.84	1.79	3.24	9.01
fat-free	74	8.41	0.82	4.06	9.94
ash-free	37	8.46	0.94	3.75	9.57
Male AHY					
wet	8	12.76	2.80	9.93	16.42
dry	8	6.30	2.44	3.84	9.46
fat-free	8	9.22	0.79	8.54	10.76
ash-free	8	8.98	0.77	8.24	10.37
Female HY					
wet	52	9.26	1.53	7.46	13.87
dry	52	4.04	1.34	2.79	8.74
fat-free	52	7.66	0.61	6.14	9.26
ash-free	12	7.92	0.60	6.82	8.92
All individuals					
wet	153	10.29	2.02	7.46	16.42
dry	153	4.69	1.73	2.79	9.46
fat-free	153	8.20	0.84	4.06	10.76
ash-free	74	8.35	0.84	3.75	10.37
Melospiza georgiana					
Male HY					
wet	4	17.22		16.20	18.06

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
dry	4	7.35		6.70	7.81
fat-free	4	14.76		13.99	15.79
ash-free	4	14.17		13.41	15.21
Female HY					
wet	3	14.87		13.72	15.93
dry	3	6.04		5.35	6.71
fat-free	3	12.97		12.23	13.63
ash-free	3	12.48		11.76	13.11
All individuals					
wet	7	16.22	1.54	13.72	18.06
dry	7	6.79	0.88	5.35	7.81
fat-free	7	13.99	1.21	12.23	15.79
ash-free	7	13.45	1.16	11.76	15.21
Zonotrichia albicollis					
Male HY					
wet	7	25.41	2.58	23.28	29.27
dry	7	10.42	1.86	8.46	13.92
fat-free	7	21.85	1.50	20.11	24.69
ash-free	2	22.76		21.37	24.14
Male AHY					
wet	5	24.54	2.04	21.80	27.14
dry	5	9.44	1.79	7.36	12.29
fat-free	5	21.99	1.16	20.49	23.20
Female HY					
wet	26	23.42	1.65	20.90	28.13
dry	26	9.18	1.06	7.53	12.02
fat-free	26	20.78	1.01	19.04	23.23
ash-free	5	21.15	1.02	20.32	22.31
Female AHY					
wet	2	21.94		21.57	22.32
dry	2	8.30		7.72	8.88
fat-free	2	19.50		18.86	20.14
All individuals					
wet	40	23.84	2.00	20.90	29.27
dry	40	9.39	1.37	7.36	13.92
fat-free	40	21.06	1.25	18.86	24.69
ash-free	7	21.61	1.39	20.32	24.14
Passerculus sandwichensis					
Male HY					
wet	55	18.39	1.64	15.00	23.30
dry	55	7.09	0.92	5.47	9.30
fat-free	55	16.54	1.31	13.69	20.14
Male AHY					
wet	75	17.48	1.43	14.44	22.60
dry	75	6.70	0.91	5.28	10.72
fat-free	75	15.81	1.22	13.12	20.34
Female HY					
wet	51	17.11	1.34	14.00	20.65
dry	51	6.36	0.76	5.12	8.14
fat-free	51	15.51	1.20	12.61	18.40
Female AHY					
wet	130	16.39	1.23	13.54	20.30
dry	130	6.39	0.93	4.99	9.94
fat-free	130	14.64	1.07	12.00	16.96

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
All individuals					
wet	311	17.12	1.55	13.54	23.30
dry	311	6.58	0.93	4.99	10.72
fat-free	311	15.40	1.37	12.00	20.34
Ammodramus maritimus					
Male HY					
wet	22	22.85	1.51	19.65	25.56
dry	22	8.23	0.68	7.08	9.68
fat-free	22	20.46	1.46	17.15	22.84
ash-free	16	19.43	1.57	16.49	21.89
Male AHY					
wet	4	20.62		18.75	23.00
dry	4	7.35		6.95	8.19
fat-free	4	18.61		16.96	20.68
ash-free	4	17.84		16.24	19.86
Female HY					
wet	16	21.12	1.38	19.20	24.25
dry	16	7.72	0.51	6.96	8.74
fat-free	16	18.83	1.33	16.55	21.77
ash-free	16	18.03	1.30	15.85	20.99
Female AHY					
wet	6	20.87	1.63	18.47	23.00
dry	6	7.31	0.73	6.41	8.32
fat-free	6	18.81	1.53	16.69	20.91
ash-free	4	17.71		15.99	19.98
All individuals					
wet	50	21.81	1.73	18.47	25.56
dry	50	7.84	0.72	6.41	9.68
fat-free	50	19.55	1.60	16.55	22.84
ash-free	42	18.54	1.58	15.85	21.89
Piranga rubra					
Male HY					
wet	47	34.96	6.27	25.50	46.58
dry	47	17.89	6.81	10.04	28.63
fat-free	47	25.29	2.10	19.40	30.82
ash-free	32	24.63	2.13	18.43	29.75
Male AHY					
wet	8	39.22	3.42	35.82	44.84
dry	8	23.51	2.80	20.01	26.84
fat-free	8	23.45	1.68	20.78	25.79
ash-free	1	21.71			
Female HY					
wet	23	36.12	5.68	27.36	47.63
dry	23	19.90	6.23	10.51	28.34
fat-free	23	24.37	2.02	20.01	27.70
ash-free	9	24.41	1.14	22.81	26.09
Female AHY					
wet	20	39.44	4.81	31.04	45.66
dry	20	23.06	5.06	12.18	28.85
fat-free	20	24.33	2.58	16.05	27.88
ash-free	4	25.56		23.58	26.94
All individuals					
wet	98	36.50	5.91	25.50	47.63
dry	98	19.88	0.44	10.04	28.85

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
fat-free	98	24.73	2.21	16.05	30.82
ash-free	46	24.60	1.95	18.43	29.75
Piranga olivacea					
Male HY					
wet	23	39.45	3.01	31.28	44.12
dry	23	23.48	2.39	18.55	28.41
fat-free	23	24.10	2.12	19.28	27.98
ash-free	14	23.38	2.38	18.43	26.95
Male AHY					
wet	11	40.19	5.29	30.43	44.85
dry	11	23.85	6.66	10.05	30.57
fat-free	11	24.56	2.36	19.28	28.59
ash-free	5	15.07	1.69	23.55	27.66
Female HY					
wet	19	39.10	4.73	24.50	44.05
dry	19	23.12	4.72	8.34	29.28
fat-free	19	24.13	1.62	21.44	27.59
ash-free	11	23.42	1.79	20.97	26.59
Female AHY					
wet	19	37.00	5.60	25.46	46.80
dry	19	19.71	6.76	8.41	29.72
fat-free	19	25.19	2.68	20.99	31.41
ash-free	10	25.00	2.71	20.81	30.34
All individuals					
wet	74	38.68	4.73	24.50	46.80
dry	74	22.27	5.42	8.34	30.57
fat-free	74	24.50	2.21	19.28	31.41
ash-free	40	24.01	2.31	18.43	30.34
Passerina cyanea					
Male HY					
wet	23	15.25	1.78	12.89	19.61
dry	23	6.65	1.80	4.99	10.99
fat-free	23	12.68	0.91	10.47	14.27
ash-free	11	11.72	0.79	10.04	12.78
Male AHY					
wet	56	15.58	2.07	12.92	22.18
dry	56	6.89	2.12	4.62	13.05
fat-free	56	12.70	0.78	11.01	14.52
ash-free	31	11.88	0.67	10.54	13.16
Female HY					
wet	15	16.04	2.88	13.31	21.36
dry	15	7.84	2.91	5.08	12.36
fat-free	15	11.94	0.87	9.62	13.12
ash-free	14	11.41	0.84	9.19	12.63
Female AHY					
wet	59	15.24	1.98	11.91	20.63
dry	59	6.97	1.99	4.38	12.29
fat-free	59	12.00	0.97	8.13	14.81
ash-free	42	11.40	1.06	7.72	14.44
All individuals					
wet	155	15.45	2.07	11.91	22.18
dry	155	6.99	2.11	4.38	13.05
fat-free	155	12.34	0.95	8.13	14.81
ash-free	100	11.59	0.90	7.72	14.44

INTRODUCTION

Eugene P. Odum

In the 1960s, my students, colleagues, and I undertook an extensive study of lipid storage and use by migrating birds. As part of these studies, we compiled an extensive data set on avian body mass and composition, collected mostly from birds killed during migration. Although we have published numerous papers from this study (e.g., Connell et al. 1960, Odum 1960, Odum et al. 1961, Marshall and Baker 1964, Hicks 1967), the full data set has never been published. Since the data are relatively unique, and still requested by researchers, I present them in the following table.

A majority of the bird specimens that were analyzed in this study were spring and fall nocturnal migrants that were killed in collision with a television tower located in Leon County, Florida, between Thomasville, Georgia, and Tallahassee, Florida, near the Gulf coast. During the fall of 1956, Herbert Stoddard searched the grounds of the TV tower at dawn each morning from August to December, collecting the birds that had been killed the previous night. All specimens were immediately frozen, and then transported to the University of Georgia where the study was conducted.

Data for some of the species were collected from other locations. A large series was collected by L. D. Caldwell from a TV tower in Michigan (Caldwell et al. 1964). W. H. Drury donated a fall series of Blackpoll Warblers (*Dendroica striata*) from Massachusetts, all in premigratory and very fat condition. Chimney Swifts (*Chaetura pelagica*) were collected from a chimney roost in Athens, Georgia. Wintering and premigratory Savannah Sparrows (*Passerculus sandwichensis*) and fall premigratory hummingbirds were collected at the Savannah River Ecology Laboratory, Aiken County, South Carolina. Some individuals of other species were collected from TV towers in the southeastern United States, however, most specimens for these species came from the Leon County tower.

Upon receipt at the University of Georgia, the specimens were classified according to species, age and sex, and then weighed and measured. This first mass is referred to as the "wet mass." Aging was done by removing the skin on the top of the head and examining the degree of skull ossification. Specimens were sexed by plumage or gonadal inspection. After weighing, the birds were placed in a vacuum oven, which was set at a constant 40°C, and allowed to dry for 36–108 h, depending on the size of the specimen. When the bird was completely dry, it was weighed again, producing the "dry mass" (Marshall and Baker 1964).

To estimate the amount of fat in each specimen, each bird was then ground in a blender or meat chopper containing about 5 cm of 95% ethyl alcohol (Connell et al. 1960). The pulverized mixture was boiled in a beaker placed in a water bath, and then strained through a very fine mesh sieve. This boiling procedure was repeated 3 times with petroleum ether substituted for the alcohol, after which the residue was dried for 12 h. The residue was weighed again, and the difference between this last measurement and the dry mass was the amount of fat removed by the petroleum ether. The "fat-free mass" was calculated by subtracting the amount of fat from the wet mass. An alternate fat extraction method using chloroform was used on some specimens.

The nonfat dry residue was then burned in a muffle furnace at 600°C until burning eliminated all organic matter, reducing the residue to the ash content of the specimen (Odum et al. 1965). The "ash-free mass" was calculated by subtracting the mass of ash from the fat-free mass. This step was not done on all specimens.

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
Icterus spurius					
Male HY					
wet	2	22.75		21.20	24.30
dry	2	9.70		8.80	10.60
fat-free	2	19.00		18.10	19.90
ash-free	2	18.23		17.34	19.12
Male AHY					
wet	1	25.50			
dry	1	12.00			
fat-free	1	19.60			
ash-free	1	18.78			
Female HY					
wet	5	21.58	2.18	20.20	25.40
dry	5	9.04	1.40	8.20	11.50
fat-free	5	18.22	1.09	17.30	20.00
ash-free	5	17.44	1.10	16.53	19.24
Female AHY					
wet	3	22.90		21.30	24.60
dry	3	10.47		9.30	11.60
fat-free	3	18.20		16.30	20.50
ash-free	3	17.46		15.66	19.65
All individuals					
wet	11	22.51	2.07	20.20	25.50
dry	11	9.82	1.45	8.20	12.00
fat-free	11	18.48	1.33	16.30	20.50
ash-free	11	17.71	1.30	15.66	19.65
Agelaius phoeniceus					
Male Unknown Age					
wet	2	58.76		53.80	63.72
dry	2	22.37		22.25	22.49
fat-free	2	54.24		48.15	60.34
Female Unknown Age					
wet	10	42.72	2.51	39.33	47.17
dry	10	17.29	1.59	14.97	19.97
fat-free	10	37.73	2.62	33.91	43.38
All individuals					
wet	12	45.39	6.98	39.33	63.72
dry	12	18.14	2.44	14.97	22.49
fat-free	12	40.48	7.33	33.91	60.34
Dolichonyx orizivorus					
Male HY					
wet	88	35.00	7.32	19.04	51.23
dry	88	19.12	5.94	10.46	33.71
fat-free	88	24.23	3.30	13.13	30.16
ash-free	77	22.92	3.41	11.92	28.80
Male AHY					
wet	19	44.29	5.29	35.18	54.10
dry	19	26.19	4.48	18.59	34.45
fat-free	19	26.82	2.62	22.22	31.80
ash-free	11	26.28	2.49	21.32	30.71
Female HY					
wet	52	27.91	5.75	19.62	40.29
dry	52	14.17	4.62	7.53	23.97
fat-free	52	20.56	2.51	16.54	27.63

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
ash-free	41	19.80	2.50	15.68	26.49
Female AHY					
wet	18	37.93	5.01	30.20	49.20
dry	18	22.08	4.16	15.00	30.71
fat-free	18	23.46	2.55	19.86	29.05
ash-free	6	23.36	2.93	18.97	28.05
All individuals					
wet	178	34.20	8.09	19.04	54.10
dry	178	18.73	6.36	7.53	34.45
fat-free	178	23.33	3.54	13.13	31.80
ash-free	136	22.24	3.57	11.92	30.71

The following table reports wet mass, dry mass, fat-free mass, and ash-free mass for 43 species. For each age and sex class, I report the sample size, mean, standard deviation, and range. Birds in their first calendar year (immatures) are classified as HY (hatching year) in the table. Adult birds are classified as AHY (after hatching year). In addition, I have included statistics for the entire sample for each species, including individual birds that were of unknown sex or age class. The addition of these individuals to the total sample results in slightly larger sample sizes in the total sample than can be summed from the individual age and sex classes.

I would like to express my special appreciation to Shirley Marshall who managed my lipid extraction laboratory with great efficiency during the period when most of these data were obtained.

Body Mass and Composition of North American Migrant Birds

	N	Mean	S.D.	Min	Max
Porzana carolina					
Male HY					
wet	6	71.14	9.85	59.40	84.13
dry	6	32.34	5.35	27.57	40.60
fat-free	6	57.44	8.78	45.17	64.78
Male AHY					
wet	4	68.56		58.21	73.20
dry	4	31.34		20.89	38.96
fat-free	4	54.84		50.84	61.91
Female HY					
wet	8	66.90	13.13	48.67	89.87
dry	8	35.68	9.58	24.41	49.21
fat-free	8	47.42	6.95	36.70	61.24
Female AHY					
wet	10	65.49	8.81	52.70	78.10
dry	10	31.09	9.13	17.50	44.21
fat-free	10	49.99	2.30	46.20	54.89
All individuals					
wet	28	67.54	9.94	48.67	89.87
dry	28	32.70	8.32	17.50	49.21
fat-free	28	51.55	6.83	36.70	64.78
Cuculus americanus					
Male HY					
wet	12	72.09	10.88	51.60	86.34
dry	12	41.25	10.34	22.03	55.68
fat-free	12	46.67	2.93	42.16	52.08
ash-free	11	44.71	2.85	40.49	49.40
Male AHY					
wet	19	77.28	11.31	54.97	88.91
dry	19	46.50	13.03	22.20	59.07
fat-free	19	46.04	4.29	37.00	55.88
ash-free	17	44.14	4.36	35.51	53.84
Female HY					
wet	13	68.56	14.62	50.50	89.23
dry	13	36.64	13.97	19.70	59.04
fat-free	13	45.19	6.27	31.56	52.29
ash-free	9	46.23	2.81	43.06	50.24
Female AHY					
wet	14	75.07	15.64	50.34	93.50
dry	14	41.13	16.25	17.27	62.02
fat-free	14	49.84	3.38	42.62	55.13
ash-free	14	47.88	3.27	40.95	53.22

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
All individuals					
wet	77	71.51	13.49	49.25	93.50
dry	77	39.71	13.88	17.27	62.02
fat-free	77	46.80	4.49	31.56	55.88
ash-free	63	45.56	3.86	35.51	53.84
Chaetura pelagica					
Male HY					
wet	13	30.37	1.23	28.00	32.41
dry	13	16.42	1.37	13.10	18.62
fat-free	13	19.71	0.84	18.03	21.00
Female HY					
wet	8	30.34	1.29	27.87	31.65
dry	8	15.96	0.88	14.89	17.59
fat-free	8	20.08	1.39	17.64	22.22
All individuals					
wet	21	30.36	1.22	27.87	32.41
dry	21	16.24	1.20	13.10	18.62
fat-free	21	19.85	1.06	17.64	22.22
Archilochus colubris					
Male AHY					
wet	9	3.50	0.77	2.38	4.99
dry	9	1.64	0.62	1.12	2.93
fat-free	9	2.50	0.32	1.84	2.89
Female HY					
wet	5	3.42	0.52	2.76	4.18
dry	5	1.44	0.40	1.07	1.96
fat-free	5	2.71	0.30	2.33	3.00
ash-free	1	2.27			
Female AHY					
wet	7	3.99	0.98	2.91	5.65
dry	7	1.96	0.79	1.21	3.33
fat-free	7	2.72	0.42	2.25	3.37
All individuals					
wet	21	3.64	0.80	2.38	5.65
dry	21	1.70	0.64	1.07	3.33
fat-free	21	2.62	0.35	1.84	3.37
ash-free	1	2.27			
Vireo griseus					
Male HY					
wet	34	10.12	0.77	8.28	11.99
dry	34	4.31	0.57	3.29	5.52
fat-free	34	8.46	0.67	7.06	10.02
Female HY					
wet	52	9.98	0.80	7.56	11.59
dry	52	4.36	0.65	3.16	5.84
fat-free	52	8.18	0.62	5.99	9.66
All individuals					
wet	86	10.04	0.79	7.56	11.99
dry	86	4.34	0.62	3.16	5.84
fat-free	86	8.29	0.65	5.99	10,02
Vireo philadelphicus					
Male HY					
wet	2	14.58		13.95	15.20

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
dry	2	6.56		6.36	6.76
fat-free	2	10.64		9.76	11.51
Male AHY					
wet	2	11.58		10.95	12.21
dry	2	5.09		4.95	5.23
fat-free	2	9.04		8.45	9.62
Female HY					
wet	1	14.51			
dry	1	7.30			
fat-free	1	9.85			
Female AHY					
wet	1	13.75			
dry	1	6.59			
fat-free	1	10.07			
All individuals					
wet	6	13.43	1.57	10.95	15.20
dry	6	6.20	0.92	4.95	7.30
fat-free	6	9.88	0.98	8.45	11.51
Vireo olivaceus					
Male HY					
wet	39	20.25	3.60	15.47	27.46
dry	39	10.03	3.37	5.50	16.36
fat-free	39	14.84	1.19	12.78	17.16
ash-free	11	13.87	0.68	12.66	14.93
Male AHY					
wet	113	19.32	2.99	13.93	26.37
dry	113	8.90	2.62	4.93	15.12
fat-free	113	14.99	1.33	11.13	19.79
ash-free	12	14.67	1.94	12.34	19.28
Female HY					
wet	55	18.65	2.62	14.12	24.78
dry	55	8.67	2.40	5.15	14.57
fat-free	55	14.54	1.19	11.64	17.11
ash-free	23	13.56	0.87	12.53	16.12
Female AHY					
wet	111	18.07	2.76	13.95	26.20
dry	111	8.42	2.34	5.10	15.29
fat-free	111	14.09	1.26	11.38	18.03
ash-free	9	13.36	1.15	11.93	15.23
All individuals					
wet	323	18.88	3.01	13.93	27.46
dry	323	8.82	2.62	4.93	16.36
fat-free	323	14.59	1.31	11.13	19.79
ash-free	57	13.88	1.26	11.93	19.28
Catharus fuscescens					
Male HY					
wet	41	42.83	4.02	32.09	53.56
dry	41	24.93	4.06	12.38	33.48
fat-free	41	27.75	3.85	22.54	38.46
Male AHY					
wet	3	43.28		42.40	44.32
dry	3	24.84		24.51	25.50
fat-free	3	33.26		32.88	33.55
Female HY					
wet	40	39.59	4.41	28.52	48.58

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
dry	40	22.42	4.66	11.59	30.01
fat-free	40	25.27	2.65	21.24	34.33
Female AHY					
wet	6	39.72	2.54	36.74	43.40
dry	6	23.92	3.27	20.46	29.20
fat-free	6	26.75	4.27	22.91	34.33
All individuals					
wet	100	41.15	4.26	28.52	53.56
dry	100	23.68	4.29	11.59	33.48
fat-free	100	26.66	3.61	21.24	38.46
Catharus minimus					
Male HY					
wet	43	31.29	4.88	23.90	47.14
dry	43	13.88	5.68		29.51
fat-free	43	25.25	2.94	20.09	34.93
ash-free	42	24.21	2.95	19.21	33.90
Male AHY					
wet	11	38.38	5.82	28.45	47.91
dry	11	19.53	5.92	10.56	29.15
fat-free	11	27.30	2.36	24.38	31.01
ash-free	11	26.26	2.31	23.31	29.88
Female HY					
wet	59	29.99	3.60	24.66	42.17
dry	59	13.00	4.10		24.29
fat-free	59	24.42	4.08	14.46	41.84
ash-free	58	23.63	3.86	19.00	40.74
Female AHY					
wet	15	35.58	5.92	27.17	45.20
dry	15	17.35	5.72	9.63	25.87
fat-free	15	26.12	1.94	22.78	30.49
ash-free	12	25.26	2.09	21.86	29.49
All individuals					
wet	133	32.08	5.43	23.90	47.91
dry	133	14.62	5.54		29.51
fat-free	133	25.20	3.45	14.46	41.84
ash-free	127	24.28	3.36	19.00	40.74
Catharus ustulatus					
Male HY					
wet	94	32.40	7.59	22.70	53.41
dry	94	15.61	6.62	7.12	34.96
fat-free	94	24.33	1.90	20.58	29.57
ash-free	88	23.20	1.85	19.72	28.39
Male AHY					
wet	52	36.52	7.87	22.00	49.51
dry	52	18.58	7.05	7.14	30.28
fat-free	52	25.53	2.10	20.79	28.95
ash-free	39	24.26	2.18	19.89	27.93
Female HY					
wet	68	28.74	6.45	20.56	45.45
dry	68	13.17	5.44	6.99	26.83
fat-free	68	22.54	1.89	19.56	27.70
ash-free	61	21.39	1.72	18.77	26.39
Female AHY					
wet	50	34.76	6.79	20.90	44.60
dry	50	17.78	6.00	7.00	27.74

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
fat-free	50	24.32	2.31	18.99	28.52
ash-free	38	23.11	2.35	18.18	27.18
All individuals					
wet	299	32.66	7.51	20.56	53.41
dry	299	15.85	6.51	6.99	34.96
fat-free	299	24.18	2.20	18.99	29.57
ash-free	239	22.96	2.18	18.18	28.39
Catharus guttatus					
Male HY					
wet	2	30.03		27.58	32.48
dry	2	11.74		10.58	12.90
fat-free	2	26.77		24.84	28.70
ash-free	2	25.74		23.87	27.62
Female HY					
wet	6	28.58	0.84	27.09	29.44
dry	6	11.38	1.00	9.95	13.03
fat-free	6	25.53	1.68	23.12	27.18
ash-free	6	24.57	1.63	22.24	26.15
All individuals					
wet	12	29.13	1.55	27.09	32.48
dry	12	11.82	1.07	9.95	13.17
fat-free	12	25.62	1.60	23.12	28.70
ash-free	12	24.66	1.55	22.24	27.62
Catharus (Hylocichla) mustelina					
Male HY					
wet	24	59.87	5.93	48.66	73.98
dry	24	29.84	6.70	17.24	43.34
fat-free	24	43.32	2.46	38.57	49.09
ash-free	22	41.58	2.52	36.85	47.21
Male AHY					
wet	19	59.08	6.61	47.65	72.14
dry	19	30.07	8.39	19.23	48.65
fat-free	19	42.06	4.02	34.31	50.13
ash-free	15	41.47	3.34	36.04	48.28
Female HY					
wet	18	54.03	6.63	44.06	65.76
dry	18	25.86	6.33	16.76	36.38
fat-free	18	40.85	3.26	34.51	48.06
ash-free	16	39.53	3.33	32.89	46.36
Female AHY					
wet	28	55.68	8.36	41.94	70.86
dry	28	26.60	7.96	16.00	39.91
fat-free	28	41.89	3.19	35.85	49.77
ash-free	26	40.48	3.10	34.52	48.00
All individuals					
wet	105	56.92	7.03	41.94	73.98
dry	105	27.70	7.33	16.00	48.65
fat-free	105	42.21	3.32	34.13	50.13
ash-free	95	40.84	3.15	32.89	48.28
Dumetella carolinensis					
Male HY					
wet	20	36.89	2.66	32.52	41.90
dry	20	15.23	1.98	11.57	19.43
fat-free	20	31.62	2.66	27.15	35.20

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
ash-free	20	30.38	2.62	25.96	33.82
Male AHY					
wet	20	37.50	2.83	32.53	42.32
dry	20	14.88	1.62	11.63	17.35
fat-free	20	32.28	2.18	28.76	36.78
ash-free	20	31.08	2.13	27.70	35.54
Female HY					
wet	37	36.37	3.81	30.29	50.14
dry	37	14.74	3.37	11.44	29.71
fat-free	37	31.36	1.89	27.15	34.37
ash-free	37	30.13	1.84	26.02	33.04
Female AHY					
wet	20	38.62	3.99	33.91	50.51
dry	20	16.25	3.77	12.24	27.33
fat-free	20	32.01	1.83	26.90	35.64
ash-free	20	30.80	1.77	25.89	34.28
All individuals					
wet	104	37.17	3.42	30.29	50.51
dry	104	15.13	2.87	11.44	29.71
fat-free	104	31.80	2.13	26.90	36.78
ash-free	104	30.58	2.08	25.89	35.54
Cistothorus palustris					
Male HY					
wet	42	10.43	1.05	7.46	12.76
dry	42	3.78	0.64	2.90	5.99
fat-free	42	9.28	0.77	6.48	11.13
ash-free	27	8.76	0.71	6.19	9.89
Male AHY					
wet	23	9.98	1.28	8.07	13.21
dry	23	4.01	1.06	2.57	6.60
fat-free	23	8.43	0.72	7.17	9.61
ash-free	12	8.09	0.66	6.89	8.79
Female HY					
wet	30	9.47	1.14	7.04	11.21
dry	30	3.64	0.82	2.34	5.55
fat-free	30	8.16	0.89	6.59	9.89
ash-free	14	8.04	0.79	6.86	9.48
Female AHY					
wet	22	8.85	0.93	7.41	10.45
dry	22	3.37	0.49	2.51	4.64
fat-free	22	7.73	0.83	6.36	8.78
ash-free	17	7.31	0.84	6.09	8.40
All individuals					
wet	127	9.77	1.25	7.04	13.21
dry	127	3.72	0.81	2.34	6.60
fat-free	127	8.48	1.01	6.36	11.13
ash-free	77	8.09	0.96	6.09	9.89
Passer domesticus					
Male HY					
wet	8	27.22	3.31	21.00	32.55
dry	8	10.21	2.38	7.29	15.39
fat-free	8	25.04	2.50	20.34	27.75
Male AHY					
wet	5	25.58	3.47	21.35	29.36
dry	5	9.32	2.49	7.07	12.41

Body Mass and Composition of North American Migrant Birds (continued)

	N	Mean	S.D.	Min	Max
fat-free	5	24.15	2.74	20.73	27.61
Female HY					
wet	14	24.82	2.80	19.99	31.01
dry	14	8.73	1.78	6.99	13.22
fat-free	14	23.00	2.42	19.45	28.32
Female AHY					
wet	5	23.65	3.80	19.78	28.82
dry	5	9.73	3.61	6.86	15.67
fat-free	5	21.42	1.81	19.13	23.89
All individuals					
wet	32	25.36	3.27	19.78	32.55
dry	32	9.35	2.34	6.86	15.67
fat-free	32	23.44	2.60	19.13	28.32
Vermivora peregrina					
Male HY					
wet	13	13.26	1.02	11.72	14.71
dry	13	7.78	0.71	6.59	8.82
fat-free	13	7.99	0.55	6.92	8.99
ash-free	3	7.27		6.65	7.63
Male AHY					
wet	17	13.17	1.26	10.52	15.37
dry	17	7.79	1.26	4.43	9.93
fat-free	17	7.97	0.49	6.84	8.81
Female HY					
wet	27	12.86	1.25	10.36	15.83
dry	27	7.71	1.15	5.71	10.72
fat-free	27	7.70	0.45	6.75	8.94
ash-free	7	7.11	0.43	6.52	7.56
Female AHY					
wet	36	12.63	1.15	9.25	14.15
dry	36	7.25	1.24	3.22	8.80
fat-free	36	7.87	0.50	6.73	9.35
All individuals					
wet	95	12.90	1.18	9.25	15.83
dry	95	7.57	1.16	3.22	10.72
fat-free	95	7.85	0.49	6.73	9.35
ash-free	12	7.19	0.41	6.52	7.63
Parula americana					
Male HY					
wet	75	8.09	1.23	5.51	11.17
dry	75	3.87	1.20	2.26	7.07
fat-free	75	6.22	0.46	4.88	7.24
ash-free	56	6.11	0.37	5.13	6.96
Male AHY					
wet	54	8.07	1.20	5.73	10.64
dry	54	3.87	1.17	2.20	6.30
fat-free	54	6.20	0.38	5.28	7.11
ash-free	54	5.97	0.37	5.09	6.86
Female HY					
wet	96	6.92	1.03	5.56	10.08
dry	96	3.10	0.98	2.11	5.56
fat-free	96	5.58	0.41	4.40	6.78
ash-free	49	5.52	0.39	4.20	6.52
Female AHY					
wet	39	7.45	1.08	5.81	10.14