Using Tarsus Width Measurements as a Guide to Selecting Band Sizes for Some Passerine and Near-Passerine Species

*Robert P. Yunick**
1527 Myron Street
Schenectady, NY 12309
*Corresponding author
e-mail: anneboby@aol.com

Edwin A. Hicks
1016 Shadick Road
Ballston Spa, NY 12020

ABSTRACT

Tarsus width measurements were taken on 7190 live birds of 110 species and 1353 museum specimens of 28 species for a total of 8543 measurements on 111 species of passerines, near-passerines and one shorebird. These were compared to internal diameter measurements taken on U. S. Bird Banding Laboratory (BBL) band sizes 0A through 3A as well as to BBL technical specifications for the manufacture of these bands. Field tests were conducted on numerous species using alternate band sizes based on these measurements. Based on these comparisons and field test results, suggestions are made for changes in currently recommended sizes for 47 species.

INTRODUCTION

In 1991 the U. S. Bird Banding Laboratory (BBL) invited comments via a Memorandum to All Banders (commonly referred to as an "MTAB") on a proposed smaller band size than the size 0 then in use (Tautin 1991a). Later that year, the BBL followed with a recommendation to create new smaller size 0 and 1 bands, to change the alloy used in manufacture and to convert from English to metric dimensions (Tautin 1991b). This conversion to metric dimensions involved rounding off some internal diameters to the nearest 0.1 mm, resulting in slightly smaller diameters in some sizes, slightly larger in others. The BBL announced changes in recommended band sizes for various species using sizes 0, 1 and 1B (Tautin 1991b), and in 1992 announced implementation of changes of manufacture starting with the FY92 band contract (Tautin 1992).

The BBL indicated in 1995 that the "old" size 0 band would still be available and the "new" smaller size 0 band would be designated size 0A; and similarly that the "old" size 1 would be retained and its smaller version would be designated size 1C (Tautin 1995). There followed in 1996 a complete revision of pages 5-5 through 5-46a of the Bird Banding Manual (BBM) suggesting band sizes for all North American species, as well as a listing of internal diameter and height of the 23 band sizes then available (Tautin 1996). Manufacture of band size 1C was discontinued in 1999 (Tautin 1999).

When I (RPY) began using these new size 0A and 1C bands as well as the newly metric-sized bands in size 1B, 1A and 2 (all slightly smaller in internal diameter than their previous English counterparts) and size 3, 3B and 3A (all slightly larger in internal diameter than their English sizes), I observed that certain species could accommodate band sizes smaller than those recommended for them in the BBM (Gustafson et al 1997a). In 1996 I began routinely banding Black-capped Chickadees and Red-breasted Nuthatches (see Appendix 1 for scientific names of all species banded and measured in this study) with the smaller size 0A rather than the recommended size 0-1 (the former the preferred size, the latter an alternate size per the BBM). Repeat and return captures of those birds showed no problems with the fit of the smaller band, so I expanded the list of species to which I fitted smaller band sizes and, in 1999, began to

collect tarsus-width data on these and other species to be able to assess quantitatively the proper fit of these newly metric-sized bands.

METHODS

Tarsus widths were measured with a dial caliper graduated to the nearest 0.1 mm, estimated to the nearest 0.01 mm. As reported by Blake (1954), Cohen (1994) and Michalak (1997, 1998), a typical tarsus has a greater anterior-posterior (front to back) diameter than the lateral or transverse diameter. I took only the wider front-to-back measurement on all the birds I measured. Measurements were made by gently moving the caliper up and down along the bottom half of the tarsus while closing the caliper to the point just short of gripping the tarsus to avoid compressing it. It was best done against a white paper background or similar lightly colored background to assure that the caliper jaws were parallel to the sides of the tarsus, rather than angled, which creates a falsely enlarged reading. Measurements on live birds were made at seven banding sites in eastern New York within 60 km of Schenectady and at Island Beach State Park near South Seaside Park, New Jersey.

The number of individuals measured per species varied considerably depending on their abundance at any site. Since museum collections were a potential source of birds not abundantly available to me in the wild, I measured tarsus widths on specimens in order to compare live and dead measurements to ascertain whether they differed or if museum data could be used to augment field data. The following collections were visited: New York State Museum in Albany, Columbia-Greene Community College in Hudson, New York, and American Museum of Natural History in New York City. Specimens were primarily of New York origin, but included some from other northeastern states and eastern Canada.

Internal diameters of band sizes 0A, 0, 1, 1B, 1A, 2, 3, 3B and 3A were similarly measured with a dial caliper allowing both caliper jaws to contact the inside metal surface. Fifty bands of each size were measured. All sizes except 0 and 1 were the "new" sizes referred to above, while the 0 and 1 size were "old" sizes still in production.

All statistical treatment of live measurements, specimen measurements, and band diameters were done by EAH using Microsoft Office Excel 2007 (12.06524.5003) SP2 MSO (12.0.6529.5000). This software is a part of Microsoft Office Professional Plus 2007 available from Microsoft Corporation, Redmond, WA.

RESULTS

Appendix 1 lists in American Ornitholigists' Union (AOU) 2010 check-list order the common names as well as scientific names and the BBL alpha codes (Gustafson et al 1997a) for the 111 species measured in this study. Table 1 lists by alpha code in alphabetical order a summary of the tarsus measurement data that were collected and analyzed. Table 2 is a summary of the measurements taken on internal diameters of bands, as well as BBL's internal diameter specifications on the nine sizes of bands, size 0A through 3A. The top line specifications are from the BBM (Gustafson et al 1997b), and differ slightly from the second specification line derived from the band order form currently on the BBL website (BBL 2007). Table 3 lists the 47 species for which suggested changes are made to the recommended band size(s) per species. This table includes, for comparison, the size recommendations from the BBM (Gustafson et al 1997a). In cases of more than one recommended size per species, the first stated size is the preferred size followed by alternate sizes in order of decreasing preference. Next listed is the suggested change in size(s) based on findings reported here. Also listed in this table are the numbers of each of these species banded with these suggested changes in band size. In each and every case, band fit was assessed when the band was applied; and in all instances, the applied band rotated freely on the tarsus, as well as moved unrestricted up and down on the tarsus. Recapture information on some of these species is reported further on below.

Table 1. A summary of tarsus width measurements on live birds and museum specimens in alphabetical order by Alpha Code (see Appendix 1 for key to species name by Alpha Code). Status refers to whether the measurements were on live (L) birds or museum (M) specimens. Where males and females were segregated, they are noted by (m) and (f), respectively.

Alpha Code	Status	n	Mean	SD	Min.	Max.	Range
AMGO	L	203	1.82	0.12	1.48	2.28	0.80
	M	66	1.76	0.10	1.55	2.01	0.46
AMRE	L	78	1.53	0.11	1.24	1.83	0.59
AMRO	L	61	3.36	0.23	3.00	4.34	1.34
AMWO	L	1	4.30	--	--	--	--
ATSP	L	107	1.95	0.10	1.70	2.24	0.54
	M	105	1.97	0.14	1.65	2.32	0.67
BAOR	L	33	2.85	0.16	2.50	3.16	0.66
BAWW	L	69	1.75	0.11	1.55	1.95	0.40
BBCU	L	1	3.63	--	--	--	--
BBWA	L	10	1.67	0.09	1.49	1.78	0.29
BCCH	L	276	1.77	0.12	1.42	2.02	0.60
	M	106	1.75	0.14	1.40	2.08	0.68
BHCO	L(m)	39	2.96	0.26	2.48	3.90	1.42
	L(f)	6	2.69	0.06	2.62	2.75	0.13
BHVI	L	31	1.83	0.14	1.60	2.07	0.47
	M	1	1.57	--	--	--	--
BITH	L	1	2.35	--	--	--	--
BLBW	L	12	1.53	0.13	1.30	1.74	0.44
BLJA	L	59	3.78	0.26	3.35	4.40	1.05
	M	66	3.77	0.22	3.32	4.11	0.79
BLPW	L	101	1.79	0.11	1.52	2.05	0.53
BOBO	L	2	2.77	0.16	2.65	2.88	0.23
BRCR	L	121	1.53	0.15	1.19	1.89	0.70
BRTH	L	21	3.94	0.17	3.58	4.26	0.68
BTBW	L	78	1.61	0.11	1.40	1.90	0.50
BTNW	L	38	1.48	0.10	1.22	1.69	0.47
BWWA	L	22	1.62	0.10	1.50	1.85	0.35
CACH	L	15	1.79	0.12	1.61	1.96	0.35
CAWA	L	27	1.62	0.12	1.40	1.89	0.49
CAWR	L	14	2.53	0.20	2.15	2.93	0.78
CCSP	L	1	1.95	--	--	--	--
CEDW	L	28	2.37	0.16	2.04	2.77	0.73
CHSP	L	169	1.81	0.11	1.41	2.02	0.61
	M	41	1.87	0.11	1.58	2.00	0.42
CMWA	L	1	1.70	--	--	--	--
COGR	L	48	4.44	0.30	3.82	5.14	1.32
CONW	L	1	1.70	--	--	--	--
CORE	L	29	1.62	0.09	1.48	1.75	0.27
COYE	L	303	1.79	0.12	1.40	2.07	0.67
	M	26	1.87	0.09	1.70	2.03	0.33
CSWA	L	20	1.54	0.11	1.31	1.78	0.47
CWWI	L	1	4.13	--	--	--	--
DICK	L	1	2.62	--	--	--	--
DOWO	L	54	2.17	0.16	1.93	2.72	0.79

Table 1 (cont'd)

Alpha Code	Status	n	Mean	SD	Min.	Max.	Range
EABL	L	36	2.31	0.21	1.92	2.70	0.78
EAKI	L	6	2.51	0.05	2.45	2.60	0.15
EAPH	L	37	1.82	0.11	1.55	2.00	0.11
EATO	L	21	3.13	0.19	2.82	3.42	0.60
EAWP	L	11	1.67	0.12	1.50	1.87	0.37
ETTI	L	124	2.40	0.20	1.56	2.90	1.34
EUST	L	1	3.75	--	--	--	--
EVGR	L	263	3.10	0.20	2.27	3.80	1.53
	M	27	3.04	0.16	2.65	3.30	0.68
EWCS	L	84	2.55	0.12	2.29	2.95	0.66
FISP	L	63	1.83	0.12	1.49	2.12	0.63
	M	36	1.94	0.12	1.70	2.19	0.49
FOSP	L	25	2.84	0.14	2.58	3.10	0.52
	M	33	2.87	0.22	2.44	3.32	0.88
GCFL	L	10	2.43	0.15	2.15	2.68	0.53
GCKI	L	222	1.39	0.13	1.14	1.80	0.66
	M	8	1.41	0.11	1.25	1.60	0.35
GCTH	L	8	2.23	0.20	1.90	2.52	0.62
GRCA	L	415	2.84	0.15	2.40	3.28	0.88
	M	80	2.91	0.18	2.55	3.30	0.75
GRSP	L	1	2.12	--	--	--	--
HAWO	L	14	3.08	0.19	2.82	3.50	0.68
HETH	L	89	2.30	0.12	2.05	2.60	0.55
	M	17	2.41	0.11	2.20	2.55	0.35
HOFI	L	23	2.16	0.14	1.90	2.48	0.58
HOSP	L	165	2.55	0.13	2.21	2.89	0.68
	M	54	2.56	0.17	2.20	2.95	0.75
HOWA	L	5	1.65	0.11	1.50	1.80	0.30
HOWR	L	31	1.88	0.12	1.69	2.20	0.51
INBU	L	49	1.96	0.11	1.70	2.22	0.52
LEFL	L	8	1.45	0.07	1.33	1.52	0.19
LISP	L	146	2.23	0.11	1.89	2.52	0.63
MAWA	L	162	1.54	0.10	1.30	1.80	0.50
MODO	L	72	4.81	0.29	4.11	5.43	1.32
	M	12	4.59	0.31	3.83	5.01	1.18
MOWA	L	7	1.88	0.15	1.70	2.10	0.40
MYWA	L	238	1.67	0.11	1.34	2.00	0.66
NAWA	L	27	1.57	0.10	1.41	1.82	0.41
NOCA	L	61	2.96	0.16	2.52	3.42	0.90
NOPA	L	73	1.51	0.10	1.20	1.82	0.62
NOWA	L	61	1.92	0.12	1.64	2.11	0.47
NSHR	L	4	3.03	0.34	2.64	3.45	0.81
OCWA	L	1	1.60	--	--	--	--
ORORR	L	2	2.54	0.02	2.52	2.55	0.03
OVEN	L	72	1.98	0.12	1.72	2.25	0.53
	M	32	1.99	0.11	1.76	2.17	0.41
PHVI	L	2	1.59	0.05	1.55	1.62	0.07
PISI	L	119	1.69	0.13	1.30	2.05	0.75

Table 1 (cont'd)

Alpha Code	Status	n	Mean	SD	Min.	Max.	Range
PIWA	L	4	1.64	0.14	1.45	1.78	0.33
PRAW	L	16	1.46	0.13	1.20	1.72	0.52
PUFI	L	226	2.14	0.15	1.70	2.71	1.01
	M	64	2.24	0.15	1.93	2.69	0.76
RBNU	L	191	1.77	0.15	1.40	2.10	0.70
	M	115	1.61	0.15	1.28	2.10	0.82
RBWO	L	8	3.41	0.21	3.03	3.65	0.62
RBGR	L	81	2.90	0.17	2.57	3.40	0.83
RCKI	L	117	1.40	0.13	1.11	1.80	0.69
	M	5	1.41	0.05	1.35	1.48	0.13
REVI	L	81	1.97	0.16	1.56	2.44	0.88
	M	48	1.77	0.10	1.50	1.95	0.45
RWBL	L(m)	23	3.44	0.17	3.07	3.75	0.68
	L(f)	24	2.86	0.18	2.50	3.26	0.76
SAVS	L	63	2.09	0.12	1.82	2.37	0.55
SCJU	L	353	2.00	0.11	1.60	2.30	0.70
	M	87	1.97	0.14	1.70	2.42	0.72
SCTA	L	3	2.31	0.11	2.18	2.38	0.20
SOSP	L	222	2.39	0.13	1.97	2.78	0.81
	M	94	2.37	0.19	1.92	2.80	0.88
SSTS	L	1	1.93	--	--	--	--
SWSP	L	107	2.21	0.14	1.95	2.58	0.63
SWTH	L	20	2.20	0.16	1.93	2.51	0.58
	M	11	2.34	0.11	2.10	2.50	0.40
TRES	L	154	1.83	0.12	1.52	2.16	0.64
TRFL	L	37	1.65	0.20	1.24	2.30	1.06
VEER	L	23	2.25	0.17	1.80	2.67	0.87
	M	14	2.42	0.16	2.20	2.74	0.54
WAVI	L	6	1.79	0.06	1.74	1.90	0.16
	M	1	1.70	--	--	--	--
WBNU	L	84	2.36	0.18	2.00	2.87	0.87
	M	62	2.05	0.16	1.80	2.60	0.80
WEVI	L	12	1.61	0.13	1.48	1.93	0.45
WEWA	L	3	2.01	0.03	1.99	2.05	0.06
WIWA	L	33	1.49	0.10	1.20	1.68	0.48
WIWR	L	14	1.64	0.12	1.50	1.85	0.35
WOTH	L	4	2.67	0.11	2.51	2.75	0.24
WTSP	L	265	2.49	0.14	2.12	2.89	0.77
	M	85	2.53	0.18	2.08	2.98	0.90
W/YPWA	L	42	1.66	0.11	1.45	1.85	0.40
YBCH	L	4	2.61	0.14	2.43	2.77	0.34
YBCU	L	5	3.83	0.06	3.75	3.93	0.18
YBFL	L	1	1.32	--	--	--	--
YBSA	L	14	2.71	0.21	2.50	3.29	0.79
YSFL	L	9	4.09	0.19	3.84	4.40	0.56
YTVI	M	2	1.95	0.21	1.80	2.10	0.30
YWAR	L	99	1.64	0.13	1.31	2.00	0.69
	M	55	1.68	0.10	1.32	1.88	0.56

Table 2. A statistical summary of measured internal diameters (ID) with BBL internal diameter specifications for band sizes 0A through 3A. All measurements in mm.

Size	0A	0	1	1B	1A	2	3	3B	3A
Spec. ID, mm (from BBM)	2.00	2.11	2.38	2.6	3.1	3.8	4.8	5.2	5.6
Spec. ID, mm (from website)	1.98	2.11	2.34	2.77	3.16	3.96	4.78	5.16	5.56
Av. ID, mm	1.84	2.00	2.43	2.92	3.33	4.22	4.45	4.94	5.37
SD, mm	0.02	0.02	0.03	0.05	0.04	0.03	0.07	0.07	0.05
Max. ID, mm	1.89	2.03	2.50	2.99	3.42	4.28	4.58	5.20	5.47
Min. ID, mm	1.80	1.97	2.33	2.78	3.26	4.16	4.30	4.82	5.26
Range, mm	0.09	0.06	0.17	0.21	0.16	0.12	0.28	0.38	0.21
Band Series*	2380-96801	1920-69701	2221-04201	2251-17001	1991-75001	1222-90401	1603-34551	1593-86601	1693-31301
Manufacturer**	Gey	Gey	Nat.	Nat.	Nat.	Nat.	Nat.	Nat.	Nat.

* This represents the first band number of the 50 consecutive bands in this series measured for each band size.

** Manufacturers are as follows: "Gey" = Gey Band and Tag Company, Norristown, PA.
"Nat." = National Band and Tag Co., Newport, KY.

Table 3. Suggested changes to recommended band sizes in the Bird Banding Manual (BBM) in alphabetical order by Alpha Code. Comment columns represent numbers of birds banded with an alternate suggested band size.

			Comment	
Alpha Code	Size in BBM	Suggested Size	N Banded	Size Used
AMGO	0/0A/1	0A/0	1575	0A
BAWW	0/0A/1	0A/0	189	0A
BLBW	0/0A	0A/0	28	0A
BCCH	0/1	0A/0	2080	0A
BLPW	0/1/0A	0A/0/1	206	0A
			5	0
			1	1
BTBW	0/0A	0A/0	180	0A
BTNW	0A/0	0A	93	0A
BHVI	1	0A/0/1	59	0A
			18	0
BWWA	0A/0	0A	13	0A
BRCR	0A/0	0A	383	0A
CAWA	0/0A	0A	118	0A
CACH	0/0A/1	0A/0	13	0A
CSWA	0A/0	0A	52	0A
CHSP	0/0A	0A/0	645	0A
			3	0
CORE	0/0A	0A	142	0A
COYE	0/1/0A	0A/0	1032	0A
			2	0

Table 3. (cont'd)

Alpha Code	Size in BBM	Suggested Size	Comment N Banded	Comment Size Used
EAPH	0/1	0A/0	121	0A
			39	0
EAWP	0/0A	0A	21	0A
FISP	0/1/0A	0A/0	93	0A
			7	0
GCFL	1A/1B	1B/1A	30	1B
			8	1A
GRSP	1	1/0	11	1
			4	0
HOWA	0/1	0A/0	6	0A
			2	0
HOWR	0/0A	0A/0	726	0A
			9	0
INBU	1	0/0A/1	64	0
			10	0A
			2	1
LEFL	0/0A	0A	31	0A
MAWA	0A/0	0A	685	0A
MOWA	0/1	0/0A	6	0A
			2	0
MYWA	0/1/0A	0A/0	961	0A
			75	0
NAWA	0A/0	0A	67	0A
NOPA	0A/0	0A	166	0A
NOWA	1/0	0A/0	104	0A
			11	0
OVEN	1/0	0/0A	96	0
			38	0A
PISI	0/0A	0A	340	0A
PRAW	0A/0	0A	22	0A
RBNU	0/1	0A	572	0A
REVI	1/0	0/0A/1	105	0
			54	0A
SAVS	1	1/0	105	1
			17	0
SWSP	1	1/0	337	1
			30	0
TRFL	0/0A	0A	41	0A
W/YPWA	0/0A	0A	72	0A
WAVI	0/1	0A	11	0A
WEVI	0/0A	0A	29	0A
WEWA	1/0	0/0A	4	0
			3	0A
YBFL	0/0A	0A	10	0A
YWAR	0/0A/1	0A	211	0A
WIWA	0A/0	0A	79	0A
WIWR	0A/0	0A	40	0A

DISCUSSION

Prior Tarsus Width Data. Relatively few previously published data exist on tarsus width measurements. Among them, the greatest share was published by Blake (1954, 1956, 1958) with the intent of using them to select proper band size by species. Michener (1947) was the first to suggest use of a leg gauge made of plastic, wood, or metal possessing rectangular notches in the edge of the material corresponding to the internal diameter of the 11 band sizes 0 through 8 available at the time. As is done with leg gauges in use today, one holds the gauge perpendicular to the tarsus fitting the tarsus into the smallest notch that provides a comfortable fit of the tarsus, each notch corresponding to a numbered band size.

Blake (1954) relied on a V gauge (see his Figure 1) graduated to the nearest 0.2 mm from 0 to 4 mm to take tarsus width measurements. A bird's tarsus was inserted into the V until contact was made and the width recorded. To select a band size, Blake used the concept of adding a clearance of 0.2 mm or six percent of the band internal diameter, whichever was larger, to the width of the tarsus to allow for adequate fit. His recommendations were based on band size dimensions which existed at the time which differ from the band dimensions newly created in 1991 (Tautin 1992, 1996).

Others followed Blake's lead using a V gauge contributing data to him (Blake 1956, 1958) or publishing on their own (Bergstrom 1954, Woodford and Lovesy 1959). Rothstein (1979) reported use of a caliper to measure tarsus widths of Gambel's White-crowned Sparrows (*Zonotrichia leucophrys gambelii)* in California to find that tarsus width on the banded leg increased about three percent in a month after banding over that of the unbanded leg. Tarsal widths were measured using a caliper with the intent to recommend appropriate band sizes for Tree Swallows and Violet-green Swallows (*Tachycineta)* in Colorado by Cohen (1994) and for Pine Siskins in British Columbia by Michalak (1997), and Song Sparrows and Puget Sound White-crowned Sparrows (*Z. l. pugetensis*) by Michalak (1998) in British Columbia. More recently, Colwell (2002, 2003) used a leg gauge to determine band size and correlated it with wing chord and sex of individual Spotted Towhees (*Pipilo maculatus*) in California to suggest a change in recommended band size based on wing chord length. Sakai (2008) found contradictory results based on what he believed to be a difference in subspecies: *P. m. megalonax* in his case and *P. m. falcifer* in Colwell's case.

Comparison of this study with prior data. Blake's data (1954, 1956, 1958) represent the best opportunity for comparison with data presented here. Blake's sample sizes varied considerably. There are 47 species in Table 1 in common with Blake's data for sample sizes of ten or more. Blake's average tarsus widths were smaller in 36 of these species, the same in one species and larger in ten species. This tendency toward narrower tarsus widths by Blake can be attributed to his use of a V gauge making contact with the tarsus compared to a caliper measurement here just short of making tarsus contact.

A comparison of TRES tarsus width in Table 1 with Cohen's results (1994) shows an average width of 1.83 mm (n = 154), range 1.52-2.16 mm compared to his 1.61 mm for males (n = 135), 1.64 mm for females (n = 157) and range for both sexes combined of 1.2-1.9 mm. PISI widths in Table 1 averaged 1.69 mm (n = 119), range 1.30-2.05 mm compared to Michalak's measurements (1997) of 1.56 mm (n = 110), range 1.30-1.83 mm.

Measured band dimensions. It was noticed while taking the band internal dimension measurements presented in Table 2 that these bands in the 0A to 3A size range tended to be slightly elliptical rather than completely circular. Using the juncture of the two butt ends of the band as a reference point and designating it N as on a compass, the line drawn N to S inside the band (axis *a*) was shorter than the E-W line (axis *b*) on band sizes 0A, 0, 1, 1B, 3, 3B and 3A, while the reverse was true for band sizes 1A, 2.

For instance, a 0A band with a = 1.85 mm had b = 2.02 mm; a size 0 with a = 2.02 mm had b = 2.19 mm; and size 1 with a = 2.40 mm had b = 2.50 mm. All internal diameters in Table 2 are axis a measurements representing conservatively the lesser internal diameter of the band. No assessment of possible changes to the internal diameter was made after closure of these bands. For a size 1A band with a = 3.47 mm, b = 3.41 mm; and a size 2 band with a = 4.35 mm had b = 4.26 mm. All of these measurements are of single bands only per size to illustrate the slightly elliptical shape of these bands.

Suggested changes in recommended band sizes. The results tabulated in Table 3 focus primarily on greater use of size 0A bands due to the findings here that many of these species have narrow enough tarsus widths to accommodate this band size. This conclusion was based not only on the tarsus widths themselves, but on the actual use of 0A bands on live birds noted in the far right column of Table 3. In every case where a size 0A or 0 was applied as a downsized alternative to a recommended larger size band, the fit of the 0A or 0 band allowed ample room to freely rotate the band on the tarsus and to move it up and down on the tarsus without any constriction or snugness of fit.

Extensive use of size 0A bands was tested on two wintering species, BCCH and RBNU, and one breeding species, CHSP, at Jenny Lake, NY, where numerous repeat and return captures of these birds were made following banding. From the total of 2080 BCCHs banded from 1996 to 2010, 1325 or 63.7 percent were recaptured a total of over 4000 times out to an age of nine years with no indication that the size 0A band fit was in any way injurious to any of them. Similarly, from 572 RBNUs banded with size 0A bands, 345 or 60.3 percent were recaptured a total of 1540 times up to six years after banding with no adverse effect noted with the fit of the band. And, 645 CHSPs banded with size 0A bands produced recaptures of 342 or 53.0 percent of these birds for a total of 955 recaptures out to an age of nine years with no adverse effect noted. These actual field results justify the changes in recommended sizes suggested in Table 3. Further, these results coupled with the observed tarsus measurements on these species support a change to size 0A as the recommended size for other species with tarsus widths similar to those of these three extensively banded species. The 1575 AMGOs banded with 0A bands were banded at several stations where site fidelity was not as prevalent as with the other three species at Jenny Lake. Nevertheless, there were numerous recaptures out to seven years without any adverse effects noted with band fit.

When the BBL revised pages in the BBM dealing with suggested band sizes (Tautin 1996), it recommended for certain ground-feeding species, such as towhees, etc., larger sized bands as a first preference over a band of normal fit to allow sufficient space between the tarsus and band to prevent accumulation of dirt between the band and tarsus. For instance, the preferred size for a male EATO was a rather loose-fitting size 2 followed by size 1A as an alternate fit.

Comparison of tarsus widths of live birds and museum specimens. Twenty-six species in Table 1 are represented by both live and museum measurements from GCKI as smallest to MODO as largest, based on live bird averages of 1.39 to 4.81 mm. Museum measurements of nine species were *smaller* than their corresponding live measurement averages, while 17 species measured *larger* as specimens compared to live birds.

Overall, it would appear that tarsus width measurements of museum specimens are an acceptable surrogate for measurements on live passerines and near passerines of the tarsus size represented here. More museum work is planned to increase sample size on some species not well represented here by live birds. Banders with access to other live species not mentioned here are encouraged to measure tarsus widths to justify possible other suggested changes in recommended band size. Also, data such as these may prove useful to the BBL if future changes are made to band manufacturing specifications.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge with thanks the following people who allowed access to their land or land under their control for taking some of these measurements: William Kornrumpf, Glenn Mahler, the late Thomas Palmer, the late Garry Veeder and Laura Sommers. Also, thanks are due to the following people who many times assisted with the netting operations at the Palmer site, allowing more time to gather these data: Laurie Freeman, Ted Hicks, Roger Miller, the late Thomas Palmer, and Carol Stack. Thanks for access and assistance with their collections also go to the following curators: Joseph Bopp at New York State Museum; William Cook at Columbia-Greene Community College; and Paul Sweet and Margaret Hart at American Museum of Natural History. We acknowledge with thanks an anonymous reviewer whose suggestions improved this paper.

LITERATURE CITED

American Ornithologists' Union. 2010. Check-list of North American birds, 7th edition (1998) and its supplements through the 51st Supplement. http://www.aou/checklist/north/full.php

Bird Banding Laboratory. 2007. Band order form. http://www.pwrc.usgs.gov/bbl/bandord/bandord.cfm

Bergstrom, E.A. 1954. More leg sizes. *Bird-Banding* 25:58-59.

Blake, C.H. 1954. Leg sizes and band sizes; first report. *Bird-Banding* 25:11-16.

Blake, C.H. 1956. Leg sizes and band sizes: second report. *Bird-Banding* 27:76-82.

Blake, C.H. 1958. Leg sizes and band sizes: third report. *Bird-Banding* 29:90-98.

Cohen, R.R. 1994. Tarsal widths and band sizes for Tree Swallows and Violet-green Swallows. *North American Bird Bander* 19:137-139.

Colwell, R.R. 2002. Recommended band size for Spotted Towees: A suggested revision. *North American Bird Bander* 27:127-129.

Colwell, R.R. 2003. Recommended band size for Spotted Towhee: A suggested revison by Rita R. Colwell (erratum). *North American Bird Bander* 28:120.

Gustafson, M.E., J. Hildenbrand, and L. Metras. 1997a. *The North American Bird Banding Manual* (Electronic Version). Version 1.0. http://www.pwrc.usgs.gov/BBL/manual/sect5.htm

Gustafson, M.E. J. Hildenbrand, and L. Metras. 1997b. *The North American Bird Banding Manual* (Electronic Version). Version 1.0. http://www.pwrc.usgs.gov/BBL/manual/sizes.htm

Michalak, L. 1997. The use of size 0A bands as a size choice for Pine Siskins. *North American Bird Bander* 22:119-121.

Michalak, L. 1998. Comparison of the tarsal widths of Song Sparrows and Puget Sound White-crowned Sparrows: the use of band size 1. *North American Bird Bander* 23:124-127.

Michener, H. 1947. Band size determination. *Bird-Banding* 18:77-79.

Rothstein, S.L. 1979. Effects of banding on the tarsus of the White-crowned Sparrow. *Bird-Banding* 50: 244-251.

Sakai, W.H. 2008. Spotted Towhee band size revisited. *North American Bird Bander* 33:12-14.

Tautin, J. 1991a. MTAB 69 (Jan 1991). Office of Migratory Bird Management , Laurel, MD.

Tautin, J. 1991b. MTAB 70 (Jul 1991). Office of Migratory Bird Management, Laurel, MD.

Tautin, J. 1992. MTAB 71 (Jan 1992). Office of Migratory Bird Management, Laurel, MD.

Tautin, J. 1995. MTAB 78 (Oct 1995). http://www.pwrc.usgs.gov/BBL/mtab/mtab.htm

Tautin, J. 1996. MTAB 79 (Jan 1996). http://www.pwrc.usgs.gov/BBL/mtab/mtab.htm

Tautin, J. 1999. MTAB 83 (Nov 1999). http://www.pwrc.usgs.gov/BBL/mtab/mtab.htm

Woodford, J. and F.T. Lovesy. 1959. Some leg sizes and band sizes. *Bird-Banding* 30:121.

Appendix 1. Common and scientific sames in AOU (2010) Check-list Order through the 51st Supplement, and alpha codes of the 111 species of birds measured in this study.

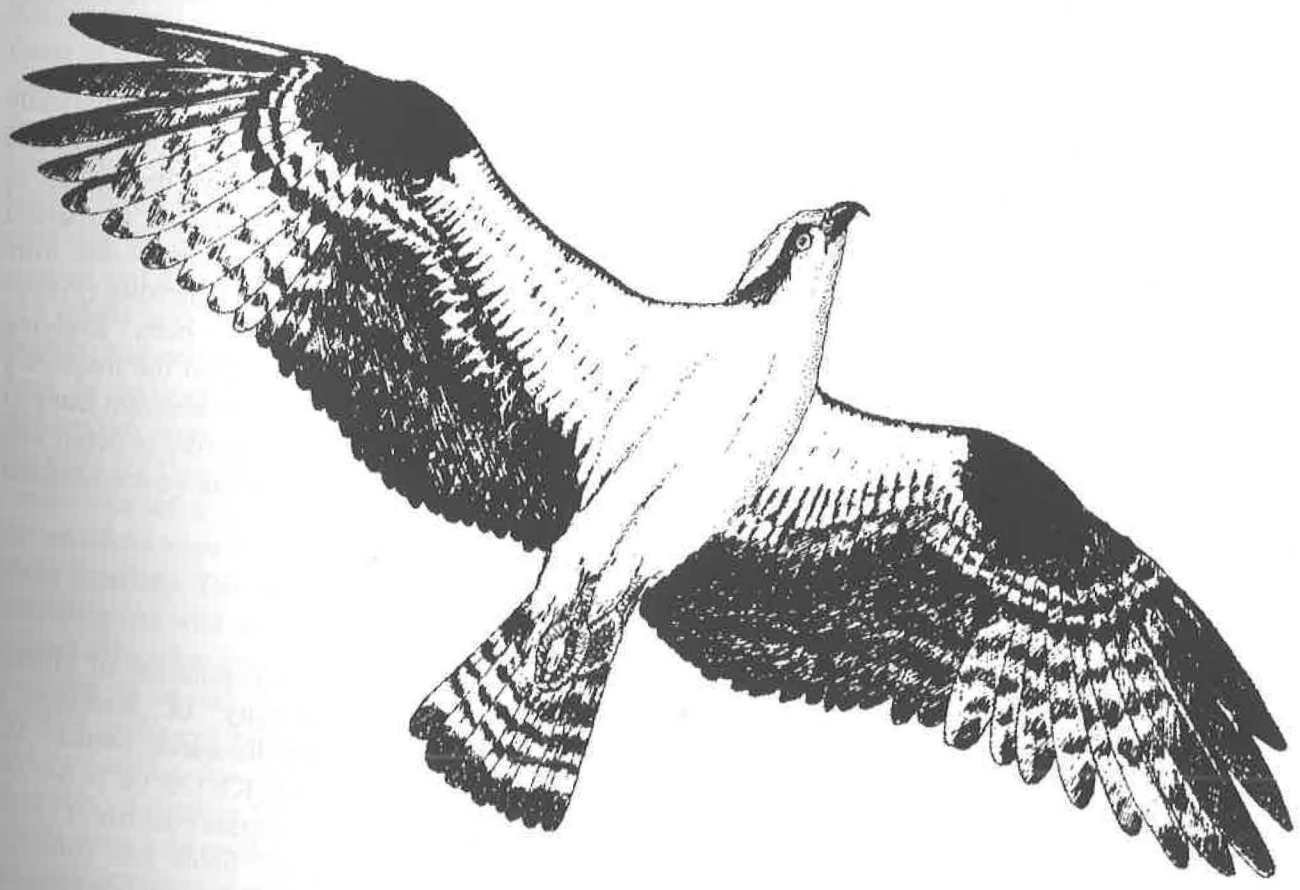
Common Name	Scientific Name	Code
American Woodcock	*Scolopax minor*	AMWO
Mourning Dove	*Zenaida macroura*	MODO
Yellow-billed Cuckoo	*Coccyzus americanus*	YBCU
Black-billed Cuckoo	*C. erythropthalmus*	BBCU
Chuck-will's-widow	*Caprimulgus carolinensis*	CWWI
Red-bellied Woodpecker	*Melanerpes carolinus*	RBWO
Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA
Downy Woodpecker	*Picoides pubescens*	DOWO
Hairy Woodpecker	*P. villosus*	HAWO
Northern Flicker	*Colaptes auratus*	YSFL
Eastern Wood-Pewee	*Contopus virens*	EAWP
Yellow-bellied Flycatcher	*Empidonax flaviventris*	YBFL
Traill's Flycatcher	*E. traillii/alnorum*	TRFL
Least Flycatcher	*E. minimus*	LEFL
Eastern Phoebe	*Sayornis phoebe*	EAPH
Great Crested Flycatcher	*Myiarchus crinitus*	GCFL
Eastern Kingbird	*Tyrannus tyrannus*	EAKI
Northern Shrike	*Lanius excubitor*	NSHR
White-eyed Vireo	*Vireo griseus*	WEVI
Yellow-throated Vireo	*V. flavifrons*	YTVI
Blue-headed Vireo	*V. solitarius*	BHVI
Warbling Vireo	*V. gilvus*	WAVI
Philadelphia Vireo	*V. philadelphicus*	PHVI
Red-eyed Vireo	*V. olivaceus*	REVI
Blue Jay	*Cyanocitta cristata*	BLJA
Tree Swallow	*Tachycineta bicolor*	TRES
Carolina Chickadee	*Poecile carolinensis*	CACH
Black-capped Chickadee	*P. atricapillus*	BCCH
Tufted Titmouse	*Baeolophus bicolor*	ETTI
Red-breasted Nuthatch	*Sitta canadensis*	RBNU
White-breasted Nuthatch	*S. carolinensis*	WBNU
Brown Creeper	*Certhia americana*	BRCR
Carolina Wren	*Thryothorus ludovicianus*	CARW
House Wren	*Troglodytes aedon*	HOWR
Winter Wren	*T. hiemalis*	WIWR
Golden-crowned Kinglet	*Regulus satrapa*	GCKI
Ruby-crowned Kinglet	*R. calendula*	RCKI
Eastern Bluebird	*Sialia sialis*	EABL
Veery	*Catharus fuscescens*	VEER
Gray-cheeked Thrush	*C. minimus*	GCTH
Bicknell's Thrush	*C. bicknelli*	BITH
Swainson's Thrush	*C. ustulatus*	SWTH
Hermit Thrush	*C. guttatus*	HETH
Wood Thrush	*Hylocichla mustelina*	WOTH
American Robin	*Turdus migratorius*	AMRO
Gray Catbird	*Dumetella carolinensis*	GRCA

Appendix 1 (cont'd)

Common Name	Scientific Name	Code
Brown Thrasher	*Toxostoma rufum*	BRTH
European Starling	*Sturnus vulgaris*	EUST
Cedar Waxwing	*Bombycilla cedrorum*	CEDW
Blue-winged Warbler	*Vermivora cyanoptera*	BWWA
Tennessee Warbler	*Oreothlypis peregrina*	TEWA
Orange-crowned Warbler	*O. celata*	OCWA
Nashville Warbler	*O. ruficapilla*	NAWA
Northern Parula	*Parula americana*	NOPA
Yellow Warbler	*Dendroica petechia*	YWAR
Chestnut-sided Warbler	*D. pensylvanica*	CSWA
Magnolia Warbler	*D. magnolia*	MAWA
Cape May Warbler	*D. tigrina*	CMWA
Black-throated Blue Warbler	*D. caerulescens*	BTBW
Myrtle Warbler	*D. coronata*	MYWA
Black-throated Green Warbler	*D.virens*	BTNW
Blackburnian Warbler	*D. fusca*	BLBW
Pine Warbler	*D. pinus*	PIWA
Prairie Warbler	*D. discolor*	PRAW
Palm Warbler	*D. palmarum*	WPWA/YPWA
Bay-breasted Warbler	*D. castanea*	BBWA
Blackpoll Warbler	*D. striata*	BLPW
Black-and-White Warbler	*Mniotilta varia*	BAWW
American Redstart	*Setophaga ruticilla*	AMRE
Worm-eating Warbler	*Helmitheros vermivorum*	WEWA
Ovenbird	*Seiurus aurocapilla*	OVEN
Northern Waterthrush	*Parkesia noveboracensis*	NOWA
Connecticut Warbler	*Oporornis agilis*	CONW
Mourning Warbler	*O. philadelphia*	MOWA
Common Yellowthroat	*Geothlypis trichas*	COYE
Hooded Warbler	*Wilsonia citrina*	HOWA
Wilson's Warbler	*W. pusilla*	WIWA
Canada Warbler	*W. canadensis*	CAWA
Yellow-breasted Chat	*Icteria virens*	YBCH
Eastern Towhee	*Pipilo erythrophthalmus*	EATO
American Tree Sparrow	*Spizella arborea*	ATSP
Chipping Sparrow	*S. passerina*	CHSP
Clay-colored Sparrow	*S. pallida*	CCSP
Field Sparrow	*S. pusilla*	FISP
Savannah Sparrow	*Passerculus sandwichensis*	SAVS
Grasshopper Sparrow	*Ammodramus savannarum*	GRSP
Saltmarsh Sharp-tailed Sparrow	*A. caudacutus*	SSTS
Fox Sparrow	*Passerella iliaca*	FOSP
Song Sparrow	*Melospiza melodia*	SOSP
Lincoln's Sparrow	*M. lincolnii*	LISP
Swamp Sparrow	*M. georgiana*	SWSP
White-throated Sparrow	*Zonotrichia albicollis*	WTSP
Eastern White-crowned Sparrow	*Z. l. leucophrys*	EWCS

Appendix 1 (cont'd)

Common Name	Scientific Name	Code
Slate-colored Junco	*Junco hyemalis*	SCJU
Scarlet Tanager	*Piranga olivacea*	SCTA
Northern Cardinal	*Cardinalis cardinalis*	NOCA
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR
Indigo Bunting	*Passerina cyanea*	INBU
Dickcissel	*Spiza amaericana*	DICK
Bobolink	*Dolichonyx oryzivorus*	BOBO
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL
Common Grackle	*Quiscalus quiscula*	COGR
Brown-headed Cowbird	*Molothrus ater*	BHCO
Orchard Oriole	*Icterus spurius*	OROR
Baltimore Oriole	*I. galbula*	BAOR
Purple Finch	*Carpodacus purpureus*	PUFI
House Finch	*C. mexicanus*	HOFI
Common Redpoll	*Acanthis flammea*	CORE
Pine Siskin	*Spinus pinus*	PISI
American Goldfinch	*S. tristis*	AMGO
Evening Grosbeak	*Coccothraustes vespertinus*	EVGR
House Sparrow	*Passer domesticus*	HOSP



Osprey by George West