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Capture Efficiency of Three Mesh Sizes of Mist Nets

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ABSTRACT

Mist nets of three mesh sizes were used at 36 net sites in old-growth chaparral. Each size was used for the same number of net hours, once at each net site, over a span of 38 weeks. The 30 mm mesh mist nets caught 54% more birds than the 36 mm mesh mist nets, and 237% more than the 60 mm mesh mist nets. Although several small species were captured more often in the 30 mm mesh, there was no significant tendency for thrush-sized birds.

INTRODUCTION

Bleitz (1970) recommended 25 mm mesh mist nets for very small birds, 32 mm mesh for warblers and wrens, 38 mm mesh for most songbirds, and 60 mm for towhees, jays and other large songbirds. Bub (1991) reported that some mist-netters used one size of mesh for thrush-sized birds, another size for smaller birds, but he did not say what the sizes were. Ralph et al. (1993) said that 36 mm mesh mist nets (hereinafter, 36 mm) are better for birds the size of a thrush. The North American Banding Council (2001) said that 30 mm mesh mist nets (hereinafter, 30 mm) are better for small birds from kinglets to thrushes, 36 mm for flickers and jays, and 60 mm mesh mist nets (hereinafter, 60 mm) for larger birds. DeSante et al. (2004) suggested 30 mm to maximize the catch of birds weighing less than 30-35 g. DeSante et al. (2009) recommended 30 mm, unless *Catharus* thrushes or larger are targeted, in which case 36 mm should be used. Avinet (2018) reported that 30 mm is better for sparrows, 36 mm is good for birds from sparrows to jays, and 60 mm is better for birds the size of large thrushes.

The recommendations have been diverse, especially for thrushes, with few published studies to support these recommendations. Only one published study was done in the United States: Heimerdinger and Leberman (1966) compared the efficiency of 30 mm and 36 mm nets at Powdermill Nature Reserve in Pennsylvania and found that 30 mm was more effective at catching smaller birds. They suggested that studies done with a different avifauna would be helpful. Ludwig (1969) reported that he used a combination of 38 mm and 60 mm mesh but did not present any data. Karr (1979, 1981), citing Heimerdinger and Leberman (1966), said that he preferred a combination of 30 mm and 36 mm. Keyes and Grue (1982) merely reported the results of Heimerdinger and Leberman (1966).

In Germany, Dorsch (1983) compared 32 mm, 1.5-meter-high twisted-fiber nets with 36 mm mesh, 2-meter-high monofilament mist nets. In his study, the mist nets with larger mesh caught more of the birds weighing over 15 g. In a study with 30 mm and 36 mm mist nets in Puerto Rico, Pardieck and Waide (1992) found that birds heavier than 26 g were caught more often in 36 mm. In Brazil, Piratelli (2003), comparing 36 mm and 61 mm mesh, found that birds less than 40 g were caught more often in the 36 mm. In Puerto Rico, Faaborg et al. (2004) reported that no change in capture rate was noticed when they changed from 36 mm to 30 mm, but no data was given. Whitman (2004) reported that most neotropical mist-netters used 36 mm even though that size may catch up to 50% fewer small birds than 30 mm would, citing Heimerdinger and Leberman (1966) and Pardieck and Waide (1992).

An informal survey of my proposed study area found that the most common species included Spotted Towhee (*Pipilo maculatus*) and California Towhee (*Melozone crissalis*). The recommendations cited above suggested that mist nets with larger mesh would be better for these species, but that larger mesh would result in a lower catch for smaller birds, such as Bewick's Wren (*Thryomanes bewickii*) and Oak Titmouse (*Baeolophus inortatus*).

METHODS

The present study is in old-growth chaparral and oak woodland in the Marshall Canyon Conservation Corridor, in La Verne, California, centered 34° 8' 0" N, 117° 46' 2" W. The southwestern end of this area is dominated by laurel sumac (*Malosma laurina*), toyon (*Heteromeles arbutifolia*), and black elderberry (*Sambucus nigra*). In the center, canyon live oak (*Quercus chrysolepis*) is dominant. The northeastern area includes oak, toyon, elderberry, golden currant (*Ribes aureum*) and other shrubs. The study site had not previously been used for any mist-netting.

Thirty-six net sites were used, distributed as terrain and vegetation allowed, in a 0.85 km line between 34° 7' 50" N, 117° 46' 14" W, and 34° 8' 10" N, 117° 45' 51" W. All mist nets were new, black nylon, 70 denier, two ply, four shelves, 2.6 meters high, 12 meters long. On most banding days, six net sites were used, with two nets of each size mesh, for five hours:

30mm:AvinetstocknumberNETHTX
36mm:AvinetstocknumberNET-ATX
60 mm: Avinet stock number 730/12

Between 10 Jul 2017 and 30 Mar 2018, each net site was used once with 30 mm, once with 36 mm, and once with 60 mm. There were an equal number of net hours (180) for each size of mesh. All captures were counted, including recaptures and birds that were not banded, and the location was recorded. Most birds were identified to species and most were measured for weight and

RESULTS

The data are summarized in Table 1, which shows the number and percentage of birds caught in each mesh size. The 30 mm nets caught 51% of the birds; 36 mm 33%, and 60 mm 15%. This distribution was significantly different from random (χ^2 = 2×10^{-14} significance defined as a value smaller than 0.05). The total distribution (51% in 30 mm, 33% in 36 mm, 15% in 60 mm) will be used as the basis for some other comparisons. Another way to describe the results is that the 30 mm caught 54% more birds than the 36 mm did (162 vs. 105), and 237% more birds than the 60 mm (162 vs. 48). Similarly, 36 mm caught 119% more birds than the 60 mm did.

In Table 2, the data are sorted geographically into the 12 net sites at the southwest end of the study area, the 12 sites in the center, and the northeastern 12 sites. The northeastern net group and the southwestern net group had a significantly different from random distribution of captures in the various mesh sizes, but not significantly different from the total distribution shown in the last row of Table 1. The center group of nets was the reverse: close to a random distribution (χ^2= 0.7442), but significantly different than the total distribution (χ^2= 0.0051). The percentage of birds caught in 30 mm illustrates the difference: in the southwestern group, 55 out of 97 birds were caught in 30 mm (57%). In the center nets, 24 out of 65 birds were caught in 30 mm (37%). In the northeastern group, 83 out of 153 birds were caught in 30 mm (54%).

Tables 3 and 4 show how the size of birds is correlated with the capture distribution among different mesh sizes. Table 3 presents data for various weight categories, and Table 4 presents data for categories of wing chord. For these calculations, if data was missing for an individual bird, it was assigned the average weight or wing chord for its species, as found in this study. If no birds of that species were measured at the study site, it was assigned the weight given in Sibley (2016) and assigned to be in the middle of the wing chord range given in Pyle (1997). When grouped by categories, birds less than 30 g and those with wing chords shorter than 78 had a capture distribution significantly different than random, and were caught most often in 30 mm. However, when we look at individual species, some birds smaller than 30 g or with wing chord less than 78mm were not significantly different from random. For all species with more than five captures, Table 5 presents the number of birds captured in each mesh size, a χ^2 test for difference from random distribution, and the average weight and wing chord. Captures were significantly different from random distribution for six species, all with an average weight less than 23 g and all with an average wing chord less than 77 mm.

DISCUSSION

Heimerdinger and Leberman (1966) found that 30 mm caught 16% more birds than 36 mm did (724 vs. 621). Pardieck and Waide (1992) found that 30 mm caught 27% more than 36 mm did (297 vs. 233). In this study, there was a larger difference: 30 mm caught 54% more birds than 36 mm did (163 vs. 104). A similar result occurs when 36 mm and 60 mm are compared. Piratelli (2003) found that 36 mm caught 53% more than 61 mm mesh did (785 vs. 511 birds). In this study, 36 mm caught 119% more than 60 mm did (105 vs. 48 birds; see Table 1). Why would 30 mm capture more birds than 36 mm does? The larger mesh has fewer threads per square meter, and if anything, should be more difficult to see. More study would be needed to see if equal numbers of birds fly into the nets and if more birds escape from the larger mesh.

Table 2 shows that the relative capture rates varied from one area to another: close to a random distribution in the center group of nets, but significantly different from random in the adjacent groups. This may be due to vegetation types and densities, but those were beyond the scope of this study. I include this variation to show that results may vary significantly from one banding location to another.

How is mesh size correlated with size of the birds? Tables 3 and 4 show that, in general, smaller birds were captured more often in 30 mm than in 36 mm or 60 mm. Table 5 shows that there was a significant difference from random for six species. Anna's Hummingbirds were caught almost equally often in 30 mm and 36 mm, but none were caught in 60 mm. Five additional small species (Bushtit, Bewick's Wren, Wrentit, Oak Titmouse, and Purple Finch) showed significant differences from random and were captured more often in 30 mm. None of the larger species had a distribution significantly different from random.

Since Heimerdinger and Leberman (1966) presented their data by band size, I used their table to show that 16 of their species had significant differences in capture by mesh size. Of those, the species captured more often in 30 mm weighed 6-20 g and had wing chord 50-84 mm; the species significantly more often in 36 mm weighed 20-130 g and had wing chord 63-154mm [weights taken from Sibley (2016), wing chord from Pyle (1997)]. Pardieck and Waide (1972) found significant differences in the capture distribution for five species. The species captured more often in 30 mm weighed 3-10 g; species captured significantly more often in 36 mm weighed 35-108 g. Piratelli (2003) reported 18 species had significant differences in captures based on mesh size. Species more often caught in 36 mm ranged from 3-19 g; species caught more often in 60 mm weighed 112-158 g. If we compare two species, it is not always true that the larger bird will be caught more often in a larger mesh. The effectiveness of mesh size depends on many factors, not just weight or wing chord (Heimerdinger and Leberman 1966). One factor is skull size (Jenni et al. 1996). If the skull is small enough, the bird's head goes through the mesh, but if the fit is tight, feathers on the head make it difficult for the bird to back out and escape. The bend of the wing is often another area of entanglement. Other anatomical and behavioral characteristics are important, but these were not within the scope of my study.

CONCLUSIONS

I have two primary conclusions: 1) In this study area, 30 mm mesh mist nets caught 54% more birds than the 36 mm mesh mist nets, and the 36 mm mesh mist nets caught 119% more than 60 mm mesh mist nets. 2) The smaller meshes did significantly better for six species, all weighing less than 23 g; larger birds were not caught significantly more often in larger mesh mist nets. For my initial hypothesis, it was not true that the larger meshes were significantly better for Spotted and California towhees, and it was true that the larger meshes caught significantly fewer Bewick's Wrens and Oak Titmice.

Other banders may have different results, since the species mix will vary by location and season. If a bander wants to capture a wide range of species, the smaller mesh nets are probably the best choice for greater quantity. However, if a species 20 g or larger is being targeted, the bander may wish to conduct a preliminary study to see which mesh size works best for that species in that location.

Table 1. Number of birds caught in mist nets of different mesh sizes, La Verne, CA, 10 July 2017 to 30 March 2018.

	30 mm mesh	36 mm mesh	60 mm mesh	χ^2 test from random distribution
Total birds caught.	162	105	48	3.6×10^{-14}
Birds per 100 net hours.	90	58	27	
Percentage caught.	51.4	33.3	15.2	

Table 2. Number of birds caught in three mesh sizes, sorted geographically.

	30 mm	**36 mm**	**60 mm**	**total**	**χ^2 test from random distribution**	**χ^2 test from total distribution**
Net sites 1-12 (southwestern end).	55	31	11	97		
Number expected if captures were randomly distributed among mesh sizes.	32	32	32		2.6×10^{-7}	
Number expected if the total distribution (Table 1, last row) was true for these net sites.*	50	32	15			0.4498
Net sites 13-24 (center section).	24	22	19	65		
Number expected if captures were randomly distributed among mesh sizes.	22	22	22		0.7442	
Number expected if the total distribution was true for these net sites.	33	22	10			0.0051
Net sites 25-36 (northeastern end).	83	52	18	153		
Number expected if captures were randomly distributed among mesh sizes.	51	51	51		5.3×10^{-10}	
Number expected if the total distribution was true for these net sites.	79	51	23			0.5197

*For example: 51.4% of the total birds were caught in 30 mm. If this distribution held true for net sites 1-12, and those nets had a total catch of 97 birds, we would expect 50 (97 × 0.514) birds to be caught in 30 mm.

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Table 3. Number of birds caught in three mesh sizes, grouped by weight of bird.

Weight (g)	30 mm mesh	36 mm mesh	60 mm mesh	χ^2 test from random distribution	χ^2 test from total distribution
0-10	58	37	9	0	0.1613
10.1-20	44	23	8	0	0.445
20.1-30	42	27	15	0.0015	0.8325
30.1-40	5	9	7	0.5647	0.0102
40.1-50	11	6	5	0.2231	0.478
75.1-85	2	3	4	0.7165	0.0045

Table 4. Number of birds caught in three mesh sizes, grouped by length of wing chord.

Wing chord (mm)	30 mm mesh	36 mm mesh	60 mm mesh	χ^2 test from random distribution	χ^2 test from total distribution
39-48	40	29	7	0	0.3081
49-58	28	15	0	0	0.0171
59-68	20	7	9	0.0169	0.1069
69-78	41	21	8	0	0.4529
79-88	21	25	13	0.1534	0.0464
89-98	9	6	5	0.5258	0.4751
99-108	2	0	3	0.2865	0.015
109-118	1	1	0	0.6065	0.7897
119-128	0	1	3	0.0821	0.0031

Table 5. Captures for species with more than five captures, listed by increasing weight.

Species	Number of birds captured in three mesh sizes			χ^2 test for difference from random	Avg weight (g)	Avg wing chord (mm)
	30 mm	36 mm	60 mm			
Anna's Hummingbird (*Calypte anna*)	18	17	0	0	4.2	48
Bushtit (*Psaltriparus minimus*)	16	6	3	0.003	5.4	46
Ruby-crowned Kinglet (*Regulus calendula*)	3	4	0	0.1054	5.5	55
Bewick's Wren (*Thryomanes bewickii*)	14	10	1	0.0038	9.9	51
Audubon's Warbler (*Setophaga auduboni auduboni*)	4	5	0	0.097	11.4	73
Wrentit (*Chamaea fasciata*)	11	6	1	0.0155	14.9	58
Oak Titmouse (*Baeolophus inornatus*)	16	6	5	0.0164	16.7	68
House Finch (*Haemorhous mexicanus*)	0	3	2	0.2865	21.6	79
Purple Finch (*Haemorhous purpureus*)	20	4	4	0	22.1	76
Gambel's White-crowned Sparrow (*Zonotrichia leucophrys gambelii*)	11	9	3	0.1122	23.4	75
Hermit Thrush (*Catharus guttatus*)	9	10	6	0.5698	23.9	86
Spotted Towhee (*Pipilo maculatus*)	5	11	5	0.1801	38.6	83
California Towhee (*Melozone crissalis*)	8	4	4	0.3329	45.1	87
California Scrub-Jay (*Aphelocoma californica*)	1	2	3	0.6065	80.9	120