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Is Morning Mist Netting More Effective Than Afternoon Mist Netting

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ABSTRACT

Although bird banding literature suggests banding in the morning hours, and although most banding stations band in the morning hours rather than the afternoon hours, there has not been a rigorous test of whether more birds are actually captured in the AM vs PM. The banding protocol at my banding station in southern California allowed for a test of this question. In comparing annual capture totals (1996-2006), significantly more birds were captured in the morning hours (AM) than in the afternoon hours (PM). The same pattern emerged for resident and migrant birds. Yet, when the analysis focused on bird families, only the Picidae, Mimidae, Parulidae, and Emberizidae had significantly more captures in the AM. The analysis of individual species were less clear. In only eight species were the differences significant (Gambel's White-crowned Sparrow, Song Sparrow, Spotted Towhee, Warbling Vireo, Audubon's Warbler, California Thrasher, Bewick's Wren, and Wrentit).

INTRODUCTION

A unique banding protocol at my Zuma Canyon bird banding station set up by my mentor and Master Bird Bander (Norm Hogg) allowed me to test an interesting hypothesis of whether morning (AM) banding efforts produce more birds than afternoon (PM) banding efforts. Bird watchers have long known that the peak activity for most birds is the early morning hours, and the low is mid-afternoon (Sibley 2002). Lynch (1995) found that the number of species detected from point counts declined through the morning hours, and Ralph et al. (1995) note that this decline in detectability of birds during the course of the day is more rapid in hot weather and in the non-breeding season.

It seems that a majority of banding stations (Point Reyes Bird Observatory [PRBO], Big Sur Ornithological Laborabory, Humboldt Bay Bird Observatory, Klamath Bird Observatory [KBO], and Tortuguero Integrated Bird Monitoring Program) with which I have been acquainted, band almost exclusively during the morning hours. The MAPS (Monitoring Avian Productivity and Survivorship) program involving some 500+ stations, bands for six hours beginning at sunrise.

Only a few protocols specifically involve banding in the afternoons. J. Alexander (pers. comm.) reported that the Rapid Ornithological Inventory [ROI] carried out in northern California and southern Oregon at the KBO includes an afternoon session followed by a morning session. B. Ortego (pers. comm.) reports that an afternoon banding session followed by a morning session is frequently done as part of surveys of landscape habitats during periods of avian residency like breeding season or winter in Texas. T. Neal (pers. comm.) reports morning and afternoon banding at Fort Morgan, AL, in the fall. The MoSI (Monitereo de Sobrevivenia Invernal) program bands from sunrise to sunset.

An internet query of Landbird Monitoring Network of the Americas (LaMNA) banding stations about afternoon banding produced numerous responses. A fair number of responders indicated that they do band or have banded in the afternoons. For example, C. Robbins (pers.comm.) reports he runs his nets from dawn to sunset in a variety of habitats. Appledore Island, MN, bands all day (D. Holmes, pers. comm.). Manomet Center in coastal Massachusetts bands from sunrise to sunset in spring and fall (J. Griffiths, pers. comm.). Braddock Bay Bird Observatory [BBBO], on the south shore of Lake Ontario, started banding six to eight hours starting at sunrise, but often opened in the late afternoons. This afternoon banding started out as a way to keep interns from getting bored, but the banders soon realized there was a flurry of activity

for an hour or two just before dusk (B. Brooks, pers. comm.) Afternoon banding was often a continuation of banding from the morning hours. The general feeling among banders was that there were more birds in the morning hours than the late afternoon to sunset hours (Kestrel Haven Avian Migration Observatory, J. and S. Gregorie, pers. comm.)

Several stations reported a late flurry of activity an hour or two before sunset or dusk (L. Laviolette, Brier Island Bird Migration Research Station; B. Brooks, BBBO; D. Grosshuesch, Hawk Ridge Bird Observatory). Afternoon banding is usually in association with migration, but there is an array of protocols ranging from sunrise to sunset, sunrise to sunset with a mid-day break of several hours, to a regular morning schedule with a few hours toward sunset or dusk (L. Loviolette, Brier Island Bird Migration Research Station, pers. comm.; R. Roberts, Sand Bluff Bird Observatory, pers. comm.; C. Robbins, pers. comm.; D. Holmes, Appledore Island, ME; D. Grosshuesch, Hawk Ridge Bird Observatory, pers. comm.; B. Brooks, BBBO; R. Roberts, Sand Bluff Bird Observatory, pers. comm.; B. Hilton, Hilton Pond Center, pers. comm.), but the protocols at most stations are inconsistent from year to year. At the very least, the effort between PM and AM were not equal, making statistical comparisons difficult.

PRBO has banded 24 hours a day for some periods of time (C.J. Ralph, pers. comm.), but the data apparently have not been analyzed. Okia (1976) in a Ugandan rain forest and C. Robbins (pers. comm.) in a variety of habitats over many years have banded all day. There are few other reports of a consistent protocol of all day banding. Landscape surveys in Texas (B. Ortego, Texas Parks and Wildlife Department) and the ROI (J. Alexander, KBO, pers. comm.) are two consistent PM and AM banding protocols. Thus, the data are there to test this hypothesis. The few results that have been published show line or column charts over the course of the day (Okia 1976, Robbins 1981) and PM to AM banding were not compared directly. The general consensus based on casual observations or incomplete analysis of data is that morning banding captures more birds than afternoon (J. Carlisle, pers. comm.).

Protocols and discussions on bird banding suggest banding in the early morning hours (Ralph et al. 1993; Ralph and Dunn 2004). Yet, while it seems intuitively true that one would capture more birds in the morning hours than the afternoon hours, I have found no real direct test of this hypothesis. Grue et al. (1981) and Robbins (1981) report that bird activity is greatest in the mornings and late afternoons and early evenings but stop short of saying the same for mist netting success. Karr (1981) and Robbins (1981) found mist netting success as a function of time of day may vary with the species, habitat, and season.

I sought to test the hypothesis that morning banding generates significantly more bird encounters than afternoon banding.

METHOD

My banding site is in the Santa Monica Mountains, an east-west range located just north of greater Los Angeles in southern California. Zuma Canyon is one of numerous north-south canyons that drain south into the Pacific Ocean. The banding station is in the parking lot of the trail head into Zuma Canyon in the Santa Monica Mountains National Recreation Area (NRA) at the end of Bonsall Avenue. The site (34°02'55" N, 118°48'44" W) is about 1.5 km north of the mouth of Zuma Canyon, which is located at Zuma Beach. The canyon is dry through most of the year, with surface water in the canyon in the vicinity of the nets present only after heavy or persistent rains.

This constant-effort, year-round bird banding station has been in operation since the spring of 1995. During each banding cycle, nets are operated for five hours on Friday afternoon until sunset, followed by five hours on the following Saturday morning beginning at sunrise. Initially, 10 nets were used, but gradually this was increased to 13 nets. Nets were standard black mist nets with a mesh size varying from 30 to 36 mm and 12 to 12.2 m (40 ft) long, the variation being due to the manufacturer.

Banding was conducted at three to four week intervals, adjusting the schedule for other commitments of the bander(s). During several cycles each year, the station operated fewer than

13 nets owing to a shortage of personnel (typically on Fridays), and/or operated with a reduced number of nets or started late/ended early because of inclement weather (wind or rain). Any cycle with an unequal number of mist-net hours on Friday afternoon and Saturday morning was eliminated from this analysis. The remaining cycles were compared pair-wise Friday afternoon (PM) vs Saturday morning (AM) using a paired t-test.

The captures were further divided into migrants vs resident birds and tested as stated above. Finally, PM vs AM captures were compared for bird families and individual species for which there were at least 10 captures from 1996 to 2006. Standard deviations are not presented throughout as the total annual effort (number of mist-net hours and number of cycles per year) varied from year to year.

RESULTS

Overall, more birds (302.7 birds/year) were caught in the PM than in the AM (387.6 birds/year) captures in most of the years, 1996-2006 (Figure 1) (paired t-test, p = 0.001). Comparing residents and migrants, I found the same pattern. For resident birds, 199.1 birds/year were captured in the PM as compared to 263.4 birds/year in the AM (paired t-test, p = 0.0002). For migrants, 103.4 birds/year were captured in the PM as compared to 125.2 birds/year in the AM (paired t-test, p = 0.0453).

The comparisons by family and species are presented in Tables 1 and 2, respectively. In five of the 15 families (shown in boldface) tested more birds captured in the AM vs PM. These results proved to be misleading, as some families were monotypic (e.g Wrentits in Timaliidae) or were dominated by one species (Hermit Thrushes in Turdidae). So, Table 2 shows that in 33 of 47 species tested, AM banding captured more individuals than PM banding; however, in only eight species were the differences statistically significant.

DISCUSSION

Weather, especially temperature, has been mentioned as an important factor affecting bird activity levels and thus mist-netting success (Eyster 1954, Quinlan and Boyd 1976, Robbins 1981, Skirven 1981, Keyes and Grue 1982). At Zuma, since we band year round, we encounter a variety of weather conditions, although the conditions are relatively mild as compared to many areas. In general, it is much cooler at sunrise than at sunset with temperatures rising gradually and peaking in the early afternoon. Temperatures drop slowly in the afternoons with the local prevailing westerly winds (sea breeze), and at sunset the weather can be quite balmy. Similarly, a marine layer hugs the coast in the morning hours burning off by late morning. The rest of the day is often clear, with the marine layer returning or not in the late afternoon.

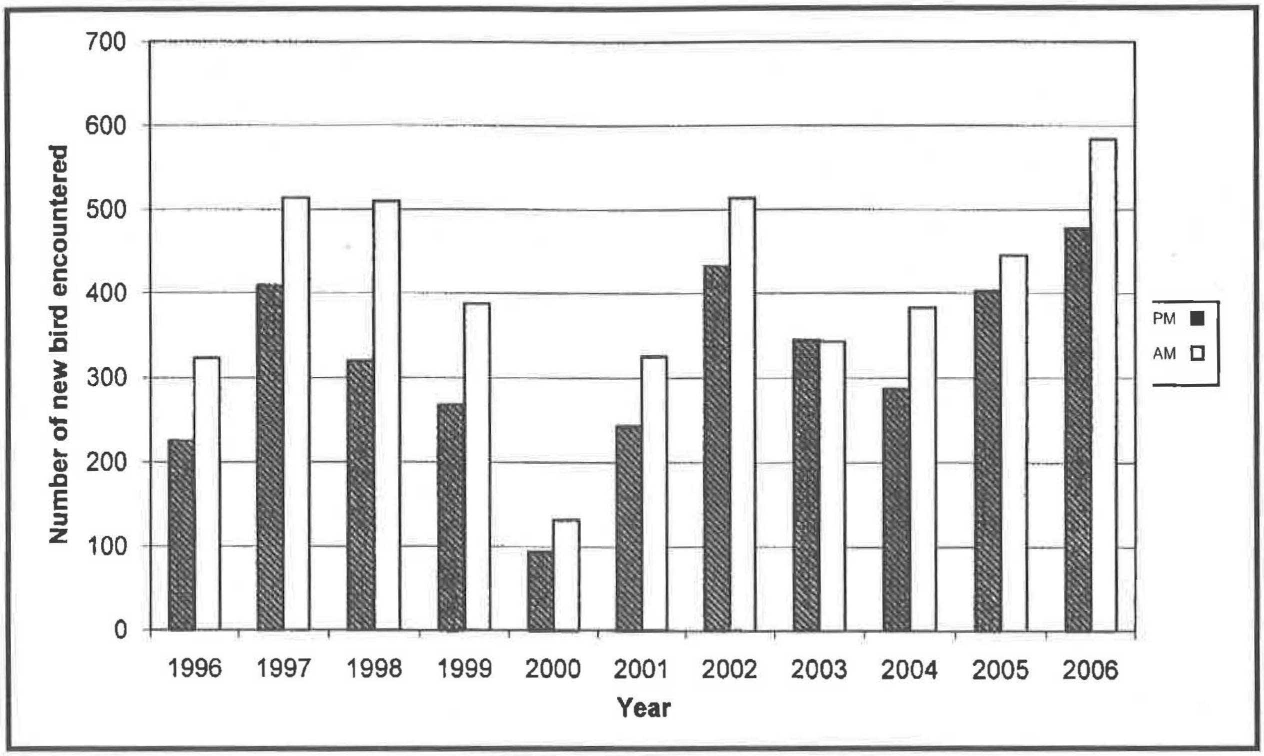
Table 1. Mean number of new birds encountered per year (1996-2006) for selected families and the respective p-values of paired t-tests.

Bird Family		Mean numbers of birds encountered per year		Paired t-test p values
		PM	AM	
Picidae	Woodpeckers	3.4	6.5	0.003
Trochilidae	Hummingbirds	20.2	21.5	0.565
Tyrannidae	Flycatchers	16.5	17.8	0.526
Troglodytidae	Wrens	14.6	20.9	0.064
Turdidae	Thrushes	21.9	21.9	1.000
Mimidae	Thrashers	7.1	11.2	0.010
Parulidae	Wood Warblers	44.5	58	0.017
Emberizidae	Sparrows	64.6	96.7	0.001
Fringillidae	Finches	24.4	29.2	0.332

Table 2. Mean number of birds encountered per year from 1996-2006 at Zuma Canyon comparing afternoon (PM) vs morning (AM) banding with p-values for paired t-tests (species with $p < 0.05$ are in bold face).

Common Name	Scientific Name	Mean Number of birds encountered per year		Paired t-test p-values
		PM	AM	
California Quail	*Callipepla californica*	1.364	0.727	0.370
Mourning Dove	*Zenaida macroura*	0.182	0.455	0.341
Downy Woodpecker	*Picoides pubescens*	0.182	1.000	0.082
Nuttall's Woodpecker	*Picoides nuttallii*	2.727	4.636	0.057
Red-shafted Flicker	*Colaptes auratus*	0.454	0.818	0.420
Black-chinned Hummingbird	*Archilochus alexandri*	0.546	1.091	0.192
Costa's Hummingbird	*Calypte costae*	1.727	1.454	0.683
Anna's Hummingbird	*Calypte anna*	10.64	12.82	0.164
Rufous Hummingbird	*Selasphorus rufus*	0.818	1.091	0.574
Allen's Hummingbird	*Selasphorus sasin*	4.181	2.909	0.190
Ash-throated Flycatcher	*Myiarchus cinerascens*	0.636	0.546	0.756
Black Phoebe	*Sayornis nigricans*	3.455	3.909	0.518
Pacific-slope Flycatcher	*Empidonax difficilis*	11.364	12.000	0.758
Willow Flycatcher	*Empidonax traillii*	0.727	0.727	1.000
Western Scrub-Jay	*Aphelocoma californica*	3.364	3.182	0.850
Hooded Oriole	*Icterus cucullatus*	1.545	1.200	0.618
Bullock's Oriole	*Icerus bullockii*	0.545	1.000	0.211
Purple Finch	*Carpodacus purpureus*	1.727	1.546	0.788
House Finch	*Carpodacus mexicanus*	14.455	20.364	0.181
Lesser Goldfinch	*Carduelis psaltria*	7.454	7.909	0.862
Gambel's White-crowned Sparrow	***Zonotrichia leucophrys gambelii***	**4.636**	**7.727**	**0.037**
Golden-crowned Sparrow	*Zonotrichia atricapilla*	7.454	10.545	0.090
Song Sparrow	***Melospiza melodia***	**19.909**	**24.455**	**0.037**
Lincoln Sparrow	*Melospiza lincolnii*	1.364	3.000	0.143
Fox Sparrow	*Passerella iliaca*	3.364	4.909	0.116
Spotted Towhee	***Pipilo maculatus***	**20.364**	**32.818**	**0.030**
California Towhee	*Pipilo crissalis*	7.000	10.636	0.823
Black-headed Grosbeak	*Pheucticus melanocephalus*	9.909	9.000	0.971
Warbling Vireo	***Vireo gilvus***	**0.182**	**1.909**	**0.048**
Hutton's Vireo	*Vireo huttoni*	0.454	0.727	0.495
Orange-crowned Warbler	*Vermivora celata*	1.636	1.727	0.925
Yellow Warbler	*Dendroica petechia*	0.364	0.727	0.258
MacGillivray's Warbler	*Oporornis tolmiei*	0.200	0.800	0.124
Audubon's Warbler	***Dendroica coronata***	**23.000**	**34.000**	**0.019**
Common Yellowthroat	*Geothlypis trichas*	14.454	16.091	0.321
Yellow-breasted Chat	*Icteria virens*	1.000	0.909	0.986
Wilson's Warbler	*Wilsonia pusilla*	3.454	3.364	0.949
Northern Mockingbird	*Mimus polyglottos*	2.364	2.546	0.819
California Thrasher	***Toxostoma redivivum***	**4.636**	**8.727**	**0.011**
Bewick's Wren	***Thryomanes bewickii***	**10.273**	**15.273**	**0.034**
House Wren	*Troglodytes aedon*	4.455	5.546	0.330
Oak Titmouse	*Baeolophus inornatus*	1.909	2.182	0.728
Wrentit	***Chamaea fasciata***	**61.636**	**79.364**	**0.0058**
Bushtit	*Psaltriparus minimus*	13.000	15.455	0.551
Ruby-crowned Kinglet	*Regulus calendula*	6.727	5.000	0.157
Swainson's Thrush	*Catharus ustulatus*	1.091	0.818	0.689
Hermit Thrush	*Catharus guttatus*	20.636	20.818	1.000

Figure 1. Mean number of birds captured during afternoon (PM) vs morning (AM) banding at Zuma Canyon from 1996-2006.



Quinlan and Boyd (1976) found that capture rates were negatively correlated with temperature, and Keyes and Grue (1982) reviewed this topic. Keyes and Grue (1982) cite two sources on mist netting success as related to time of day (Karr 1981; Robbins 1981). Even here, Karr (1981) based his findings on four sampling periods over two years in the Panamanian rain forest. One site caught more birds in the morning (0600 - 1000), another site caught more birds in the late afternoon (1400 - 1800), and the third site caught an equal number of birds during the two periods. Karr (1981) and Robbins (1981) report the effect of time of day on mist-netting captures may vary among species, as seen in Tables 1 and 2.

Okia (1976) presented capture data from 0400 - 2000 from banding efforts in Ugandan forest birds, showing a distinct bimodal activity pattern at 0800 and 1600 with a higher peak in the afternoon; however, it is not clear if this meant more birds were captured in the afternoon than in the morning hours. Robbins (1981), using a larger sample of captures, showed a high early morning peak followed by a rapid decline in captures. The late afternoon peak described by others was there but not obvious.

At Zuma Canyon, significantly fewer woodpeckers were captured in the PM as compared to the AM (Table 1). This was contrary to the findings of Robbins (1981), who reported that woodpecker captures were constant from 0800 to about 1500. For the three species of woodpeckers (Downy and Nuttall's woodpeckers *[Picoides pubescens, P. nuttalli]*, and Red-shafted Flickers *[Colaptes auratus])* analyzed in Table 2, none showed any significant difference in PM and AM captures.

Capture records found no difference between PM and AM capture of hummingbirds overall (Table 1) as well as for the five individual species (Table 2). Hilton (pers. comm.) reported the bulk of his trap captures of Ruby-throated Hummingbirds *(Archilochus colubris)* from the last week of August through mid-September were during the last two hours before sundown at Hilton Pond Center for Piedmont Natural History (York, SC). C. Robbins (pers.comm.) reports hummingbirds in winter in the tropics have a peak activity at 0800 and activity declines during the course of the day in the winter in the tropics. These differences could result from several factors including time of year, habitat, nectar availability, and species. At Zuma Canyon, Anna's Hummingbird *(Calypte anna)* is a year-

round resident, while Costa's, Rufous, and Black-chinned hummingbirds *(Calypte costae, Selasphorus rufus, Archilochus alexandri)* are migrants. In addition, in the Santa Monica Mountains there are two subspecies of Allen's Hummingbird *(Selasphorus sasin)*, one resident and one migrant.

Robbins (1981) reported activity of flycatchers and flycatching birds (e.g., American Redstarts [*Setophaga ruticillia*]) was consistent throughout the day, similar to the findings here for both the family and the species tested (Ash-throated and Pacific-slope flycatchers [*Myiarchis cinerascens, Empidonax difficillis*], and Black Phoebe [*Sayornis nigricans*]) (Tables 1 and 2).

Mueller and Berger (1966), Robbins (1981), and Deslauriers and Francis (1991) reported that thrushes and thrush-like birds (waterthrushes, ovenbirds) had peak activity in the early morning hours, although C. Robbins (pers. comm.) reports peak activity just before dark in winter in the tropics. Mueller and Berger (1966) showed a second smaller peak at 1800. Deslauriers and Francis (1991) suggested that thrushes work the litter looking for soft, moist prey in the ground and were active in the early morning hours before the ground becomes hot and dry. Probably the prey move deeper into the litter as the temperature rises and the heat dries the ground. The findings do not bear this out for Swainson's Thrushes *(Catharus ustulatus)*, a passage migrant, and Hermit Thrushes *(Catharus guttatus)*, a winter resident. It is possible that my coastally located station does not become hot and/or dry enough. California Thrashers *(Toxostoma redivivum)*, year-round residents with similar foraging behavior, were more commonly caught in the morning hours in Zuma Canyon, while another mimid, the Northern Mockingbird *(Mimus polyglottos)*, was caught equally PM vs AM.

One might expect seed-eating birds like finches and goldfinches to be active throughout the day, as their primary food items, seeds, are not affected by weather conditions. The findings support this idea, as members of the Fringillidae (Purple and House finches [*Carpodacus purpureus, C. mexicanus*], and Lesser Goldfinches [*Carduelis psaltria*]) were captured equally PM vs AM (Tables 1 and 2). Seed eaters like California Quail *(Callipepla californica)* and Mourning Dove *(Zenaida macroura)* were also captured in equal abundance PM vs AM (Table 2).

Robbins (1981) found that wood warblers had a peak of activity in the early AM. Deslauriers and Francis (1991) found that warblers, along with vireos and kinglets, peak mid-AM. Presumably, some morning warmth was necessary for the foliage insects to become active and visible to these warblers to glean. My results were mixed (see Tables 1 and 2). Gleaners such as Bushtits *(Psaltriparus minimus)*, Oak Titmice *(Baeolophus inornatus)*, and Ruby-crowned Kinglets *(Regulus calendula)* (Sibley 2002) were captured in equal frequency PM to AM (Tables 1 and 2). There were more captures of the very abundant migrant Audubon's Warblers *(Dendroica coronata)* in the AM vs the PM, but there was no difference for the common resident Common Yellowthroats *(Geothlypis trichas)* and the "other" warblers (all migrants). Audubon's Warblers were regularly seen gleaning foliage insects and moving in small flocks from one shrub to the next, as well as flycatching and sallying from taller shrubs to catch aerial prey, while Common Yellowthroats were seen mostly skulking in the chaparral shrubbery. Vireos feed arboreally on invertebrates (Sibley 2002) and are a contrast from wrens which feed on invertebrates on the ground and lower vegetation (Kennedy and White 1997, Johnson 1998). Warbling Vireos *(Vireo gilvus)* were caught more frequently in the AM; however, there was no difference for Hutton's Vireos *(Vireo huttoni)*. Similarly, Bewick's Wrens *(Thryomanes bewickii)* were caught more frequently in the AM, while there was no difference in the other common wren, the House Wren *(Troglodytes aedon)* (Table 2). So, other aspects of the behavior of these two pairs of birds are probably in play.

Omnivorous birds like Western Scrub-Jays (*Aphelocoma californica;* Sibley 2002), Northern Mockingbirds (Sibley 2002), and Black-headed Grosbeaks (*Pheucticus melanocephalus;* Hill 1995) were captured in equal frequency PM vs. AM. Feeding opportunistically on plant and animal matter, they are less affected by weather. Wrentits *(Chamaea fasciata)* are also omnivorous (Geupel and Ballard 2002), yet they exhibited the greatest difference in captures PM vs AM (Table 2). Possibly their skulking behavior in dense scrub habitat somehow explains its AM captures.

For both residents and migrants, fewer birds were captured during the PM hours as compared to the AM hours. Yet, when the findings were broken down by taxa, no pattern emerged (Table 2). Six emberizids were analyzed, three migrants (Gambel's White-crowned, Golden-crowned, and Fox sparrows [*Zonotrichia leucophrys gambelii, Z. atricapilla, Passerella iliaca*]) and three residents (Song Sparrows, California and Spotted towhees [*Melospiza melodia, Pipilo crissalis, P. maculatus*]). PM captures were not always fewer than AM captures (Table 2). Other factors such as foraging behavior may be involved in all of these birds.

Regardless of the findings, there are certain practicalities that favor banding in the AM vs the PM. Removing birds from mist nets is certainly easier during daylight hours as compared to sunset or dusk, as my banders typically worked with headlamps at sunset. Similarly, ageing and sexing of birds is easier to do in natural sunlight vs by flashlight or lantern. It is easier to take down mist nets during daylight hours compared sunset or dusk. Zuma Canyon is the trail head for hikes into the canyon. AM banding has less human, canine, and equestrian traffic, as visitors tend not to start arriving until the late morning but continue to trek through the canyon until dusk (pers. observ.). Dog traffic has recently been shown to reduce bird activity (Banks and Bryant 2007). PM banding has also allowed us to capture a few birds that we would not otherwise capture in AM banding. These were a rare Common Poorwill *(Phalaenoptilus [Chordeiles] nuttallii)* or Western Screech-Owl *(Megascops kennicottii).* However, in looking at rare birds (birds captured only once at Zuma Canyon), 12 of the 14 species were captured during AM banding.

It is likely that we will continue the existing protocol for the foreseeable future. One other benefit of our protocol is its flexibility. Volunteers who can come in the afternoons are able to come on Fridays, while those who are free to come in the morning hours come on Saturdays.

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