

A Comparison of Bird Use
at the Mayacamas Mountains Audubon Sanctuary
Before and After the September 2004 Fire

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BACKGROUND

Volunteers from the Madrone Audubon Society, in Santa Rosa, CA, conducted bird surveys at the Mayacamas Mountains Audubon Sanctuary (MMAS) from 1996 through 2006. The surveys were based on the “Area Search” protocol developed for volunteer-based nationwide surveys in Australia (Ambrose 1989. RAOU Newsletter, Royal Australasian Ornithologists Union. 80:1-2) and followed instructions provided by PRBO Conservation Science. Field methods involved 20-minute searches of several habitat-specific survey areas: chaparral, forest, grassland, mixed habitat, oak woodland, riparian. Because the areal extents of survey areas were unspecified (varying in size from approximately one to three ha.; Figure 1), the count data provide general information on bird abundances but cannot be used to determine bird densities. Field instructions provided to field observers are attached (Appendix).

Additional, detailed information on habitat types, field methods, survey areas, project coordinators, and field observers is available in the project files, at the Cypress Grove Research Center of Audubon Canyon Ranch. Courtney Fischer provided crucial help with data entry and review.

DATA ANALYSIS

Because of the small survey areas and the limited (20-minute) duration of individual counts, the number of species observed on individual counts was generally small, leading to highly skewed (non-normal) abundance distributions for individual species. Consequently, neither mean nor median values for species abundances could be used to evaluate the extent of bird use or to compare bird use before and after the fire. Therefore, I converted the count data to rank values for each species, calculated across all groupings of the data, and used Mann-Whitney tests to measure differences in rank sums before and after the fire. This nonparametric approach tests for differences in “location” (mean rank bird abundance) and is analogous to using t-tests in parametric analyses. In addition, for each species, I reported the maximum and median number of birds detected within the 20-minute survey-area counts, before and after the fire. To provide more general information on bird use, I included two calculated variables in the analyses:

total number of birds (across all species) and species (species richness) detected in each 20-minute count.

Bird counts were conducted in all months and analyzed within four seasons: breeding (April-June); summer (July-August); fall (September-October); winter (November-March). The number of counts conducted annually was 114 (1996), 90 (1997), 150 (1998), 123 (1999), 18 (2000), 29 (2004), 177 (2005, and 89 (2006). The percent of counts conducted in each habitat type was similar before and after the fire, with the exception of riparian areas (Table 1). Therefore, to provide a general assessment of changes in bird use at MMAS before and after the fire, I pooled the data across habitat types and years within pre- and post-fire periods to summarize the results and test for associated differences in overall bird use. Increased survey effort in riparian areas after the fire suggests a possible conservative bias that might mask subtle declines in riparian species, but inferences based on significant declines (suggesting adverse effects of the fire) would be strengthened.

Interpretation of results based on rank data

Because the bird data were not adequate for analysis of raw counts (see above), differences in bird use could not be detected or understood by simply comparing the average number of birds observed, or even by comparing the median number of birds (half of counts higher and half lower). This constraint is illustrated in the tables of results by the frequent appearance of zero-values for the median number of birds counted before and after the fire. Therefore, comparisons of bird use were evaluated by converting the bird counts to ranks, such that the lowest bird count for each species among all observations before and after the fire (within each season) was converted to a 1, the second lowest to a 2, and so on. Tied counts were given an average rank value so that the highest rank for each species was equal to the total number of counts conducted in that season.

Comparisons were then made by testing for differences between mean ranks before and after the fire. Mean ranks for each species were calculated separately for periods before and after the fire, by summing the rank values and dividing each sum by the number of counts. Therefore, the magnitude of a particular mean rank does not reflect the absolute abundance of birds—but it does reflect the relative ranking of bird use before or after the fire. In addition, mean ranks are not larger for more abundant species (or smaller for rare species)—they simply reveal relative bird use when ranks are averaged for each of the “before fire” or “after fire” groups. Thus, differences in mean ranks can be used to “rank” bird use before vs. after the fire. Statistical tests evaluate whether the differences in mean ranks before and after the fire are large enough that there is less than a 5% likelihood that they could have occurred by random chance. Such differences are assumed to significantly reflect the effects of the fire.

SUMMARY OF RESULTS

Most of the significant changes in seasonal mean abundance ranks suggested increases in bird use after the fire (Tables 2-5). This is not surprising because many bird species benefit from the habitat effects of fire and the associated recovery of vegetation. Relatively few bird species declined significantly after the fire; those species may have declined because of fire-related habitat alteration or loss.

The total number of birds (across all species) and the number of species (species richness) within each count increased significantly in the period after the fire, in all seasons except summer (Tables 2-5). The significant declines in species richness and the number of birds detected during summer suggest fire-related declines in the persistence of breeding-season habitat values during summer. Alternatively, however, significant post-fire declines in summer bird use might reflect underlying seasonal factors unrelated to the fire, such as differences in summer climate or the intraseasonal timing of counts in relation to the timing of post-breeding dispersal and molt.

For most species, differences in seasonal abundance before and after the fire were not detectable, given the data (Tables 2-5). The lack of significant detectable change may reflect stable abundances between pre- and post-fire periods (within seasons), possibly related to individual fidelity to familiar habitat areas, or, alternatively—and likely given the data—a considerable lack of precision needed to detect a change. This lack of precision is a consequence of a limited number of counts, the small size of survey areas, short duration of count periods, differences in sampling effort among habitat types, observer variation, annual differences in abundance among years (within the before-fire and after-fire count periods), differences in intraseasonal timing of counts, and other factors. A more intensive analysis to account for fire effects within habitat types and sampling variation among habitats might be valuable.

In presenting these results, I emphasize that bird use is typically dynamic over time and suggested differences associated with the 2004 fire at MMAS might reflect other, underlying effects. Such effects could include ecological or population processes that occur at larger or smaller spatial scales, unrelated to the fire, such as insect (prey) dynamics or large-scale changes in bird population size.

Table 1. Percent counts by habitat type within seasons, before and after the fire, and total number of counts (*n*) by habitat type, within seasons.

	Before-fire percent	After-fire percent	<i>n</i>
<u>Breeding</u>			
Chaparral	15	12	37
Forest	17	15	42
Grassland	26	21	64
Mixed habitat	7	0	12
Oak woodland	11	11	28
Riparian	21	39	67
Serpentine	3	3	8
<u>Total</u>	<u>100</u>	<u>100</u>	<u>258</u>
<u>Summer</u>			
Chaparral	11	11	14
Forest	16	13	19
Grassland	27	17	30
Mixed habitat	7	0	6
Oak woodland	11	9	13
Riparian	23	46	40
Serpentine	4	4	5
<u>Total</u>	<u>100</u>	<u>100</u>	<u>127</u>
<u>Fall</u>			
Chaparral	13	8	11
Forest	18	15	17
Grassland	28	21	25
Mixed habitat	7	0	4
Oak woodland	10	10	10
Riparian	20	41	28
Serpentine	3	5	4
<u>Total</u>	<u>100</u>	<u>100</u>	<u>99</u>
<u>Winter</u>			
Chaparral	15	10	38
Forest	19	15	52
Grassland	27	24	79
Mixed habitat	8	0	14
Oak woodland	11	11	34
Riparian	16	36	77
Serpentine	3	4	12
<u>Total</u>	<u>100</u>	<u>100</u>	<u>307</u>

MMAS Bird survey results: Winter (November-March)

Variable	Mann-Whitney tests				Change in rank abundance	Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Species richness	153	155	0.02	0.88		6	6	19	16
Total birds	156	152	0.13	0.71		16	17	192	132
Acorn Woodpecker	154	154	0.00	0.99					
American Crow	154	155	0.11	0.74		0	0	32	3
American Kestrel	154	154	0.03	0.87		0	0	1	2
American Robin	154	154	0.00	0.97		0	0	150	120
Anna's Hummingbird	164	142	10.10	0.00		0	0	4	2
Belted Kingfisher	153	155	2.56	0.11		0	0	0	1
Bewick's Wren	155	152	0.36	0.55		0	0	5	3
Brown-headed Cowbird	154	154	0.78	0.38		0	0	1	0
Black Phoebe	151	158	2.15	0.14		0	0	2	1
Brewer's Blackbird	155	153	2.37	0.12		0	0	2	0
Brown Creeper	153	155	0.18	0.67		0	0	3	2
Band-tailed Pigeon	160	147	8.97	0.00	Decrease	0	0	65	40
Burrowing Owl	155	153	1.57	0.21		0	0	1	0
California Quail	154	154	0.14	0.70		0	0	10	2
California Thrasher	156	152	3.98	0.046	Decrease	0	0	2	0
Californis Towhee	160	146	6.63	0.01	Decrease	0	0	3	3
Chestnut-backed Chickadee	152	157	0.76	0.38		0	0	30	10
Cedar Waxwing	155	152	0.65	0.42		0	0	30	50
Common Bushtit	158	149	4.10	0.04	Decrease	0	0	20	18
Cooper's Hawk	154	154	0.06	0.81		0	0	1	1
Common raven	150	159	1.86	0.17		0	0	3	5
Dark-eyed Junco	150	159	0.74	0.39		0	1	40	56
Downy Woodpecker	153	156	0.61	0.43		0	0	1	4
Eoropean Starling	155	153	0.10	0.75		0	0	18	9
Fox Sparrow	158	149	4.49	0.03	Decrease	0	0	34	2
Golden-crowned Kinglet	157	150	4.75	0.03	Decrease	0	0	12	12
Gcolden-crowned Sparrow	157	151	1.98	0.16		0	0	15	7
Grasshopper Sparrow	154	154	0.78	0.38		0	0	1	0
Hairy Woodpecker	140	172	30.79	0.00	Increase	0	0	2	7
Hermit Thrush	155	153	0.08	0.77		0	0	6	4
House Finch	152	156	2.18	0.14		0	0	2	3
House Wren	151	158	6.27	0.01	Increase	0	0	1	2
Hummingbird species	154	155	1.27	0.26		0	0	0	1
Hutton's Vireo	156	152	0.36	0.55		0	0	5	4
Lark sparrow	156	152	3.98	0.046	Decrease	0	0	2	0
Lesser Goldfinch	149	160	4.91	0.03	Increase	0	0	10	16
Lincoln sparrow	149	161	14.48	0.00	Increase	0	0	0	5
Mallard	154	154	0.03	0.86		0	0	2	2
Merlin	153	155	2.56	0.11		0	0	0	1
Mourning Dove	153	156	1.16	0.28		0	0	1	5
Mountain Quail	153	155	0.49	0.48		0	0	2	2
Northern Flicker	145	166	5.86	0.02	Increase	0	0	3	4
Northern Harrier	155	153	2.37	0.12		0	0	1	0
Northern Pygmy Owl	151	158	4.81	0.03	Increase	0	0	2	2
Nuttalls' Woodpecker	145	166	14.70	0.00	Increase	0	0	2	5
Oak Titmouse	150	159	2.08	0.15		0	0	5	6
Orange-crowned Warbler	157	150	3.55	0.06	Decrease	0	0	4	3
Pine Siskin	154	155	1.27	0.26		0	0	0	10
Pileated Woodpecker	154	154	0.03	0.87		0	0	2	2
Pacific Slope Flycatcher	155	153	1.57	0.21		0	0	2	0
Purple Finch	151	158	3.44	0.06	Increase	0	0	6	18
Ring-billed Gull	154	154	0.78	0.38		0	0	10	0
Red-breasted Nuthatch	149	160	6.12	0.01	Increase	0	0	7	5

MMAS Bird survey results: Winter (November-March) -- continued

Variable	Mann-Whitney tests				Change in rank abundance	Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Red-breasted Sapsucker	154	154	0.01	0.93		0	0	3	1
Ruby-crowned Kinglet	160	146	2.76	0.10		0	0	12	12
Rufous-crowned Sparrow	154	154	0.00	0.98		0	0	3	2
Red Crossbill	154	155	1.27	0.26		0	0	0	24
Rock Wren	155	153	1.57	0.21		0	0	1	0
Red-shouldered Hawk	152	156	1.01	0.31		0	0	2	1
Red-tailed Hawk	152	156	0.35	0.55		0	0	2	2
Red-winged Blackbird	154	154	0.05	0.82		0	0	39	8
Say's Phoebe	154	154	0.03	0.86		0	0	1	1
Savannah Sparrow	154	154	0.03	0.86		0	0	7	3
Song Sparrow	147	163	12.77	0.00	Increase	0	0	2	7
Spotted Towhee	163	143	9.11	0.00	Decrease	0	0	4	4
Sharp-shinned Hawk	153	156	3.85	0.050	Increase	0	0	0	1
Steller's Jay	144	166	6.24	0.01	Decrease	0	0	14	5
Townsend's Warbler	154	154	0.09	0.77		0	0	2	2
Tree Swallow	153	155	1.59	0.21		0	0	2	2
Turkey Vulture	152	157	1.61	0.20		0	0	4	5
Varied Thrush	158	149	3.48	0.06	Decrease	0	0	14	3
Violet-green Swallow	153	156	1.20	0.27		0	0	3	20
Warbling Vireo	155	153	1.57	0.21		0	0	2	0
White-breasted Nuthatch	151	157	1.31	0.25		0	0	4	4
White-crowned Sparrow	154	154	0.14	0.70		0	0	3	1
Western Bluebird	159	148	2.45	0.12		0	0	10	18
Western Kingbird	154	154	0.00	1.00		0	0	0	0
Western Meadowlark	158	149	2.04	0.15		0	0	8	40
Western Screech Owl	154	155	1.27	0.26		0	0	0	1
Wild Turkey	153	155	2.56	0.11		0	0	0	15
Winter Wren	154	154	0.01	0.91		0	0	1	2
Wrentit	163	142	14.86	0.00	Decrease	0	0	4	1
Western Scrub Jay	165	140	11.39	0.00	Decrease	0	0	6	5
White-tailed Kite	154	154	0.03	0.85		0	0	4	3
Yellow-rumped Warbler	156	151	1.23	0.27		0	0	17	1

MMAS Bird survey results: Breeding season (April-June)

Variable	Mann-Whitney tests					Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Species richness	119	156	13.6	0.00	Increase	9	11	19	27
Total birds	119	156	13.3	0.00	Increase	16	20	62	64
Acorn Woodpecker	123	145	6.9	0.01	Increase	0	0	7	6
Allen's Hummingbird	130	129	0.4	0.52		0	0	1	0
American Crow	128	133	1.4	0.24		0	0	3	6
American Goldfinch	130	128	0.5	0.49		0	0	4	1
American Kestrel	128	134	1.7	0.20		0	0	3	2
American Robin	122	147	8.7	0.00	Increase	0	0	4	6
Anna's Hummingbird	131	126	0.4	0.52		0	0	4	2
Ash-throated Flycatcher	129	131	0.1	0.71		0	0	5	2
Barn Swallow	130	129	0.4	0.52		0	0	2	0
Bewick's Wren	130	128	0.1	0.72		0	0	3	2
Blue-gray Gnatcatcher	133	121	7.9	0.00	Decrease	0	0	5	0
Brown-headed Cowbird	129	130	0.1	0.80		0	0	1	2
Black-headed Grosbeak	117	159	26.2	0.00	Increase	0	1	3	5
Black Phoebe	132	124	1.6	0.20		0	0	3	1
Brewer's Blackbird	128	134	2.2	0.14		0	0	2	9
Brown Creeper	130	129	0.0	0.84		0	0	3	3
Black-throated Gray Warbler	128	133	1.0	0.33		0	0	3	4
Band-tailed Pigeon	129	131	0.6	0.42		0	0	8	8
Bullock's Oriole	127	136	6.8	0.01	Increase	0	0	2	2
California Quail	125	141	9.9	0.00	Increase	0	0	6	7
California Thrasher	130	128	1.7	0.20		0	0	2	0
Californis Towhee	134	119	4.5	0.03	Decrease	0	0	6	4
Cassin's Vireo	129	132	0.1	0.70		0	0	6	6
Chestnut-backed Chickadee	130	129	0.0	0.89		0	0	7	5
Cedar Waxwing	130	128	1.2	0.27		0	0	14	0
Chipping Sparrow	129	132	0.6	0.44		0	0	2	2
Cliff Swallow	129	131	2.0	0.15		0	0	5	2
Common Bushtit	132	124	2.6	0.10		0	0	20	3
Cooper's Hawk	130	129	0.0	0.85		0	0	1	1
Common raven	129	130	0.0	0.98		0	0	3	3
Double-crested Cormorant	129	130	0.4	0.51		0	0	1	4
Dark-eyed Junco	125	141	3.2	0.07		0	0	10	7
Downy Woodpecker	129	132	0.6	0.44		0	0	2	2
Eropean Starling	130	129	0.0	0.99		0	0	60	11
Fox Sparrow	129	130	0.4	0.52		0	0	2	1
Gcolder-crowned Sparrow	129	130	0.0	0.87		0	0	6	3
Golden Eagle	130	129	0.4	0.52		0	0	1	0
Grasshopper Sparrow	130	129	0.4	0.52		0	0	1	0
Hairy Woodpecker	121	150	20.5	0.00	Increase	0	0	2	4
Hermit Thrush	130	128	1.2	0.27		0	0	1	0
House Finch	129	131	0.7	0.40		0	0	2	3
House Wren	123	145	13.5	0.00	Increase	0	0	2	5
Hummingbird species	131	127	2.5	0.11		0	0	1	0
Hutton's Vireo	133	120	3.6	0.06	Decrease	0	0	3	2
Lazuli Bunting	118	157	27.9	0.00	Increase	0	0	4	4
Lark sparrow	131	125	3.8	0.051	Decrease	0	0	2	0
Lesser Goldfinch	128	134	0.7	0.40		0	0	9	10
Lincoln sparrow	129	130	0.0	0.86		0	0	1	2
Mallard	128	133	4.1	0.04	Increase	0	0	2	3
Mourning Dove	121	149	12.6	0.00	Increase	0	0	3	8
Mountain Quail	121	149	22.1	0.00	Increase	0	0	2	3
Nashville Warbler	130	128	1.7	0.20		0	0	1	0
Northern Flicker	124	142	7.8	0.01	Increase	0	0	2	3
Northern Pygmy Owl	130	128	0.2	0.64		0	0	2	1
Northern Rough-winged Swallow	131	127	2.1	0.15		0	0	6	0

MMAS Bird survey results: Breeding season (April-June) -- continued

Variable	Mann-Whitney tests					Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Nuttalls' Woodpecker	127	136	3.5	0.06	Increase	0	0	2	1
Oak Titmouse	126	137	3.2	0.07	Increase	0	0	4	5
Orange-crowned Warbler	133	120	2.2	0.14		0	0	6	3
Olive-sided Flycatcher	127	136	3.7	0.053	Increase	0	0	2	2
Pine Siskin	130	129	0.4	0.52		0	0	1	0
Pileated Woodpecker	129	132	0.4	0.52		0	0	2	3
Pacific Slope Flycatcher	128	132	0.2	0.64		0	0	7	4
Purple Finch	125	141	7.1	0.01	Increase	0	0	5	4
Purple Martin	126	137	13.5	0.00	Increase	0	0	4	3
Pygmy Nuthatch	129	131	2.4	0.12		0	0	0	1
Red-breasted Nuthatch	126	139	10.4	0.00	Increase	0	0	2	3
Ruby-crowned Kinglet	131	126	1.8	0.18		0	0	2	2
Rufous-crowned Sparrow	130	128	0.4	0.51		0	0	3	7
Red Crossbill	129	131	2.4	0.12		0	0	0	7
Rock Wren	129	132	4.9	0.03	Increase	0	0	0	2
Red-tailed Hawk	130	128	0.1	0.75		0	0	3	1
Red-winged Blackbird	128	132	1.3	0.25		0	0	4	2
Song Sparrow	124	143	22.9	0.00	Increase	0	0	1	4
Spotted Towhee	130	129	0.0	1.00		0	0	5	4
Sharp-shinned Hawk	130	129	0.2	0.65		0	0	1	1
Steller's Jay	116	162	28.2	0.00	Increase	0	1	5	10
Townsend's Warbler	130	129	0.0	0.85		0	0	4	2
Tree Swallow	130	129	0.0	0.96		0	0	3	1
Turkey Vulture	125	140	4.4	0.04	Increase	0	0	4	5
Vaux's Swift	130	129	0.4	0.52		0	0	1	0
Varied Thrush	130	129	0.8	0.36		0	0	2	0
Violet-green Swallow	123	145	9.3	0.00	Increase	0	0	5	12
Warbling Vireo	132	123	1.4	0.24		0	0	6	4
White-breasted Nuthatch	123	145	10.9	0.00	Increase	0	0	6	3
Western Bluebird	133	122	2.3	0.13		0	0	4	2
Western Kingbird	129	131	0.7	0.41		0	0	2	3
Western Meadowlark	129	131	0.1	0.78		0	0	7	2
Western Tanager	124	142	5.7	0.02	Increase	0	0	2	5
Wild Turkey	125	139	11.1	0.00	Increase	0	0	2	6
Wilson's Warbler	129	130	0.0	0.97		0	0	2	1
Winter Wren	131	127	2.5	0.11		0	0	3	0
Wrentit	136	113	15.4	0.00	Decrease	0	0	5	0
Western Scrub Jay	139	107	15.0	0.00	Decrease	0	0	6	4
White-tailed Kite	130	128	1.2	0.27		0	0	1	0
Western Wood Pewee	126	138	13.7	0.00	Increase	0	0	1	3
Yellow-rumped Warbler	132	123	4.8	0.03	Decrease	0	0	7	1
Yellow Warbler	130	129	0.4	0.52		0	0	1	0

MMAS Bird survey results: Summer (July-August)

Variable	Mann-Whitney tests					Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Species richness	58	75	6.3	0.01	Increased	6	9	20	21
Total birds	57	77	8.4	0.00	Increased	13	23	63	115
Acorn Woodpecker	60	70	3.0	0.08		0	0	9	6
Allen's Hummingbird	64	64	0.2	0.68		0	0	1	2
American Crow	64	63	0.2	0.69		0	0	8	9
American Goldfinch	65	63	1.1	0.28		0	0	1	0
American Kestrel	64	64	0.0	0.87		0	0	3	2
American Robin	60	71	4.8	0.03	Increased	0	0	19	18
Anna's Hummingbird	70	54	11.0	0.00	Decreased	0	0	3	1
Ash-throated Flycatcher	61	70	6.0	0.01	Increased	0	0	2	4
Barn Swallow	64	65	1.8	0.18		0	0	0	3
Belted Kingfisher	64	64	0.6	0.45		0	0	1	0
Bewick's Wren	65	63	0.2	0.68		0	0	3	2
Blue-gray Gnatcatcher	67	60	5.4	0.02	Decreased	0	0	3	0
Brown-headed Cowbird	64	64	0.6	0.45		0	0	1	0
Black-headed Grosbeak	62	68	3.0	0.09		0	0	2	3
Black Phoebe	60	70	5.6	0.02	Increased	0	0	3	2
Brewer's Blackbird	64	65	1.8	0.18		0	0	0	2
Brown Creeper	64	64	0.0	0.87		0	0	2	2
Black-throated Gray Warbler	66	61	4.2	0.04		0	0	2	0
Band-tailed Pigeon	64	64	0.6	0.45		0	0	1	0
Bullock's Oriole	64	64	0.6	0.45		0	0	1	0
California Quail	63	66	0.9	0.36		0	0	14	8
California Thrasher	65	63	1.1	0.28		0	0	1	0
Californis Towhee	68	56	7.2	0.01	Decreased	0	0	6	1
Cassin's Vireo	66	60	2.5	0.11		0	0	3	1
Chestnut-backed Chickadee	64	64	0.0	0.96		0	0	20	4
Chipping Sparrow	63	66	1.3	0.25		0	0	2	4
Common Bushtit	67	58	5.4	0.02	Decreased	0	0	20	8
Cooper's Hawk	65	63	1.1	0.28		0	0	3	0
Common raven	63	66	1.4	0.23		0	0	3	3
Dark-eyed Junco	60	70	2.7	0.10		0	0	17	30
Downy Woodpecker	62	67	1.3	0.26		0	0	1	2
Fox Sparrow	64	65	1.8	0.18		0	0	0	1
Golden-crowned Kinglet	64	64	0.6	0.45		0	0	1	0
Golden-crowned Sparrow	64	64	0.0	1.00		0	0	0	0
Great-horned Owl	64	64	0.6	0.45		0	0	1	0
Golden Eagle	64	65	1.8	0.18		0	0	0	2
Hairy Woodpecker	59	74	11.7	0.00	Increased	0	0	2	4
Hermit Thrush	64	65	1.8	0.18		0	0	0	1
Hermit Warbler	64	64	0.6	0.45		0	0	6	0
House Finch	63	66	2.6	0.11		0	0	10	6
House Wren	57	76	16.3	0.00	Increased	0	0	5	6
Hutton's Vireo	68	57	5.0	0.03	Decreased	0	0	4	1
Lazuli Bunting	61	70	4.9	0.03	Increased	0	0	2	12
Lesser Goldfinch	59	74	6.6	0.01	Increased	0	0.5	25	12
Lincoln sparrow	64	65	1.8	0.18		0	0	0	1
Mourning Dove	63	65	0.1	0.71		0	0	5	4
Mountain Quail	63	65	1.2	0.26		0	0	1	1
Nashville Warbler	64	64	0.6	0.45		0	0	1	0
Northern Flicker	59	73	7.9	0.01	Increased	0	0	2	3
Northern Harrier	64	64	0.0	1.00		0	0	0	0
Northern Pygmy Owl	64	64	0.2	0.68		0	0	1	2
Northern Rough-winged Swallow	63	66	3.5	0.06		0	0	0	20
Nuttalls' Woodpecker	62	67	1.9	0.17		0	0	1	1
Oak Titmouse	63	66	0.5	0.49		0	0	3	5
Orange-crowned Warbler	64	64	0.0	0.84		0	0	1	1

MMAS Bird survey results: Summer (July-August) -- continued

Variable	Mann-Whitney tests					Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Olive-sided Flycatcher	63	66	1.6	0.21		0	0	2	2
Pileated Woodpecker	65	62	1.5	0.22		0	0	2	1
Pacific Slope Flycatcher	66	60	1.5	0.21		0	0	3	3
Purple Finch	59	73	11.7	0.00	Increased	0	0	5	7
Purple Martin	62	68	5.8	0.02	Increased	0	0	3	2
Red-breasted Nuthatch	62	68	3.6	0.06	Increased	0	0	4	2
Rufous-crowned Sparrow	63	65	1.2	0.26		0	0	1	2
Red Crossbill	64	65	1.8	0.18		0	0	0	1
Red-shouldered Hawk	64	64	0.2	0.68		0	0	1	1
Red-tailed Hawk	61	68	4.9	0.03	Increased	0	0	3	1
Song Sparrow	61	69	8.0	0.00	Increased	0	0	1	8
Spotted Towhee	61	69	1.8	0.18		0	0	5	5
Sharp-shinned Hawk	64	65	1.8	0.18		0	0	0	1
Steller's Jay	59	74	6.4	0.01	Increased	0	1	7	7
Swainson's Thrush	64	65	1.8	0.18		0	0	0	1
Townsend's Warbler	65	63	1.7	0.19		0	0	2	0
Tree Swallow	65	63	1.1	0.28		0	0	4	0
Turkey Vulture	61	69	6.7	0.01	Increased	0	0	4	6
Vaux's Swift	64	64	0.2	0.68		0	0	1	1
Violet-green Swallow	55	80	29.5	0.00	Increased	0	0	7	82
Warbling Vireo	66	60	3.6	0.06	Decreased	0	0	3	5
White-breasted Nuthatch	60	71	4.8	0.03	Increased	0	0	4	6
Western Bluebird	61	69	2.9	0.09		0	0	10	6
Western Kingbird	64	64	0.6	0.45		0	0	2	0
Western Meadowlark	63	65	0.6	0.42		0	0	8	7
Western Screech Owl	64	64	0.6	0.45		0	0	1	0
Western Tanager	64	64	0.0	0.92		0	0	2	2
Wild Turkey	64	64	0.6	0.45		0	0	10	0
Wilson's Warbler	64	64	0.0	0.98		0	0	2	1
Winter Wren	64	64	0.6	0.45		0	0	2	0
Wrentit	69	56	10.3	0.00	Decreased	0	0	5	0
Western Scrub Jay	67	58	3.5	0.06	Decreased	0	0	9	4
White-tailed Kite	64	64	0.2	0.68		0	0	1	2
White-Throated Sparrow	64	64	0.0	1.00		0	0	0	0
Western Wood Pewee	62	68	7.2	0.01	Increased	0	0	0	2
Yellow-rumped Warbler	64	64	0.0	0.90		0	0	6	1
Yellow Warbler	64	64	0.2	0.68		0	0	1	1

MMAS Bird survey results: Fall (September-October)

Variable	Mann-Whitney tests					Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Species richness	42	62	11.9	0.00	Increased	7	10	19	22
Total birds	43	61	10.2	0.00	Increased	15	30	66	91
Acorn Woodpecker	48	53	1.0	0.33		0	0	7	9
American Crow	51	48	2.7	0.10		0	0	2	0
American Goldfinch	51	49	2.0	0.16		0	0	1	0
American Kestrel	52	46	3.0	0.08		0	0	2	1
American Robin	48	52	0.7	0.39		0	0	25	25
Anna's Hummingbird	50	50	0.0	0.87		0	0	1	1
Belted Kingfisher	50	50	0.1	0.77		0	0	2	1
Bewick's Wren	50	49	0.1	0.79		0	0	2	3
Blue-gray Gnatcatcher	50	51	1.5	0.21		0	0	0	1
Black-headed Grosbeak	50	51	1.5	0.21		0	0	0	1
Black Phoebe	48	53	3.2	0.07	Increased	0	0	1	1
Brewer's Blackbird	50	50	0.6	0.42		0	0	1	0
Brown Creeper	50	50	0.0	0.93		0	0	3	2
Black-throated Gray Warbler	49	52	1.0	0.32		0	0	3	1
Band-tailed Pigeon	50	50	0.0	0.92		0	0	40	40
California Quail	50	49	0.1	0.73		0	0	15	25
California Thrasher	50	50	0.6	0.42		0	0	1	0
Californis Towhee	48	52	1.2	0.27		0	0	2	3
Chestnut-backed Chickadee	50	50	0.0	0.84		0	0	7	5
Cedar Waxwing	51	49	1.3	0.25		0	0	12	0
Chipping Sparrow	50	50	0.1	0.75		0	0	2	4
Common Bushtit	50	50	0.0	0.88		0	0	18	8
Cooper's Hawk	50	51	1.5	0.21		0	0	0	1
Common raven	48	53	1.9	0.17		0	0	2	2
Common Yellowthroat	50	51	1.5	0.21		0	0	0	1
Dark-eyed Junco	49	52	0.2	0.64		2	2	20	38
Downy Woodpecker	47	55	4.9	0.03	Increased	0	0	1	3
Eropean Starling	50	50	0.0	0.83		0	0	8	3
Fox Sparrow	51	49	2.0	0.16		0	0	1	0
Golden-crowned Kinglet	50	50	0.1	0.76		0	0	2	2
Gcouden-crowned Sparrow	46	57	8.7	0.00	Increased	0	0	15	14
Golden Eagle	50	50	0.1	0.75		0	0	1	1
Hairy Woodpecker	45	57	9.1	0.00	Increased	0	0	1	4
Hermit Thrush	48	53	2.3	0.13		0	0	2	5
House Finch	50	50	0.0	0.85		0	0	1	4
House Wren	44	60	22.7	0.00	Increased	0	0	0	2
Hutton's Vireo	51	49	0.5	0.49		0	0	2	2
Lazuli Bunting	50	51	1.5	0.21		0	0	0	2
Lark sparrow	50	51	1.5	0.21		0	0	0	2
Lesser Goldfinch	51	49	0.1	0.73		0	0	12	24
Lewis's Woodpecker	50	51	1.5	0.21		0	0	0	1
Lincoln sparrow	46	56	13.2	0.00	Increased	0	0	0	6
Merlin	50	51	1.5	0.21		0	0	0	1
Mourning Dove	50	51	1.5	0.21		0	0	0	3
Northern Flicker	47	55	2.5	0.11		0	0	3	3
Northern Pygmy Owl	50	51	0.2	0.66		0	0	1	1
Nuttalls' Woodpecker	48	54	3.2	0.07	Increased	0	0	1	2
Oak Titmouse	47	55	4.5	0.03	Increased	0	0	2	5
Orange-crowned Warbler	51	49	1.3	0.25		0	0	1	0
Olive-sided Flycatcher	50	50	0.6	0.42		0	0	1	0
Pine Siskin	49	52	3.1	0.08		0	0	0	20
Pileated Woodpecker	48	54	4.8	0.03	Increased	0	0	1	1
Purple Finch	47	55	8.6	0.00	Increased	0	0	1	7
Purple Martin	50	51	1.5	0.21		0	0	0	8
Red-breasted Nuthatch	48	53	1.9	0.17		0	0	3	2
Red-breasted Sapsucker	49	52	2.3	0.13		0	0	1	1
Ruby-crowned Kinglet	45	58	8.2	0.00	Increased	0	0	10	18
Rufous-crowned Sparrow	50	50	0.6	0.42		0	0	1	0

MMAS Bird survey results: Fall (September-October) -- continued

Variable	Mann-Whitney tests					Plot counts			
	Mean rank before fire	Mean rank after fire	Approx X^2	P		Median before	Median after	Maximum before	Maximum after
Red Crossbill	50	50	0.6	0.42		0	0	6	0
Rock Wren	50	51	1.5	0.21		0	0	0	1
Red-shouldered Hawk	51	49	0.8	0.36		0	0	1	1
Red-tailed Hawk	50	51	0.2	0.69		0	0	1	3
Red-winged Blackbird	50	50	0.6	0.42		0	0	1	0
Savannah Sparrow	48	53	3.5	0.06	Increased	0	0	12	2
Song Sparrow	46	56	11.9	0.00	Increased	0	0	1	4
Spotted Towhee	52	47	1.2	0.28		0	0	2	2
Steller's Jay	51	49	0.1	0.78		0.5	0	7	6
Townsend's Warbler	48	54	8.0	0.00		0	0	0	2
Tree Swallow	50	50	0.6	0.42		0	0	1	0
Turkey Vulture	50	50	0.6	0.42		0	0	1	0
Varied Thrush	48	53	3.7	0.06	Increased	0	0	1	3
Violet-green Swallow	47	55	8.2	0.00	Increased	0	0	20	30
Warbling Vireo	51	49	1.3	0.25		0	0	1	0
White-breasted Nuthatch	48	53	1.9	0.16		0	0	2	3
White-crowned Sparrow	50	51	0.3	0.61		0	0	10	2
Western Bluebird	48	53	1.7	0.19		0	0	20	9
Western Kingbird	50	50	0.0	1.00		0	0	0	0
Western Meadowlark	50	50	0.0	1.00		0	0	13	23
Western Tanager	48	53	5.1	0.02	Increased	0	0	2	6
Wild Turkey	50	50	0.6	0.42		0	0	1	0
Wilson's Warbler	49	52	2.1	0.15		0	0	1	2
Winter Wren	49	52	4.7	0.03	Increased	0	0	0	2
Wrentit	54	45	7.9	0.00	Decreased	0	0	4	0
Western Scrub Jay	54	44	4.2	0.04	Decreased	0	0	5	4
White-tailed Kite	50	51	1.5	0.21		0	0	0	1
White-Throated Sparrow	50	50	0.6	0.42		0	0	1	0
Yellow-rumped Warbler	48	54	4.9	0.03	Increased	0	0	1	6
Yellow Warbler	50	51	1.5	0.21		0	0	0	1

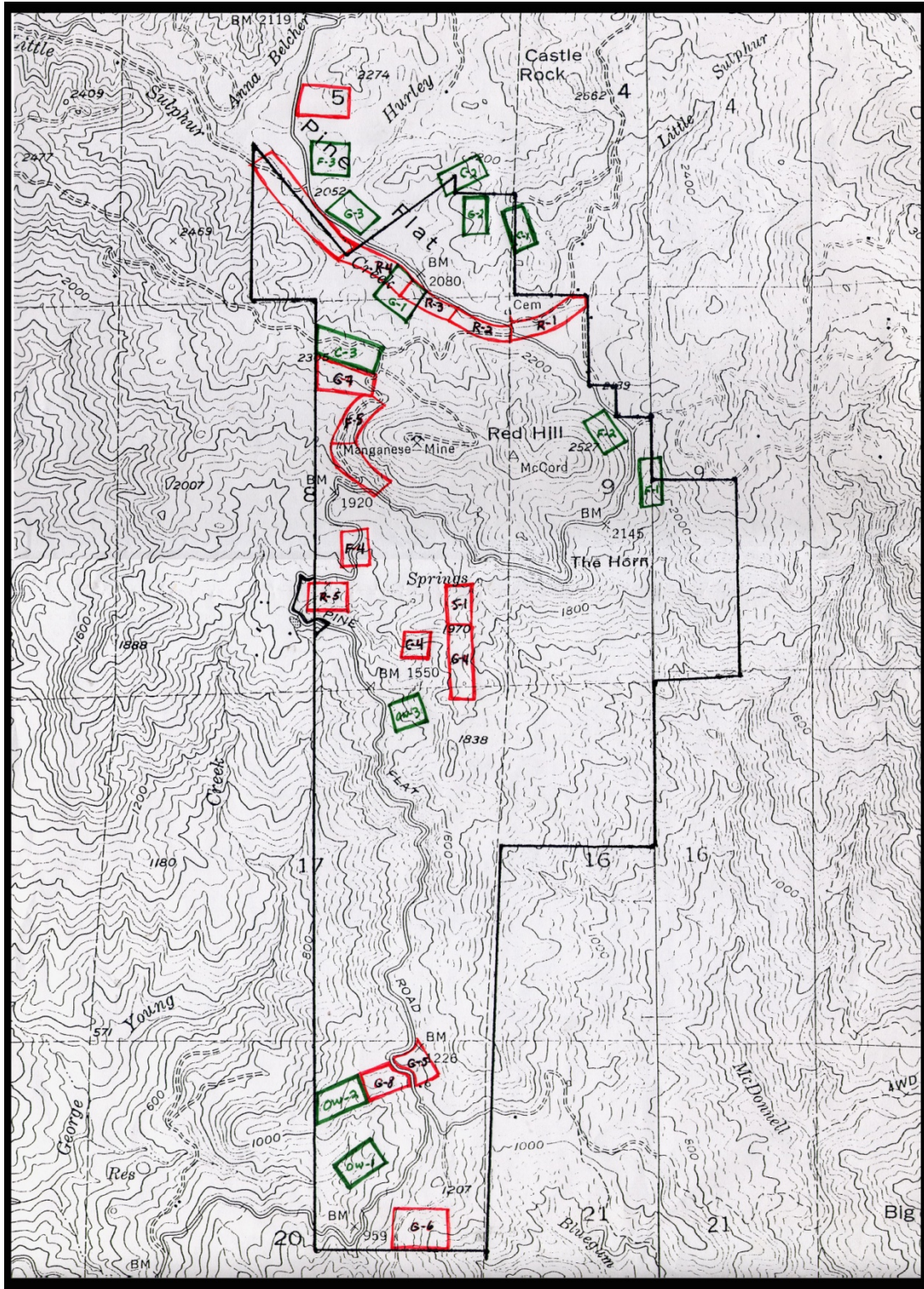


Figure 1. Map used to document bird count areas at Mayacamas Mountains Audubon Sanctuary, California, 1996-2008.

APPENDIX: PRBO Area Search Instruction

PRBO AREA SEARCH CENSUS INSTRUCTIONS May 1999

Background:

Recently adopted for the Australian Bird Count as a follow up to their completed Breeding Bird Atlas, area search censuses are time constrained bird censuses, similar to a “Christmas Bird Count” or repeated “breeding bird atlas” census. However, area search censuses differ significantly in that the census areas are defined by habitat rather than by political boundaries. This allows bird relationships to be determined and land management techniques assessed. This method is also ideal for volunteers and observers with limited identification skills. Observers are able to interact, compare notes, and chase down unfamiliar species or sounds. It is ideal for recruiting new observers in that it requires little training and allows skilled observers to train new observers. Non-birders may even participate by serving as recorders or tallying obvious species.

1. Choosing a site:

Any site containing a definable habitat may be chosen for a census. Riparian, oak woodland, grassland, coastal scrub, chaparral, and coniferous forests are current priority habitats of California Partners in Flight. Area searches can be done in any habitat, Important Bird Area (IBA), or site where bird information is needed.

Each site generally consists of three separate plots or “search areas”. For those of you setting up your own sites, each site should be registered with PRBO (using Table 1) and defined according to its current land use or habitat criteria (e.g. grazing, controlled burning, recreational park land, mixed riparian woodland, etc.). Habitat criteria will initially follow classifications in “California Statewide Wildlife Habitat Relationships System” (WHR) (*A guide to wildlife habitats of California*, 1988. K.E. Mayer and W.F. Laudenslayer editors, available from California Department of Fish and Game, CA), and/or from *A Manual of California Vegetation* (J.O. Sawyer and T. Keeler-Wolf, 1995). Contact PRBO if more information is needed.

2. Choosing a plot (or search area):

All search areas at a given site should be the same size and of the same habitat type. Avoid mixing habitat types, or standing water (i.e. lakes), or areas of high human activity. Standard protocol recommends 3 search areas within a given site. However, each site may have anywhere from 1 to 12 search areas, depending on volunteer availability and land access. For forested habitats, each plot should be about 3 hectares (e.g. 150m by 200m; 1 hectare=100m by 100m). Larger areas can be used in more open habitats (up to 10 hectares). The size of the plot should be such that it can be easily covered and birded thoroughly over a 20 minute period, and this is the most useful criteria in setting up the size of your plots. Plots may be of any shape. The different plots may have adjoining boundaries. In general the plot boundaries should be at least 25 meters from edges or different habitats; however this is frequently impossible, especially in riparian habitat, it is usually only the rule for areas containing continuous habitat. Plot boundaries should be planned and marked using permanent geographic features so that they can be relocated in subsequent visits, seasons and years, and often by different observers. These boundaries should be described in detail, and if necessary a map clearly delineating these boundaries and the plots should be made.

3. Conducting a census:

Each area search plot is covered in 20 minutes during a census (some exceptions may apply, i.e. 30 minute censuses). Typically 3 plots should be covered in a single morning. In general, observers cover the entire plot in the time allotted. Observers are free to stop the area search (and the clock) to investigate songs,

calls, or breeding activity. This may be necessary for identifying species you are not familiar with. Do not be distracted or spend too much time looking for rare birds or nests (if you are doing nest searches, do them after the census).

It is a good idea, whether you are conducting the census alone or with other observers, to walk through and explore the plot prior to the actual census. It helps to have a good sense of the borders of the plot so it can be thoroughly covered. The “time constraint” nature of area search censuses is an important feature; never extend your time to include “just a few good birds”. Carefully record your starting time when you begin, stay aware of the time throughout the census to ensure both good coverage and correct timing, and keep track of any pauses you take in the 20 minutes. With groups it may be helpful to designate one observer as timekeeper. Additionally, please try to be sensitive to the subjects of your census and in particular do not stay too long near a nest or anywhere where birds are distress calling.

Begin by filling out the observer and census information at the top of the PRBO AREA SEARCH FORM. Only one address is needed although there may be additional observers; their names go on the bottom of the form. Complete the weather information, consulting the PRBO Area Search Code Key. During the census, carefully record the name of each species seen or heard on the plot in the species column. If you know the American Ornithologists’ Union 4-letter code for the bird (e.g. WIWA for Wilson’s Warbler) please use that, if not record the full individual name of the bird. Fill in the Total column for each species after the census is complete. Record data as described on the enclosed PRBO Area Search Code Key. For each individual of each species, record a single letter (S=song, V=visual, C=call), in the order of priority explained in the code key. You should change the data, i.e. from a call to a song, if a higher priority observation later occurs for that individual. Recording any special behaviors (such as food carries, flocking, displaying), is strongly recommended but not required; there are respective columns on the form for these observations, following breeding bird atlas methodology. Other species not recorded in the 20 minutes, observed off the plot, or exhibiting interesting behaviors, may be recorded under Notes and Flyovers or on a separate sheet of paper (such as the “Off Census Bird List and Breeding Observations” form).

Observers: At least one observer should be able to identify by sight and sound most of the species likely to be encountered. Surveying the area prior to conducting a census is recommended. Observers not familiar with the birds, habitat or methods are encouraged to participate as recorders or counters of easily identified species. Up to 6 observers per plot is acceptable under certain circumstances, but 1 or 2 is preferable. During the census, observers should keep together, **act as one observer**, and record all observations on the same sheet by the designated recorder. Encourage beginners to come along and learn their local birds.

4. Frequency

3 plots should be done in a single morning. We recommend at least 2, and ideally 3, censuses of each plot during the breeding season; during the winter a single census may be adequate, while during the fall migration they should probably be conducted a minimum of once a week. The same exact plots must be censused annually, and at approximately the same time of year.

PRBO Area Search Code Key May 1999

Name and Address: Contact information for primary person conducting the area search.

Date and Visit #: Day in which census is done, and corresponding visit number (1, 2, 3, 4 etc.)

Location: County in which area search is conducted.

Site: Specific name (two-letter code unique to the county) given to the site.

Plot #: Consecutive number or letter given to the specific area search plot within the site.

Weather (Censuses should not be conducted in bad weather, which includes high winds):

Temperature: Celsius or Fahrenheit (specify) of temperature at time of census

Cloud Cover: Percent of sky covered by clouds

Wind Speed: mph, knots, or kmph (specify) of average wind speed during census

Number of Observers: Number of people involved in conducting the census. Ideally should be only one or possibly two.

Start Time: Time the 20 minute census was begun.

End Time: Time the census was completed. Is not always 20 minutes after start time as interruptions may occur. Indicate below why it is not 20 minutes (i.e spent 5 minutes tracking down a bird, etc.)

Species: Use current 4-letter code from the AOU checklist as well as subspecies if discernible. If you do not know the 4 letter code please write name in full.

Tally of Individuals: Put an S (song), V (visual), or C (call) for each individual encountered in the following priority:

Priority is S, V, C. For example, if you first see an individual (V) then later during the census hear it call (C), and after a few minutes hear it sing (S), the only code recorded on the form in the end for this individual would be an S. If you hear a bird sing (S) then see it (V), the only code recorded would be an S.

Total: After each area search is complete, tally the total number of individuals of each species encountered.

Behavior: Check each column if any individual of the species is observed doing the following:

Forag: Foraging observed

Flock: Bird observed in a flock

Copul: Copulation observed

Displ: Breeding display observed

Pair: 2 birds believed to be a mated pair observed; courtship behavior observed

Mater. Carry: Individual observed carrying nest material

Food Carry: Individual observed carrying food

Nest: Active nest found.

Fledg: Dependent fledgling observed (being fed by adults, begging, with fledgling-length tail)

Notes and flyovers: Flyovers (birds flying above and not through the plot) are recorded here, as can be birds detected outside of the boundaries of the plot, and any other information deemed pertinent, including nest predators.

Other Observers: Give the names of the observers whose personal information is not filled out above.