Landbird Monitoring at Northeastern National Wildlife Refuges 2008-2010:

Results, Recommendations and Protocols for Future Monitoring

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INTRODUCTION

Efficient and effective survey methods are needed to enable U.S. Fish and Wildlife Service National Wildlife Refuges (NWR) to evaluate Refuge plans and biological objectives. The purpose of this project was to develop a rapid monitoring protocol suitable for assessing the status and change over time in populations of fall-migrating landbirds using shrub habitats on refuges. This included methods for both population response and quality of habitat (including vegetation species composition, structure, and productivity of food, especially fruits).

The monitoring framework was a 3-tiered approach of varying degrees of effort based on the level of information needed to evaluate refuge landbird objectives. The monitoring protocols ranged from minimum staff survey effort, such as the use of citizen science (eBird), to more intensive efforts, such as constant-effort mist-netting. The purpose is to have a high degree of confidence that the data will be able to guide refuge management actions by adapting to observed changes. The resulting protocol (Appendix A) describes the details of sampling designs and field data collection methods, post-data collection processing of samples, defines training of field observers, and suggests data analysis approaches.

This report details the results of the of data collection from 2008-2010 using these protocols on six Refuges, discusses the effectiveness of the protocols for target management objectives, and outlines recommendations for future monitoring.

METHODS AND PROTOCOLS

In general, the various refuges (Figure 1) used the data collection methods as detailed in Ralph and Knutson (Appendix A). Some specifics for analyses and data collected are described in detail in the document below.

All protocols

The ability of the six refuges to provide data varied according to levels of available personnel (Tables 1 and 2). Further, data from a seventh refuge (Cape May NWR) was received too late to include in this summary. A very satisfactory sample of area searches was obtained and fairly well-distributed over the refuges. The Mobbing survey technique was well-tested, primarily from Eastern Shore NWR. Activity budgets are essential for understanding just what habitat component is being used, and good samples were obtained from most refuges, although Eastern Shore outdid themselves in this regards. Banding data were obtained from three refuges. Fruit abundance and timing was obtained from two refuges. Relevé data for vegetation composition was obtained from the Eastern Shore NWR.

Editing of the species and location codes was required for all protocols. We combined subspecies into their associated species, e.g., both “Yellow-shafted Flicker” and “Northern Flicker” as “Northern Flicker,” both “Unknown Yellow-rumped Warbler” and “Myrtle Warbler” as “Yellow-rumped Warbler.”

For consistency, and because we are mainly interested in fall migration, we used data from August 21 to November 30 from 2008 to 2010.

Data were not standardized using effort, unless otherwise stated.

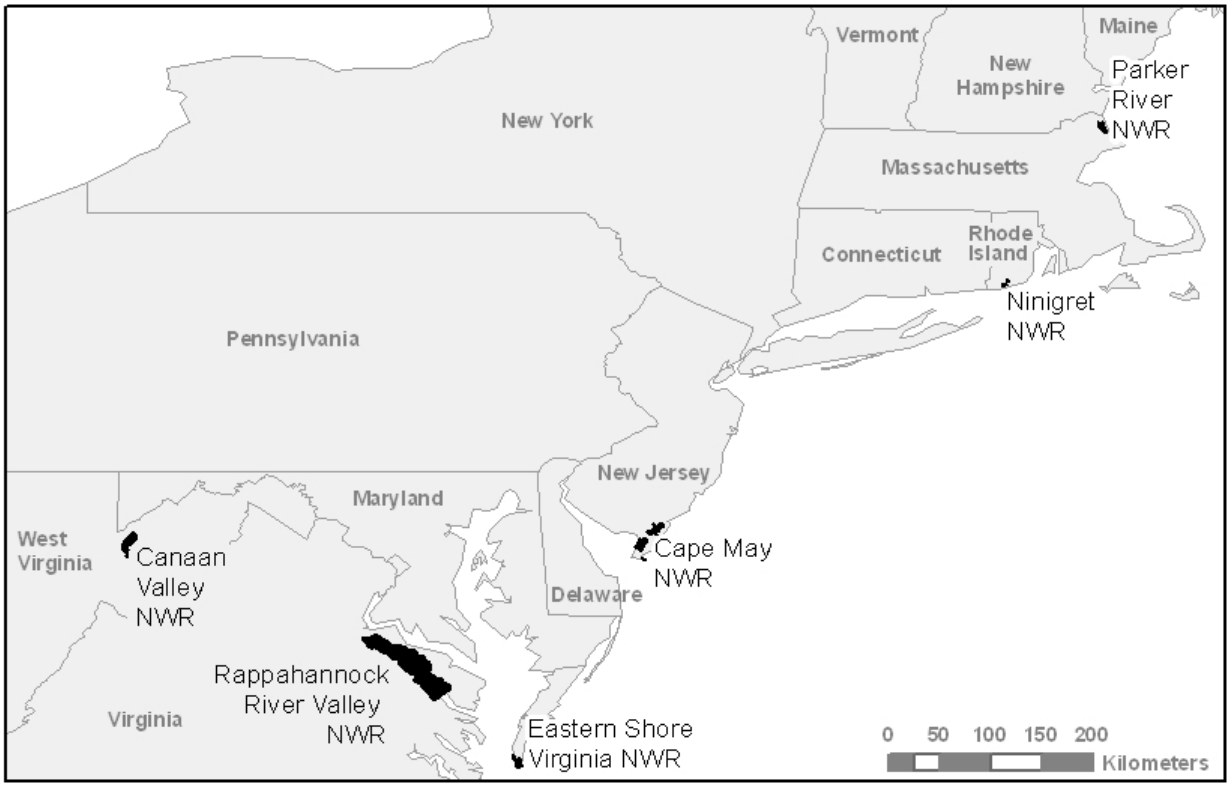

Figure 1. Map of U. S. Fish and Wildlife Service refuges in the Northeast from which we received data. The GIS locations for the Great Meadows NWR complex, located near Maynard Massachusetts, were not available online and are thus absent from this map.

Table 1. Data received from each refuge by protocol and year.

Refuge	Area search	Mobbing	Activity budget	Banding	Fruit	Vegetation - relevé
Canaan Valley	2009, 2010	2009	2009, 2010			
Eastern Shore of Virginia and CCB[1]	2009, 2010	2009	2009, 2010	2009, 2010	2009	2009, 2010
Great Meadows	2008, 2009, 2010		2009			
Ninigret	2008, 2009, 2010	2008, 2009, 2010	2008, 2009, 2010	2008, 2009	2008	
Parker River	2008, 2009, 2010	2008	2009, 2010	2008, 2009, 2010		
Rappahannock River Valley	2007, 2008, 2009	2007, 2008	2009			

[1]CCB: The Center for Conservation Biology, The College of William and Mary and Virginia Commonwealth University: contributed banding data for Eastern Shore of Virginia

Table 2. List of protocols with associated effort used in each refuge for all years combined.

Refuge	Area search (Number of person-hour)	Area search (Number of records)	Mobbing (Number of person-hour)	Activity budget (Number of days)	Activity budget (Number of observations)	Banding (Number of person-hour)	Banding (Number of records)	Fruit (Number of plots)	Vegetation - relevé (Number of plots)
Canaan Valley	22.0	66	3.8	21	211	0	0	0	0
Eastern Shore of Virginia	83.7	251	18.0	74	2223	280	19497	12	127
Great Meadows	22.7	68	0.0	9	129	0	0	0	0
Ninigret	13.3	40	1.0	18	371	142	3892	10	0
Parker River	47.3	71	0.5	13	137	378	4133	0	0
Rappahannock River Valley	61.0	183	4.3	2	10	0	0	0	0

Area search

Area searches consisted of 20-minute censuses, each covering 1-3 ha. They were used to compare bird abundance between vegetation treatment plots (Table 3) on various refuges and estimate the power of different sample sizes to detect population trends for abundant species. To calculate the area search effort, the number of stations surveyed per refuge was calculated, combining all years. Person-hours were calculated as (surveys * 20 minutes) / 60. All six refuges provided area search data, sampling from late August through November.

Area search power analysis for trends

All analyses of power and sample size were performed by refuge and species using area search data. Birds were analyzed at the refuge scale. The objective was to analyze what sample size would be needed to detect trends over time for abundance, especially at 5, 10 and 15 years.

To run the power analysis, we used the mean count per survey morning at each point. We calculated mean counts by species and year to calculate the grand mean which was needed as the basis for the power and sample size estimates. This grand mean served as a starting point for the estimator. The power estimator assumed a Poisson distribution of the data; the count data followed a Poisson distribution typical of counts. The power estimator requires information on grand mean, percent change to be detected, number of years of survey (minimum and maximum), alpha, number of tails in the test (1,2), number of areas or stations (minimum and maximum) and number of field visits in a season.

Grand mean was calculated as $\overline{\overline{X}} = \frac{\sum \overline{X_i}}{n}$

We estimated appropriate power and sample size for detecting trends in the count data over time for 3 levels of alpha (0.05, 0.10, 0.20), 3 levels of percent change (-5, -10, -20), and a range of time (5-15 years).

We then fit a linear trend over time on the natural log of the mean count for an individual refuge area for each species. At a particular area or station the model is the following for year *i*:

$$\log \lambda = a + b*i + \varepsilon_i$$

where *a* and *b* are the respective intercept and slope to be estimated, *i* is a 4-digit year (2002-2009), $\varepsilon_i \sim N(0, \sigma^2)$ and $Cov\ (\varepsilon_1, \varepsilon_i) = \rho^{|i-j|}\ \sigma^2$. The covariance structure used was the spatial power law (SP(POW)) which assumes correlations between counts at any two years decreases as the distance between years increases. Further, we also assumed that the observed number of birds of a particular species at that area or station has a Poisson distribution with mean λ_i given a realized value or error term of ε_i:

$$Y_i \mid \varepsilon_i \sim Poisson(\lambda_i)$$

We estimated the values of a, b, σ2 and ρ using maximum likelihood. The procedure PROC GLIMMIX (SAS 2007) was used for later trend calculations.

Mobbing

Using point counts, we compared the 5 minutes before, during, and just after an audio lure recording of Black-capped Chickadees (*Poecile atricapillus*) and an owl was played. We used data from these three time periods (pre-during-post mobbing audio lure) for each species and refuge to get the number of individuals detected (some of those may be individual birds tallied twice if, for example, they were counted in the during and post audio lure point counts). These data were available for Canaan Valley NWR, Eastern Shore of Virginia NWR, Ninigret NWR, Parker River NWR, and Rappahannock NWR. The effort for mobbing was calculated in person hours as: 3 point counts * 5 minutes * 1 person / 60 minutes = 0.25 hour per each survey station, route, date, and Refuge.

eBird

eBird data were downloaded from the Avian Knowledge Network (AKN, http://www.avianknowledge.net/content/) at Cornell University: all species per state. Each record included collection code (assigned by the AKN), scientific name, latitude and longitude, country, state, observation count, observation count at least, observation count at most, date, count duration in hours, time at start, time at end, and unique identifiers. Count "at least" and "at most" are the low and high values, respectively, of a range count of individuals detected or observed. We used scientific name, count at least, and latitude/longitude to calculate the total number of individuals and percent of total for each Refuge (Appendix B).

To associate the eBird observations with individual refuges, we downloaded refuge location data from the web at: http://www.fws.gov/northeast/gis/metadata.html. Using ArcMap,

we extracted the minimum and maximum latitude and longitude for each refuge, creating a north-south oriented rectangle, and eBird observations falling within those ranges became associated with the appropriate refuge. We used only records identified to species, that is, we removed general categories such as accipiter sp., hirundinidae sp., and hybrids. We did not calculate the effort associated with eBird as many records do not have the duration in hours recorded, as well as other issues that would be ideal to be resolved at a later date.

Banding

For consistency, we used only records of newly-banded birds since we had recapture data only from Ninigret NWR. Banding data provided demographic information, number of individuals, number of species captured, mean percent young, and average condition. Banding data were provided by Eastern Shore of Virginia NWR, Ninigret NWR, and Parker River NWR.

Bird's condition was obtained through the following formula: wing/weight*100. Age ratio was calculated as the number of hatching year birds (young) divided by the total number of birds captured for each species, refuge and date. We used the average daily age ratio per species and refuge as the value for percentage of young.

Activity budgets

Activity budgets provide a very direct estimate of the value of fruit and vegetation to birds, and were tallied by bird species, types of activities observed, and the substrates on which activities occurred. We compared the use of plant species from activity budgets with the available habitat, especially shrubs, from the analysis of relevé data. The activity budget effort was derived from the number of activity budget records by refuge. Most records represented a different bird species-plant species or bird species-substrate combination, though this varied.

RESULTS AND DISCUSSION

Comparison of bird abundance between treatment units

Some area searches on four of the refuges (Table 3) were conducted and associated with specific habitats. As expected, the refuges varied greatly with Great Meadows specializing in American Robins, Ninigret in Yellow-rumped Warblers and Tree Swallows, Parker River being relatively uniformly distributed between species except for European Starlings in the shrub habitat, and Rappahannock River having relatively few birds evenly distributed.

Only Parker River sampled more than one habitat type. Most species that showed a preference preferred the shrub habitat over fields, including Blue Jays, Black-capped Chickadees, European Starling, Yellow-rumped Warbler, and Slate-colored Juncos. Only American Crows, Song Sparrows, and American Goldfinches showed a slight preference for fields.

Table 3. Comparison of species found in Area Searches taken in three types of vegetation treatment plots in Great Meadows NWR, Ninigret NWR, Parker River NWR, and Rappahannock River Valley NWR.

Species selected for analysis were the top 10 species of each refuge (see abundance tables, Appendix B).

	Great Meadows		Ninigret		Parker River				Rappahannock River Valley	
	Old Field		Shrub		Field		Shrub		Field	
Species	Mean[1]	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Canada Goose	1.49	1.01	0	0	0	0	0	0	1.01	0.59
Red-bellied Woodpecker	0.34	0.07	0.03	0.03	0	0	0	0	0.73	0.06
Blue Jay	3.57	0.29	1.90	0.48	0.36	0.16	1.53	0.29	0.95	0.09
American Crow	2.10	0.53	0.13	0.06	0.14	0.11	0.07	0.05	1.01	0.14
Tree Swallow	0	0	31.53	17.35	0	0	0	0	0.77	0.45
Black-capped Chickadee	1.93	0.22	3.68	0.47	0.21	0.12	1.53	0.26	0	0
Eastern Tufted Titmouse	0.57	0.11	0.40	0.13	0	0	0	0	0.66	0.09
Carolina Wren	0.22	0.07	0.15	0.06	0	0	0	0	0.93	0.07
American Robin	16.31	4.20	0.30	0.13	0.29	0.11	1.84	0.72	0.23	0.10
Gray Catbird	1.63	0.25	3.53	0.6	0.46	0.17	1.12	0.36	0.17	0.03
European Starling	0.16	0.11	0	0	0	0	24.65	16.26	0.01	0.01
Yellow-rumped Warbler	0.87	0.24	73.98	14.27	0.39	0.24	2.86	0.67	1.10	0.28
Eastern Towhee	0.07	0.04	1.75	0.28	0.07	0.05	0.86	0.21	0.26	0.05
Song Sparrow	3.85	0.49	0.40	0.17	1.21	0.27	1.12	0.32	0.41	0.09
White-throated Sparrow	3.06	0.69	0.28	0.11	0.43	0.36	0.28	0.12	0.94	0.17
Slate-colored Junco	0.28	0.15	0.05	0.03	0	0	0.77	0.25	0.02	0.01
Northern Cardinal	1.13	0.14	0.50	0.12	0.04	0.04	0.14	0.09	0.66	0.07
Red-winged Blackbird	2.13	0.68	0	0	0	0	0	0	0.36	0.13
Common Grackle	2.13	0.68	0	0	0	0	0	0	1.04	0.83
American Goldfinch	2.38	0.50	0.78	0.29	0.18	0.10	0.07	0.05	0.16	0.06
Total birds	44.22		119.39		3.78		36.84		11.42	

[1] Mean = mean number per survey across all surveys and years.

Area search power analysis for trends

Data derived from area search surveys can be used to monitor trends. By monitoring trends we can determine if populations and species diversity are being maintained.

As an example, we ran analyses with data from a few species on the Rappahannock River Valley (Table 4), as even just a single analysis results in voluminous results.

We determined the statistical power to detect changes in bird population measures using current sampling levels. For each target species, tables were produced for a variety of annual percent population change over different numbers of years at a variety of alpha levels (Table 4). We performed estimates at the refuge scale. Species selected to be of interest in this example

were the Eastern Meadowlark, Blue Jay, and White-throated Sparrow, as they are abundant and widespread species. The data were counts for each species.

Descriptive statistics were performed on all three species by year, irrespective of age class. Power and sample size estimation required input of information from the user: grand mean, percent change, number of years (minimum, maximum), alpha, number of tails (1, 2), number of areas (minimum, maximum), number of stations, and number of field visits in a season.

To use the power tables below, select a percent of change to detect, a level of certainty of results, or a selected spatial or temporal scale. For example, for the Blue Jay in the first power table (Table 4A), we estimate an 88% power to detect a 10% annual decline or increase in abundance, sampling 70 point count stations for 6 years (alpha=0.05). The Eastern Meadowlark, a less abundant species, requires 10 years (or additional plots) to detect a similar trend at 85% power with the same certainty level.

Table 4. Probability of detecting change between years by area search censuses through estimates of statistical power at two levels of Type I error (0.05, 0.10) and two levels of annual percent population change (5%, 10%). Population change is detected by changes in number of separate area search counts ("Effort") of birds. A range of years of sampling are shown. The values highlighted in yellow are used in the text example above.

A. Rappahannock River Valley – 10% annual change, 2-tailed, alpha=0.05

		Number of Years						
Species	**Effort**	**5**	**6**	**7**	**8**	**9**	**10**	**15**
Blue Jay	40	0.45	0.66	0.83	0.94	0.98	1.00	1.00
	70	0.68	0.88	0.97	1.00	1.00	1.00	1.00
	100	0.83	0.96	1.00	1.00	1.00	1.00	1.00
	130	0.91	0.99	1.00	1.00	1.00	1.00	1.00
	160	0.96	1.00	1.00	1.00	1.00	1.00	1.00
	190	0.98	1.00	1.00	1.00	1.00	1.00	1.00
Eastern Meadowlark	40	0.15	0.22	0.30	0.40	0.51	0.63	0.96
	70	0.22	0.34	0.48	0.62	0.75	0.85	1.00
	100	0.30	0.46	0.62	0.77	0.88	0.95	1.00
	130	0.37	0.56	0.74	0.87	0.95	0.98	1.00
	160	0.44	0.65	0.82	0.93	0.98	1.00	1.00
	190	0.51	0.72	0.88	0.96	0.99	1.00	1.00
White-throated Sparrow	40	0.45	0.66	0.83	0.93	0.98	1.00	1.00
	70	0.68	0.88	0.97	1.00	1.00	1.00	1.00
	100	0.83	0.96	1.00	1.00	1.00	1.00	1.00
	130	0.91	0.99	1.00	1.00	1.00	1.00	1.00
	160	0.96	1.00	1.00	1.00	1.00	1.00	1.00
	190	0.98	1.00	1.00	1.00	1.00	1.00	1.00

Table 4. (contd.)

B. Rappahannock River Valley – 5% annual change, 2-tailed, alpha=0.05

Species	Effort	Number of Years						
		5	6	7	8	9	10	15
Blue Jay	40	0.16	0.24	0.34	0.46	0.60	0.72	0.99
	70	0.24	0.37	0.54	0.70	0.83	0.92	1.00
	100	0.32	0.50	0.69	0.84	0.94	0.98	1.00
	130	0.40	0.61	0.80	0.92	0.98	1.00	1.00
	160	0.48	0.70	0.87	0.96	0.99	1.00	1.00
	190	0.54	0.77	0.92	0.98	1.00	1.00	1.00
Eastern Meadowlark	40	0.08	0.09	0.12	0.15	0.19	0.24	0.58
	70	0.09	0.13	0.17	0.23	0.30	038	0.82
	100	0.11	0.16	0.23	031	0.40	0.51	0.93
	130	0.13	0.20	0.28	0.38	0.50	0.62	0.97
	160	0.15	0.23	0.33	0.45	0.58	0.71	0.99
	190	0.17	0.26	0.38	0.52	0.66	0.78	1.00
White-throated Sparrow	40	0.16	0.23	0.34	0.46	0.59	0.72	0.99
	70	0.24	0.37	0.53	069	0.83	0.92	1.00
	100	0.32	0.50	0.68	0.84	0.93	0.98	1.00
	130	0.40	0.60	0.79	0.92	0.98	1.00	1.00
	160	0.47	0.70	0.87	0.96	0.99	1.00	1.00
	190	0.54	0.77	0.92	0.98	1.00	1.00	1.00

C. Rappahannock River Valley – 10% annual change, 2-tailed, alpha=0.10

Species	Effort	Number of Years						
		5	6	7	8	9	10	15
Blue Jay	40	0.58	0.77	0.90	0.97	0.99	1.00	1.00
	70	0.79	0.93	0.99	1.00	1.00	1.00	1.00
	100	0.90	0.98	1.00	1.00	1.00	1.00	1.00
	130	0.95	1.00	1.00	1.00	1.00	1.00	1.00
	160	0.98	1.00	1.00	1.00	1.00	1.00	1.00
	190	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Eastern Meadowlark	40	0.24	0.32	0.42	0.53	0.64	0.74	0.98
	70	0.33	0.46	0.60	0.73	0.84	0.91	1.00
	100	0.42	0.58	0.74	0.86	0.93	0.97	1.00
	130	0.50	0.68	0.83	0.93	0.97	0.99	1.00
	160	0.57	0.76	0.89	0.96	0.99	1.00	1.00
	190	0.63	0.82	0.93	0.98	1.00	1.00	1.00
White-throated Sparrow	40	0.58	0.76	0.90	0.97	0.99	1.00	1.00
	70	0.78	0.93	0.99	1.00	1.00	1.00	1.00
	100	0.90	0.98	1.00	1.00	1.00	1.00	1.00
	130	0.95	1.00	1.00	1.00	1.00	1.00	1.00
	160	0.98	1.00	1.00	1.00	1.00	1.00	1.00
	190	0.99	1.00	1.00	1.00	1.00	1.00	1.00

Table 4. (contd.)

D. Rappahannock River Valley – 5% annual change, 2-tailed, alpha=0.10

Species	Effort	Number of Years						
		5	6	7	8	9	10	15
Blue Jay	40	0.25	0.34	0.46	0.60	0.71	0.82	1.00
	70	0.35	0.504	0.66	0.80	0.90	0.96	1.00
	100	0.44	0.62	0.79	0.91	0.97	0.99	1.00
	130	0.53	0.72	0.87	0.96	0.99	1.00	1.00
	160	0.60	0.80	0.93	0.98	1.00	1.00	1.00
	190	0.66	0.85	0.96	0.99	1.00	1.00	1.00
Eastern Meadowlark	40	0.14	0.16	0.20	0.24	0.29	0.35	0.70
	70	0.16	0.21	0.27	0.24	0.42	0.51	0.89
	100	0.19	0.25	0.33	0.43	0.53	0.63	0.96
	130	0.22	0.30	0.39	0.51	0.62	0.73	0.99
	160	0.24	0.34	0.45	0.58	0.70	0.81	1.00
	190	0.27	0.38	0.51	0.64	0.77	0.86	1.00
White-throated Sparrow	40	0.25	0.34	0.46	0.59	0.71	0.82	1.00
	70	0.35	0.50	0.65	0.79	0.90	0.96	1.00
	100	0.44	0.62	0.79	0.90	0.97	0.99	1.00
	130	0.52	0.72	0.87	0.97	0.99	1.00	1.00
	160	0.60	0.79	0.92	0.98	1.00	1.00	1.00
	190	0.66	0.85	0.96	0.99	1.00	1.00	1.00

Overall, we found that the current sampling effort and distribution of sampling locations is sufficient for a 90% probability of detecting trends over the sampled area in 5 to 10 years (Table 4) for the species shown. The tables we presented for the specific species will help to plan sampling levels and budgets for the future. In general, the sample sizes for these species should apply to any similar-sized unit.

Attraction to mobbing calls

We compared the ability of mobbing playbacks to attract birds of different species. Only a few species had more than 25 individuals surveyed (Table 5). The counts of birds pre-, during, and post-playback are shown as well as the percent of the total in each category.

When reacting to audio lure, most species seemed attracted to it (those species known to mob from the literature) and only a few species had a decrease in numbers during and post-playback. Some species were indifferent to the audio lure or possibly even repelled by it.

For example, the Yellow-rumped Warbler increased from 304 (33%) detections before, to 368 (40.1%) during the playback. Another seven species also had their maximum detections during the playback, and six species after the playback, for a total of 14 species during and/or after the playback, versus just five who had highest numbers before the playback. Thus it appears that there is a modest value in the playback, but few species would have gone completely undetected. Our result is different than that observed in eastern forests during the winter, when birds were extremely responsive to such mobbing playbacks (Ken Rosenberg, Cornell Laboratory of Ornithology, pers. comm.).

Table 5. Comparison of number of birds by species during the pre-, during, and post- mobbing surveys using audio lure. All Refuges, years, and months were combined for this analysis, and are ordered by descending order of total birds counted.

Percentages indicated by an asterisk (*****) appeared to have a higher percent than those at other time periods (no statistical tests were performed). Those species with <25 total counts (below the dashed horizontal line) were not discussed in detail.

	Number of birds				Percent of birds		
	Pre-playback	**During playback**	**Post-playback**	**Total**	**Pre-playback**	**During playback**	**Post-playback**
Yellow-rumped Warbler	304	368	235	907	33.52	40.57*	25.91
Common Grackle	60	60	50	170	35.29	35.29	29.41
Tree Swallow	75	12	47	134	55.97*	8.96	35.07
Blue Jay	45	38	46	129	34.88	29.46	35.66
Carolina Wren	45	40	37	122	36.89	32.79	30.33
American Goldfinch	30	35	46	111	27.03	31.53	41.44*
Savannah Sparrow	40	31	34	105	38.10	29.52	32.38
American Crow	41	26	32	99	41.41*	26.26	32.32
American Robin	1	4	75	80	1.25	5.00	93.75*
Gray Catbird	35	16	26	77	45.45*	20.78	33.77
American Coot	44	10	12	66	66.67*	15.15	18.18
Northern Cardinal	17	30	17	64	26.56	46.88*	26.56
Palm Warbler	22	22	14	58	37.93	37.93	24.14
Cedar Waxwing	2	34	21	57	3.51	59.65*	36.84
Red-winged Blackbird	6	26	25	57	10.53	45.61*	43.86*
Black-capped Chickadee	10	27	14	51	19.61	52.94*	27.45
Northern Flicker	23	9	16	48	47.92*	18.75	33.33
Carolina Chickadee	6	15	22	43	13.95	34.88	51.16*
White-throated Sparrow	9	18	16	43	20.93	41.86*	37.21*
Common Yellowthroat	12	20	9	41	29.27	48.78*	21.95
Eastern Towhee	9	10	8	27	33.33	37.04	29.63
Tufted Titmouse	4	11	12	27	14.81	40.74*	44.44*

Sharp-shinned Hawk	11	7	7	25	44.00	28.00	28.00
Northern Mockingbird	10	6	8	24	41.67	25.00	33.33
Turkey Vulture	11	0	13	24	45.83	0.00	54.17
House Wren	5	8	7	20	25.00	40.00	35.00
Red-breasted Woodpecker	9	3	6	18	50.00	16.67	33.33
Canada Goose	14	1	2	17	82.35	5.88	11.76

Table 5 (contd.).

	Number of birds				Percent of birds		
	Pre-playback	**During playback**	**Post-playback**	**Total**	**Pre-playback**	**During playback**	**Post-playback**
Double-crested Cormorant	13	3	0	16	81.25	18.75	0.00
Rosy-crowned Kinglet	3	9	4	16	18.75	56.25	25.00
Song Sparrow	4	5	7	16	25.00	31.25	43.75
Swamp Sparrow	5	5	6	16	31.25	31.25	37.50
Eastern Phoebe	4	4	6	14	28.57	28.57	42.86
Field Sparrow	7	4	3	14	50.00	28.57	21.43
Indigo Bunting	2	6	5	13	15.38	46.15	38.46
Downy Woodpecker	2	6	4	12	16.67	50.00	33.33
Eastern Meadowlark	4	2	6	12	33.33	16.67	50.00
Brown Thrasher	4	4	2	10	40.00	40.00	20.00
Bobolink	1	2	6	9	11.11	22.22	66.67
Mourning Dove	8	1	0	9	88.89	11.11	0.00
American Redstart	1	6	1	8	12.50	75.00	12.50
Eastern Wood-Pewee	4	2	2	8	50.00	25.00	25.00
Cooper's Hawk	4	2	1	7	57.14	28.57	14.29
Eastern Bluebird	2	1	4	7	28.57	14.29	57.14
Hermit Thrush	1	3	3	7	14.29	42.86	42.86
Merlin	6	1	0	7	85.71	14.29	0.00
Brown-headed Cowbird	0	5	1	6	0.00	83.33	16.67
Eastern Tufted Titmouse	0	1	5	6	0.00	16.67	83.33
Northern Harrier	3	1	2	6	50.00	16.67	33.33
Pileated Woodpecker	2	1	3	6	33.33	16.67	50.00
Bald Eagle	2	1	2	5	40.00	20.00	40.00
Belted Kingfisher	3	1	1	5	60.00	20.00	20.00
Northern Bobwhite	5	0	0	5	100.00	0.00	0.00
Pine Warbler	2	2	1	5	40.00	40.00	20.00
Red-eyed Vireo	2	3	0	5	40.00	60.00	0.00
Blue-gray Gnatcatcher	1	1	2	4	25.00	25.00	50.00
Peregrine Falcon	1	3	0	4	25.00	75.00	0.00
White-breasted Nuthatch	3	1	0	4	75.00	25.00	0.00
Black-and-White Warbler	0	3	0	3	0.00	100.00	0.00
Black Vulture	1	2	0	3	33.33	66.67	0.00
Golden-crowned Kinglet	3	0	0	3	100.00	0.00	0.00
American Kestrel	0	0	2	2	0.00	0.00	100.00

Table 5 (contd.).

	Number of birds				Percent of birds		
	Pre-playback	**During playback**	**Post-playback**	**Total**	**Pre-playback**	**During playback**	**Post-playback**
Blue Grouse	2	0	0	2	100.00	0.00	0.00
Blackpoll Warbler	0	2	0	2	0.00	100.00	0.00
Brown Creeper	0	1	1	2	0.00	50.00	50.00
Broad-winged Hawk	1	0	1	2	50.00	0.00	50.00
Common Loon	1	0	1	2	50.00	0.00	50.00
Eastern Screech-Owl	0	2	0	2	0.00	100.00	0.00
Fish Crow	0	2	0	2	0.00	100.00	0.00
Killdeer	0	0	2	2	0.00	0.00	100.00
Magnolia Warbler	1	1	0	2	50.00	50.00	0.00
Northern Parula	0	2	0	2	0.00	100.00	0.00
Northern Waterthrush	0	1	1	2	0.00	50.00	50.00
Red-headed Woodpecker	2	0	0	2	100.00	0.00	0.00
White-eyed Vireo	1	0	1	2	50.00	0.00	50.00
Yellow-breasted Sapsucker	0	1	1	2	0.00	50.00	50.00
Yellow Warbler	1	0	1	2	50.00	0.00	50.00
Baltimore Oriole	1	0	0	1	100.00	0.00	0.00
Caspian Tern	0	1	0	1	0.00	100.00	0.00
Connecticut Warbler	0	0	1	1	0.00	0.00	100.00
Common Raven	0	0	1	1	0.00	0.00	100.00
European Starling	1	0	0	1	100.00	0.00	0.00
Great Blue Heron	1	0	0	1	100.00	0.00	0.00
Greater Yellowlegs	1	0	0	1	100.00	0.00	0.00
Hairy Woodpecker	0	0	1	1	0.00	0.00	100.00
Osprey	0	1	0	1	0.00	100.00	0.00
Red-breasted Nuthatch	1	0	0	1	100.00	0.00	0.00
Red-tailed Hawk	1	0	0	1	100.00	0.00	0.00
Ruby-throated Hummingbird	0	0	1	1	0.00	0.00	100.00
Vesper Sparrow	0	0	1	1	0.00	0.00	100.00
Wilson's Snipe	0	1	0	1	0.00	100.00	0.00
	1018	993	950	2961	34.38	33.54	32.08

Bird condition from banding captures

We used data from three banding stations (Table 6) to compare bird condition by species. Body condition basically measures the amount of fat and muscle standardizing for the overall size of the bird, and is calculated by dividing the wing length by the weight and multiplying by 100. We found marked variation between each refuge, as some species averaged relatively low, high, or similar body condition between refuges.

Looking at condition between refuges, we found condition to be lower at the Eastern Shore of Virginia in the American Redstart, Black-and-white Warbler, and Traill's Flycatcher. By contrast, condition was higher at the Eastern Shore of Virginia in the Yellow-rumped and Blackpoll warblers, as well as the Ruby- and Golden-crowned kinglets. The Blackpoll is famous for its trans-Atlantic flight for the Northeast, and this high condition could reflect a buildup of fat in this most coastal of stations, prior to their migration out over the Atlantic. The body condition of the sparrows and year-round residents seems to vary less between refuges while those of warblers had greater differences. Shorter migration routes for sparrows compared with warblers may explain the stability of body condition between locations in the fall. The body condition of many species was similar between two northern refuges: Ninigret and Parker River.

Table 6. Mean condition of banded birds by species and refuge, calculated as wing/weight*100. Species indicated with an asterisk (***)** appeared to have different body condition between at least one of the three refuges (no statistical analyses were performed).

	Eastern Shore of Virginia NWR			**Ninigret NWR**			**Parker River NWR**		
Species	**Num. birds**	**Mean condition**	**SE**	**Num. birds**	**Mean condition**	**SE**	**Num. birds**	**Mean condition**	**SE**
Traill's Flycatcher*****	75	500.93	7.36	25	519.72	12.81	9	552.33	16.44
Eastern Phoebe	17	434.18	6.31	18	428.58	5.92	33	432.01	5.18
Red-eyed Vireo*****	275	409.29	2.89	25	440.70	7.43	67	429.83	5.75
Blue Jay	11	148.06	3.57	10	149.65	2.75	5	155.25	6.47
Scrub Jay	85	414.64	2.61	7	378.79	12.62	118	412.46	2.90
Tree Swallow	1	490.99		20	583.04	9.55	17	568.56	6.89
Black-capped Chickadee	.	.	.	55	588.41	4.28	54	573.96	3.80
Golden-crowned Kinglet*****	144	992.00	5.80	13	957.61	13.30	232	961.45	5.86
Ruby-crowned Kinglet*****	90	945.25	6.69	10	892.09	13.66	97	904.85	6.83
Swainson's Thrush	28	323.52	6.72	4	312.57	9.00	14	306.86	8.28
Hermit Thrush	176	309.51	1.82	14	294.67	3.68	120	298.40	1.94
Gray Catbird	1231	229.46	0.45	171	229.58	1.24	596	238.47	0.68
Northern Waterthrush	189	420.67	3.76	3	470.27	8.39	29	426.12	7.62
Black-and-white Warbler*****	92	610.78	5.59	6	639.73	6.18	45	637.05	8.98
Common Yellowthroat	502	514.12	2.30	67	519.32	3.90	129	516.75	3.41
American Redstart*****	556	719.40	3.73	20	712.32	18.80	74	736.27	8.22
Magnolia Warbler	101	706.14	6.75	3	705.86	34.02	31	695.58	11.45
Yellow Warbler	41	607.57	9.61	4	619.99	33.96	44	603.32	8.49

Table 6 (contd.).

Species	Eastern Shore of Virginia NWR			Ninigret NWR			Parker River NWR		
	Num. birds	Mean condition	SE	Num. birds	Mean condition	SE	Num. birds	Mean condition	SE
Blackpoll Warbler*	124	595.95	9.26	29	561.31	14.65	136	548.80	7.43
Palm Warbler	222	640.73	3.26	9	636.68	14.08	10	646.57	16.97
Yellow-rumped Warbler*	8646	592.75	0.47	939	556.37	1.52	946	559.34	1.53
Eastern Towhee	22	212.31	3.06	24	194.94	2.81	56	200.68	1.61
Chipping Sparrow	27	555.68	5.01	2	549.38	18.62	.	.	.
Song Sparrow	277	323.35	1.31	29	312.00	4.04	91	321.05	2.27
Swamp Sparrow	411	368.77	1.40	29	357.41	4.90	23	361.99	5.98
White-throated Sparrow	492	295.46	0.98	9	287.88	5.41	324	285.99	1.19
White-crowned Sparrow	2	285.05	10.98	2	301.71	8.93	3	289.19	12.41
Northern Cardinal	114	212.53	1.05	6	224.05	6.97	25	210.11	2.35

Age ratios from banding

The proportion of young captured in banding stations (Table 7) can be used in a variety of ways. Ralph (1981) suggested that a high percent of young along the coast during migration is associated with an inland main route where a more normal percent of young to adult are found. All three refuges with banding data are located adjacent to the Atlantic coast. A relatively low percent of young for arriving winter birds and residents, such as the White-throated Sparrow, were found at Ninigret. The Common Yellowthroat had high percent of young at the Eastern Shore of Virginia, and at Parker River, but lowest at Ninigret. Age ratio data suggest that Eastern Shore of Virginia NWR is located within the main migration route of Yellow Warbler and Blackpoll Warbler. Ninigret NWR is within the main migration route of Eastern Towhee while Parker River NWR is for Black-and-White Warbler, Yellow Warbler, Magnolia Warbler, Blackpoll Warbler, American Robin and Eastern Towhee. The Blackpoll Warbler is the only species known to use the coast as its main migration route as it is en route out over the Atlantic on a direct route to South America.

Table 7. Mean percent of young (mean percent [pct.] and standard error [SE]) captured per day by species and refuge. No recaptured birds were used in this analysis. The list contains each refuge's top 20 most abundant species.

	Eastern Shore of Virginia NWR			Ninigret NWR			Parker River NWR		
Species	**Num. days**	**Mean pct.**	**SE**	**Num. days**	**Mean pct.**	**SE**	**Num. days**	**Mean pct.**	**SE**
Eastern Phoebe	13	100.00	0.00	9	100.00	0.00	26	100.00	0.00
Red-eyed Vireo	60	96.01	1.84	14	100.00	0.00	49	97.96	2.04
Blue Jay	10	80.00	13.33	9	77.78	14.70	5	100.00	0.00
Scrub Jay	31	91.53	3.87	6	100.00	0.00	42	90.76	3.75
Tree Swallow	1	0.00	.	2	97.50	2.50	2	78.02	6.59
Black-capped Chickadee	.	.	.	25	92.67	4.52	27	97.53	2.47
Golden-crowned Kinglet	37	98.21	1.12	7	100.00	0.00	48	99.10	0.72
Ruby-crowned Kinglet	27	90.41	4.68	5	100.00	0.00	30	97.50	1.84
Swainson's Thrush	18	97.22	2.02	5	100.00	0.00	12	100.00	0.00
Hermit Thrush	46	85.86	4.26	11	100.00	0.00	48	95.83	2.91
American Robin	29	78.79	6.12	7	57.14	20.20	79	79.02	4.16
Gray Catbird	107	95.33	1.70	58	87.81	2.58	120	94.09	1.55
Cedar Waxwing	2	50.00	50.00	3	100.00	0.00	6	66.67	21.08
Blue-winged Warbler	.	.	.	3	83.33	16.67	2	50.00	50.00
Black-and-White Warbler	45	97.68	1.28	4	100.00	0.00	30	78.89	7.41
Common Yellowthroat	73	93.77	1.32	37	72.31	6.45	76	90.79	2.90
American Redstart	64	92.62	1.46	13	98.46	1.54	47	89.93	3.83
Magnolia Warbler	41	93.21	3.05	3	100.00	0.00	21	74.60	9.46
Yellow Warbler	18	82.87	7.87	4	50.00	28.87	21	79.37	7.88
Blackpoll Warbler	39	61.88	5.73	16	95.63	3.29	61	80.65	4.38
Yellow-rumped Warbler	91	91.90	0.91	34	99.18	0.44	51	93.43	2.20
Canada Warbler	6	100.00	0.00	.	.	.	6	100.00	0.00
Eastern Towhee	17	89.22	6.54	23	57.97	9.07	42	77.78	6.16
Chipping Sparrow	19	100.00	0.00	2	100.00	0.00	.	.	.
Song Sparrow	58	93.65	1.77	22	80.30	7.73	65	85.64	4.03
White-throated Sparrow	64	74.47	4.06	7	64.29	17.98	72	97.38	1.25
Northern Cardinal	61	86.04	4.05	4	25.00	25.00	17	94.12	5.88

Degree of agreement and effectiveness of various census monitoring protocols

The results of different monitoring protocols were compared in order to determine which species are perhaps under-sampled by one method compared to another. The basic objective was

to produce each refuge's species list and count by protocol: area search, mobbing surveys, banding, and eBird (Appendix B).

Whenever available, eBird has a longer list of species and higher number of birds, as compared with area search, mobbing, and banding. eBird is however a citizen science project where surveys are not always performed by trained biologists and often does not include effort. Whenever a species was not detected in eBird, we found that banding was more often the protocol that detected the species (i.e., if the species is not present in eBird, it is usually not present in area search or mobbing either).

We chose the 15 most abundant species (Table 8) for a detailed analysis. Here we compare the number of individuals detected by each protocol and the percent that each made up of the total within the protocol and refuge. We included only landbirds in the comparison of percentage, although all species are shown in Appendix B.

Overall, each protocol has different scales in time and space. Area search and eBird are most comparable as both are census protocols. Banding had in general good agreement with census, in regards to abundance, being mindful of the added demographic and condition information that such data contains. Mobbing is another census technique and is used here primarily for comparison, as it had a much smaller sample size.

The best agreements between all protocols were for Song Sparrow, Gray Catbird, and, despite its rarity, the Carolina Wren. These are all regularly caught by mist nets at banding stations and are readily encountered in censuses because they are relatively vocal. Good agreements were found in most of the other species. Some exceptions were flocking birds such as the Red-winged Blackbird, Common Grackle, European Starling, Tree Swallow, and Yellow-rumped Warbler, as they differed between protocols markedly.

Table 8. Comparison of selected species' counts and percent of total by refuge and protocol. See Appendix B for complete list of all species per refuge.

A. Blue Jay

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	38	3.83	.	.	29	10.62	112	7.98
East Shore Virginia NWR	109	1.27	12	0.06	34	1.8	424	0.63
Great Meadows NWR	243	6.65	.	.	.	.	719	2.53
Ninigret NWR	76	1.56	12	0.31	0	0	78	2.13
Parker River NWR	76	4.12	5	0.12	0	0	2649	0.91
Rappahannock NWR	174	5.39	.	.	66	9.34	391	0.58

B. Tree Swallow

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	30	3.02	.	.	0	0	0	0
East Shore Virginia NWR	811	9.48	1	0.01	105	5.57	10342	15.29
Great Meadows NWR	0	0	.	.	.	.	335	1.18
Ninigret NWR	1261	25.91	119	3.06	14	17.5	2208	60.26
Parker River NWR	0	0	20	0.48	0	0	205320	70.49
Rappahannock NWR	140	4.34	.	.	15	2.12	1244	1.84

Table 8 (contd).

C. Black-capped Chickadee

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	15	1.51	.	.	25	9.16	82	5.84
East Shore Virginia NWR	0	0	0	0	0	0	0	0
Great Meadows NWR	131	3.59	.	.	.	.	868	3.05
Ninigret NWR	147	3.02	76	1.95	18	22.5	148	4.04
Parker River NWR	72	3.9	54	1.31	8	53.33	2869	0.99
Rappahannock NWR	0	0	0	0	0	0	0	0

D. Eastern Tufted Titmouse

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	9	0.91	.	.	4	1.47	41	2.92
East Shore Virginia NWR	0	0	1	0.01	0	0	66	0.1
Great Meadows NWR	40	1.10	.	.	.	.	363	1.28
Ninigret NWR	16	0.33	17	0.44	2	2.5	42	1.15
Parker River NWR	0	0	2	0.05	0	0	58	0.02
Rappahannock NWR	120	3.72	.	.	27	3.82	323	0.48

E. Carolina Wren

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	0	0	4	0.29
East Shore Virginia NWR	233	2.72	40	0.21	97	5.14	257	0.38
Great Meadows NWR	15	0.41	.	.	.	.	140	0.49
Ninigret NWR	6	0.12	2	0.05	0	0	10	0.27
Parker River NWR	0	0	3	0.07	0	0	120	0.04
Rappahannock NWR	170	5.27	.	.	25	3.54	515	0.76

F. American Robin

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	5	1.83	35	2.49
East Shore Virginia NWR	137	1.6	117	0.6	67	3.55	4585	6.78
Great Meadows NWR	1109	30.35	.	.	.	.	2930	10.3
Ninigret NWR	12	0.25	7	0.18	4	5	100	2.73
Parker River NWR	87	4.72	164	3.97	4	26.67	7649	2.63
Rappahannock NWR	42	1.3	.	.	0	0	1147	1.69

Table 8 (contd.)

G. Gray Catbird

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	1	0.1	.	.	0	0	5	0.36
East Shore Virginia NWR	209	2.44	1272	6.52	52	2.76	324	0.48
Great Meadows NWR	111	3.04	.	.	.	.	615	2.16
Ninigret NWR	141	2.9	455	11.69	22	27.5	10	0.27
Parker River NWR	61	3.31	618	14.95	0	0	2528	0.87
Rappahannock NWR	32	0.99	.	.	3	0.42	80	0.12

H. European Starling

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	86	8.67	.	.	0	0	94	6.7
East Shore Virginia NWR	53	0.62	0	0	1	0.05	3681	5.44
Great Meadows NWR	11	0.3	.	.	.	.	1067	3.75
Ninigret NWR	0	0	0	0	0	0	44	1.2
Parker River NWR	1060	57.48	0	0	0	0	18986	6.52
Rappahannock NWR	1	0.03	.	.	0	0	19991	29.53

I. Yellow Warbler

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	0	0	0	0
East Shore Virginia NWR	3	0.04	41	0.21	2	0.11	7	0.01
Great Meadows NWR	1	0.03	.	.	.	.	11	0.04
Ninigret NWR	0	0	4	0.1	0	0	0	0
Parker River NWR	0	0	44	1.06	0	0	75	0.03
Rappahannock NWR	0	0	.	.	0	0	19	0.03

J. Yellow-rumped Warbler

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	0	0	21	1.5
East Shore Virginia NWR	2745	32.09	12409	63.65	763	40.46	6521	9.64
Great Meadows NWR	59	1.61	.	.	.	.	324	1.14
Ninigret NWR	2959	60.8	2671	68.63	0	0	492	13.43
Parker River NWR	134	7.27	978	23.66	2	13.33	5977	2.05
Rappahannock NWR	202	6.26	.	.	142	20.08	684	1.01

Table 8 (contd).

K. Savannah Sparrow

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	54	5.44	.	.	0	0	1	0.07
East Shore Virginia NWR	468	5.47	4	0.02	105	5.57	36	0.05
Great Meadows NWR	1	0.03	.	.	.	.	446	1.57
Ninigret NWR	0	0	6	0.15	0	0	0	0
Parker River NWR	0	0	1	0.02	0	0	1709	0.59
Rappahannock NWR	0	0	.	.	0	0	506	0.75

L. Song Sparrow

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	8	0.81	.	.	7	2.56	15	1.07
East Shore Virginia NWR	512	5.99	298	1.53	1	0.05	224	0.33
Great Meadows NWR	262	7.17	.	.	.	.	986	3.46
Ninigret NWR	16	0.33	41	1.05	0	0	18	0.49
Parker River NWR	82	4.45	98	2.37	0	0	2183	0.75
Rappahannock NWR	75	2.32	.	.	8	1.13	1378	2.04

M. Northern Cardinal

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	0	0	10	0.71
East Shore Virginia NWR	289	3.38	118	0.61	35	1.86	249	0.37
Great Meadows NWR	77	2.11	.	.	.	.	459	1.61
Ninigret NWR	20	0.41	7	0.18	0	0	34	0.93
Parker River NWR	7	0.38	27	0.65	0	0	1010	0.35
Rappahannock NWR	120	3.72	.	.	29	4.1	707	1.04

N. Red-winged Blackbird

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	0	0	15	1.07
East Shore Virginia NWR	102	1.19	0	0	57	3.02	19586	28.95
Great Meadows NWR	145	3.97	.	.	.	.	1769	6.22
Ninigret NWR	0	0	0	0	0	0	28	0.76
Parker River NWR	0	0	0	0	0	0	359	0.12
Rappahannock NWR	66	2.05	.	.	0	0	13618	20.12

Table 8 (contd).

O. Common Grackle

Refuge	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canaan Valley NWR	0	0	.	.	0	0	9	0.64
East Shore Virginia NWR	48	0.56	0	0	0	0	1428	2.11
Great Meadows NWR	145	3.97	.	.	.	.	5514	19.38
Ninigret NWR	0	0	0	0	0	0	0	0
Parker River NWR	0	0	0	0	0	0	555	0.19
Rappahannock NWR	190	5.89	.	.	170	24.05	10209	15.08

Habitat analyses and activity budgets: Value of fruit and vegetation to birds.

Activity budgets: Activities and substrates

Refuges conducted over 5,000 activity budgets. Tables 9 and 10 contain complete lists of activity and substrate codes, grouped into like activities and substrates. Most of the activities were maintenance activities, such as looking and hopping. Foraging activities such as flycatching, gleaning, and plucking fruit were most representative of specific combinations of activity and the substrate towards which they were directed.

Substrates that the birds were using (Table 8) often contained obvious food, such as fruit and flowers. However, we assume that insects especially can be found in any and all substrates, especially those with interstices, such as bark and branches. For an effort summary of activity budgets by species, see Appendix C.

Table 9. List of activity codes from activity budget surveys with their definitions and the count of times a bird was observed in that activity. Activities were grouped in broad categories, based on the first activity if a double code was recorded (such as "AL-CH").

Category	Activity	Definition	Count
Sitting/looking	AL	active look	1,416
	AL-CH	active look/chattering	1
	AS	active sit	259
	AS-FL	active sit/fly	1
	bill wiping	bill wipe	1
	D	defecate	22
	PN	preen	45
	SI	sit quietly	45
			1,790
Call/Sing/Chatter	CA	call	379
	CA-FL	call/fly	9
	CH	chatter	29
	CH-HO	chatter/hop	1
	SG	sing	23
			441

Table 9 (contd.)

Category	Activity	Definition	Count
Active movement	CR	creep	4
	CS	chase	35
	FL	fly	1,291
	FL-CA	fly/call	1
	HO	hop	964
			2,295
Foraging	FC	flycatch	148
	GL	glean	302
	GLS	glean seeds	38
	HV	hover	16
	PE	peck	18
	PF	pick fruit	70
	PL	pluck	34
	PR	probe	9
			635
Other	Other	other	43
Total			5,207

Table 10. List of substrate codes from activity budget surveys with their definitions and category.

Category	Substrate	Definition
Branch/twig/stem	LB	large branch
	MB	medium branch
	SB	small branch
	SB, TW	small branch, twig
	STEM	stem
	TW	twig
Trunk	TR	trunk
	TR, LB	trunk, large branch
Fallen	FB	fallen branch
	FT	fallen twig
Terminal bud	TB	terminal bud
Flower	FL	flower
Foliage	FO	foliage
Fruit	FR	fruit
Vine	VINE	vine
	vine-grape	vine
Grass	GA	grass
Ground	GR	ground
	GROUND	ground
Other	OT	other
	PLASTIC	plastic

Available vegetation and bird use

We compared shrub habitat and fruit availability with bird use from activity budget surveys. We analyzed data from Eastern Shore of Virginia NWR, the only refuge that collected relevé vegetation, fruit surveys, and conducted activity budgets at the same locations (Table 11).

We found little specialization of foraging in these substrates, although the data clearly could benefit from more analyses, as well as additional data in different times of the season.

The vegetation with highest bird use (>10% each of all foraging activities) were Black Locust (18.1%), Groundsel Tree (14.8%), Black Cherry (11.5%), Bayberry (Wax Myrtles) (11.0%), and unidentified grasses (10.8%). Other species showing some use are blackberry (briars), grapes, Japanese honeysuckle, autumn olive, and loblolly pine. In general, fruiting species were used, but the birds spent a great deal of time in other foraging pursuits, probably primarily hunting insects, despite the likely diminishing returns as fall turns into winter.

Table 11. Vegetation recorded in relevé surveys at Eastern Shore of Virginia NWR in 2009 and 2010, showing fruit availability and bird foraging activities. The number and percentage of plots where each vegetation occurred is shown (*n*=127 plots). "Percent ripe fruit" is the percent of fruit that were ripe. "Bird activity budget" included all foraging activity types from the activity budgets, such as gleaning, pecking, plucking and flycatching. Each recorded activity was counted, and the percent of all foraging activities was calculated. Non-foraging activities such as preening and roosting were not included. Plant species which were used frequently in comparison to others (Use = F) or appeared to be used at a greater rate than their abundance would suggest, are indicated by an asterisk (*).

Abundance (Abun.) of the plant is coded as: A = Abundant (>40%), P = Present (15-40%), R = Rare (5-15%), and O=Occasional and very rare (≤ 5%). Use of the plant species is coded as: F = Frequent (>10%), M = Moderate (2-10%), S = Seldom (< 2%), and N = Not used.

				Vegetation		Percent ripe fruit	Bird activity budget	
Abun.	**Use**	**Common name**	**Scientific name**	**No. plots**	**Percent**		**Number**	**Percent**
A	F	Unidentified grass*		77	60.6	.	41	10.8
R	N	love grasses	*Eragrostis* spp.	9	7.1	.	.	.
R	S	Native warm season grasses		15	11.8	.	3	0.8
-	-	Common Ragweed	*Ambrosia artemisiifolia*	1	0.8	.	.	.
-	-	pussytoes	*Antennaria* spp.	5	3.9	.	.	.
R	N	Broomsedge Bluestem	*Andropogon virginicus*	11	8.7	.	.	.
R	N	Little Bluestem Grass	*Schizachyrium scoparium*	8	6.3	.	.	.
P	S	Horseweed	*Conyza canadensis*	17	13.4	.	6	1.6
-	-	Wild Carrot	*Daucus carota*	1	0.8	.	.	.

Table 11 (contd.)

				Vegetation		Percent ripe fruit	Bird activity budget	
Abun.	**Use**	**Common name**	**Scientific name**	**No. plots**	**Percent**		**Number**	**Percent**
-	-	American persimmon	*Diospyros virginiana*	1	0.8	.	.	.
-	-	fleabanes	*Erigeron* spp.	1	0.8	.	.	.
A	S	Dog Fennel	*Eupatorium capillifolium*	58	45.7	.	4	1
P	S	Sweet Fennel	*Foeniculum vulgare*	19	15	.	5	1.3
-	-	Eupatorium	*Eupatorium* spp.	1	0.8	.	.	.
-	-	clovers	*Lespedeza* spp.	2	1.6	.	.	.
-	-	Pokeweed	*Phytolacca americana*	2	1.6	10.8 (*n*=108)[1]	1	0.3
A	S	goldenrods	*Solidago* spp.	117	92.1	.	7	1.8
R	S	Dogbane; Indian hemp	*Apocynum cannabinum*	7	5.5	.	1	0.3
-	-	Devil's Walking Stick	*Aralia spinosa*	2	1.6	.	.	.
R	S	Trumpet Creeper	*Campsis radicans*	11	8.7	.	2	0.5
A	M	Japanese Honeysuckle	*Lonicera japonica*	57	44.9	.	8	2.1
R	S	Virginia Creeper	*Parthenocissus quinquefolia*	8	6.3	100.0 (*n*=89)	6	1.6
R	S	Multiflora Rose	*Rosa multiflora*	7	5.5	.	2	0.5
A	M	blackberry; briars	*Rubus* spp.	74	58.3	.	14	3.7
-	-	Poison Ivy	*Toxicodendron radicans*	6	4.7	.	.	.
R	M	grapes*	*Vitus* spp.	9	7.1	58.1 (*n*=111)	15	3.9
A	F	Groundsel Tree*	*Baccharis halimifolia*	60	47.2	.	54	14.2
-	-	Hackberry	*Celtis occidentalis*	1	0.8	.	2	0.5
-	-	Pagoda dogwood	*Cornus alternifolia*	1	0.8	.	.	.
-	-	Dogwood	*Cornus florida*	1	0.8	.	.	.
-	-	Persimmon Tree	*Diospyros virginiana*	3	2.4	.	5	1.3
P	M	Autumn Olive*	*Elaeagnus umbellata*	15	11.8	100.0 (*n*=12)	15	3.9
-	-	American Holly	*Ilex opaca*	.	.	.	.	.

Table 11 (contd.)

				Vegetation		Percent ripe	Bird activity budget	
Abun.	**Use**	**Common name**	**Scientific name**	**No. plots**	**Percent**	**fruit**	**Number**	**Percent**
-	-	Yaupon holly	*Ilex vomitoria*	.	.	.	1	0.3
-	-	Juniper	*Juniper virginiana*	4	3.2	.	3	0.8
R	N	Eastern Red-cedar	*Juniperus virginiana*	7	5.5	.	.	.
-	-	Chinese Privet	*Ligustrum sinense*	1	0.8	.	1	0.3
-	-	privets	*Ligustrum* spp.	1	0.8	.	.	.
P	S	Sweetgum	*Liquidambar styraciflua*	19	15	.	3	0.8
A	F	Bayberry (Wax Myrtle)*	*Myrica* spp.	64	50.4	94.6 (*n*=79)	42	11.0
P	M	Loblolly Pine*	*Pinus taeda*	46	36.2	.	14	3.7
P	F	Black Cherry*	*Prunus serotina*	26	20.5	.	44	11.5
P	N	Callery Pear	*Pyrus calleryana*	17	13.4	.	.	.
-	-	Willow Oak	*Quercus phellos*	2	1.6	.	.	.
-	-	Northern Red Oak	*Quercus rubra*	2	1.6	.	2	0.5
-	-	Winged Sumac	*Rhus copallina*	1	0.8	.	1	0.3
R	N	Smooth Sumac	*Rhus glabra*	8	6.3	.	.	.
R	F	Black Locust*	*Robinia pseudoacacia*	7	5.5	.	69	18.1
O	M	Sassafras*	*Sassafras albidum*	3	2.4	.	9	2.4

[1]*n* = number of plants sampled for fruit production

MANAGEMENT RECOMMENDATIONS

Value of each protocol

As we have pointed out throughout this account, each protocol has advantages and disadvantages. These are reviewed below.

Censuses

Area search is good for quickly assigning the status of a bird at all seasons of the year and is relatively economical. This includes the very important data of abundances during the non-breeding season. Also, by using a standardized protocol, surveys in varied habitats and different treatments may be compared to assess the relative value of each to a particular species. Adding a mobbing playback tape is only slightly useful for attracting select species. One disadvantage of area searches is that they are time and personnel intensive compared to using citizen science databases.

eBird does a potentially very useful job by making use of many citizen scientists gathering data, although often without associated effort, as well as the locations may not be as precise as refuge-gathered area searches. However, with the tools now available on the eBird

web site (www.ebird.org), a great deal of very important information can be garnered from this large database and analyzed relatively easily at a low cost. Other large, citizen scientist databases that are available for analyses include the Breeding Bird Surveys (http://www.mbr-pwrc.usgs.gov/bbs/bbs.html) conducted by U.S.G.S. Patuxent Wildlife Research Center and the Christmas Bird Count (http://birds.audubon.org/christmas-bird-count) conducted by the National Audubon Society.

Area search power analysis for trends

The analyses we presented assumed relatively high parameters of alpha levels of 0.05-0.10, and detected population changes of 5-10%. By choosing to reduce either of these parameters to less stringent levels or choosing to accept a probability of detection under 0.90, it would reduce the number of samples or years needed to detect an increase or decrease in population levels. If requested, we can supply data, information, or analyses on other species and refuges.

Banding

Banding gives a great deal more information than mere abundance, and does a fairly good job at that task as well. Age ratio and capture-mark-recapture data gives information about productivity and survival during migration, while bird's body condition can provide information about the quality of the habitat. Since migration is a period associated with low survival in songbirds (Sillet and Holmes 2002), banding data from refuges during this crucial period can provide answers about some of the limiting factors associated with healthy migrating songbird populations (Newton 2006).

Operation of the stations is relatively expensive. As with eBird, banding stations are relatively common in the area of interest. Our data shows that in the states of the Northeast Region there are about 20 stations, and counting adjacent states, a total of approximately 65 stations (Table 12). Often a little bit of encouragement from refuge personnel can produce a great deal of very worthwhile data from these stations.

Table 12. Landbird Monitoring Network of the Americas (LaMNA) banding stations in some northeastern states.

State	Number of banding stations	Neighboring state with Banding NE Refuge
Connecticut	4	Massachusetts
Kentucky	1	Virginia
Maryland	7	Virginia
Massachusetts	6	Banding NE Refuge State
New Hampshire	5	Massachusetts
New Jersey	4	Banding NE Refuge State
New York	8	New Jersey, Rhode Island
North Carolina	7	Virginia
Pennsylvania	4	New Jersey
Rhode Island	3	Banding NE Refuge State
Tennessee	2	Virginia
Vermont	6	Massachusetts
Virginia	8	Banding NE Refuge State
West Virginia	0	NE Refuge State but no LaMNA banding stations
Total Stations	**65**	

Bird use of habitat

Detailed activity budgets allow an analyst to look at deeper questions about a species uses habitat. In combination with relevé vegetation and fruit surveys, one can analyze how birds use the available vegetation on a refuge. In our analysis of the Eastern Shore of Virginia NWR, we found birds foraged on nine plants at a greater rate than their abundance would suggest, indicating a possible preference for the food these plants produce or the insect fauna associated with them. Two of these plants were invasive species – the Autumn Olive and Black Locust, indicating a positive role in the ecosystem for plants that otherwise might be removed.

Relevé data was able to give good detail of vegetation coverage for the amount of time spent gathering the data. Without this detail, it would be difficult to discern which plants are most used by the birds compared to their occurrence on the landscape. More analyses could be done than what has been outlined in this report. Examples of additional information that could be obtained using the present vegetation relevé and activity budget protocol, are individual bird species' preferences for plant species, habitat structure, vegetation layers, and others.

Management questions and answers

Question 1: What fall-migrating landbirds of management concern are using national wildlife refuges in Region 5 during a specific time period (fall)? How are refuges different than the rest of the region?

Censuses (area search and eBird) and banding data bring complementary information about species using a specific location during fall season. Specific species, particularly smaller landbirds, tend to be detected through banding surveys while censuses will add data on those not usually caught in nets such as birds of prey, shorebirds, waterfowls, corvids, and others. It is important to repeat surveys at regular intervals throughout the season as well as over multiple years in order to assess species composition and abundance over time.

Comparing eBird and banding station data between a refuge and the surrounding landscape will help identify potentially unique bird habitats and associated bird species provided by refuges. Obtaining eBird data from internet is free and relatively easy to acquire. Unless requesting eBird data from eBird's personnel directly, basic skills with GIS will allow a user to obtain bird observations associated with a refuge (see section Methods and protocols – eBird). Additional banding data may potentially be obtained from banding stations neighboring the refuge(s) (see section Management recommendation – Value of each protocol – Banding).

Question 2: What is the body condition and age ratio of fall-migrating landbirds using national wildlife refuges in Region 5? How does this compare with the Region as a whole? Are coastal locations different than inland sites?

This question can be best answered through comparing banding data from the refuge with banding data from other regions (whether coastal/inland or northern/southern, etc). See section Management recommendation – Value of each protocol – Banding, for number of banding stations in the region and the section Methods and protocols – Banding, for the methodology used to calculate body condition and age ratio.

Question 3: What fall-migrating landbirds are using restored or actively managed shrub habitats on my refuge? How does the species composition and abundance compare with unmanaged sites? How does the composition of managed sites change over time as restoration and management proceed and the sites approach the desired future condition (management objective)?

During fall season, area searches can adequately shed light on the impact of managed versus unmanaged habitats on species composition and abundance. Taken over a period of years, it is possible to detect changes in a species' population. Results from power analysis can be used to determine the number of area searches needed each year in both managed and unmanaged sites in order to detect changes in bird abundance (see Table 4).

Additional insights can be found through the use of activity budget and vegetation surveys (relevé and fruit production). This would allow the manager to quantitatively compare bird's use of habitat between the two sites.

Question 4: What shrub species are fall-migrating landbirds using on my refuge? Are they eating mostly berries, mostly insects, or both? Are they using shrubs or trees with berries at a higher rate than shrubs or trees without berries?

The protocols for vegetation (relevé and fruit production) and activity budget surveys, when combined, are designed to provide fine scale information about bird's use of habitat and food sources in relation with habitat availability. The vegetation data gives an assessment of the resources available to birds, while the activity budget gives the birds a "vote" on what vegetation they use most as well as how they use it. Activity budgets include information on both the plants the birds are using and how they are using it – directly for food resources (plucking berries, gleaning insects), perches for flycatching, or for roosting and other activities.

Overall recommendations

Based on these conclusions, we would propose a tiered approach to monitoring based on available time, personnel and management questions (Table 13). One might also select one protocol above others depending upon monitoring needs.

Table 13. Recommendations based on personnel and budget availability for data collection as well as refuge management questions.

Budget	Protocol	Expenses	Information obtained	Training required
None	eBird only	Free	Distribution of species over the landscape and over time.	None
$	Area search	Relatively low cost to survey (mostly personnel)	Above information plus abundance and trends between years.	Bird identification using field guides and song tapes
$$$	Area search and banding	Above cost and substantial additional costs for banding material and personnel	Above information plus bird demographics and health condition.	Banding requires specialized training (see North American Banding Council website)
$$$$	Area search, banding, and activity budget	Additional cost of personnel for the activity budget	Above information plus birds' use of habitat.	Minor additional to the above
$$$$$	Area search, banding, activity budget, and vegetation (relevé and fruit)	Additional cost of personnel for vegetation	Above information plus how the bird's use of habitat relates to the available habitat and food resources (plant species, structure, etc).	Modest additional to the above

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APPENDIX A. A RAPID MONITORING PROTOCOL SUITABLE FOR ASSESSING THE STATUS AND CHANGE OVER TIME IN POPULATIONS OF FALL-MIGRATING LANDBIRDS USING SHRUB HABITATS ON SERVICE FIELD STATIONS

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BACKGROUND AND OBJECTIVES

Objectives

The purpose of this document is to outline what we have determined as the appropriate bird monitoring methods to assay the effects on birds of vegetation treatment methods used to manage and restore native shrubland habitat. These treatments are primarily to benefit migratory landbirds in the fall in stop-over habitat in New England shrublands, especially the Parker River, Rachel Carson, Great Meadows, and Rhode Island National Wildlife Refuges. This protocol and its Appendices describe the details of a sampling design and field data collection methods, post-data collection processing of samples, training of field observers, and suggest data analysis approaches.

Surveys ideally are performed within discrete management units ("plots") which receive different treatments to enhance shrub habitat quality for migrating birds. A small number of replicates of each treatment is best, acknowledging that generally only a few management units will receive similar treatments.

Metrics of Success

The objectives are to detect treatment-based differences in fall migratory bird response within a 5-10 year period, through changes in bird population size, demography, and behavior in the species of interest. This could also help the manager to determine effects of treatments on the vegetation itself through differences in habitat surrogates such as shrub density and cover, availability of berries, and diversity of fruiting shrub species. The benchmark is to strive to detect a 50% difference in the use of treated management units through the course of the fall migration period by the selected bird species.

Selection of Field Plots and Effort

This entire study is based on selection and monitoring of relatively small field "plots" where "treatments" take place on a Refuge. The treatments may be non-invasive, following normal succession, or may be intrusive. In many cases, the biologists will use totally opportunistic field plots that have good access to field personnel through existing trails or openings. If possible, additional plots can be selected that more fully represent the range of conditions, either existing or desired, on a Refuge.

Size of study plots

Ideally, each refuge will strive for at least two, approximately 10-acre (4 ha), plots where treatments have been carried out. Some Refuges with large areas of shrub habitat can extrapolate to Refuge as a whole by choosing plots whose habitat is representative.

Treatments considered

Initially, biologists can select study plots based on having at least one with a 'desired condition' and one that has potential for treatments. Desired condition would be what past research or observations have indicated as a high use habitat or area for migratory (and resident) landbirds. An example of a treatment plot would be converting to native shrubland, a grassland area, or a shrubland invaded by exotic shrubs.

Available personnel

In each refuge, ideally biologists can strive for a minimum of 6-8 hours per week for census and fruit assay. It would be beneficial to operate a constant-effort mist netting station for one to five days per week. While due to the limitations of personnel, Refuges can select subsets of monitoring methods, we strongly recommend that the minimum suite of methods (the "core metrics" referred to below) be employed on each Refuge unit.

Additional benefits

At the least, this work will provide critical data on life-history phenology and parameters of resident species. Also, the New England cottontail appears to use much the same vegetation as migrants, and the same metrics of available habitat might well apply.

METHODS

Bird Abundance

Numbers of birds over time during the rapidly-changing autumnal migration can be estimated by both direct census and by constant-effort capture and banding. The former is direct and various manifestations of it can provide an index to many species, while the latter provides many additional data, such as timing of physiological events and condition of the migrants.

Detailed discussion of the advantages and disadvantages of the commonly-used census methods can be found in various publications in the Literature Cited, especially Ralph and Scott (1981) and Ralph et al. (1993). Suffice it to say that all methods provide good, useful data, whether they are point counts, transect counts, spot mapping, or area searches. They do differ markedly in efficiency, however. Also, various methods of double counting distance estimation, and others often provide useful additions to the metrics.

In the fall (and other non-breeding situations), much research has shown that cue emission is much lower than in the breeding season so that methods that involve longer and more flexible techniques result in more detections. Thus, unless another method is already used in the fall, we recommend the Area Search technique that involves a plot of 1-2 ha, and up to about 3 ha. The size can be fixed at, for example 2 ha, or it can depend upon how much area can be fairly completely covered in 20 minutes (Appendix A1). The advantage of the method over point counts is that, as the observer moves around in a somewhat restricted area, unfamiliar calls can be tracked down, flocking birds can be followed, and quiet birds found. This method can measure changes in the relative abundance of landbirds from year to year or between seasons at many selected sites and habitats.

A useful method in the fall that increases detections of some species is the use of a tape-recorded owl being mobbed by a chickadee. The observer uses standard point count technique, repeated for three 5-minute counts. This has been shown to be an effective method of luring

some species closer to the observer (Gunn et al. 2000). This method is most effective in the post-breeding, and especially winter, season (K. Rosenberg, pers. comm.). This technique was tested on the Refuges and provides increased detections of some species. The specific methodology is in Appendix A2.

A very useful adjunct method is the use of eBird, a rich data source on the web. These data, taken by the public are proving to be very powerful tools in understanding bird changes and occurrences. Details of this method as applied to the refuges are in this report (Ralph et al. (2011), with eBird data downloaded from the Cornell University, Laboratory of Ornithology's Avian Knowledge Network (AKN, http://www.avianknowledge.net/content/).

Activity Budgets

Observations of foraging birds can determine utilized habitat and potential competition between species by recording location and activities of actively foraging birds. This method brings what is otherwise an abstraction of a bird being in a general habitat area to the actual use of a specific resource (e.g. fruit, insect) on a specific plant species. In this, the observer with a tape recorder and data sheet records the bird's activity, the substrate that it is foraging on or directing its attention towards (e.g., fruit, twigs, branches, ground, etc.), and the species of plant. We have found that a minimum of about 25 foraging individuals of a species can give an excellent measure of habitat use. A detailed protocol and data sheet is available in Appendix A3.

Constant Effort Mist-netting

Mist netting provides many data critical to understanding the health of birds in stop-over habitat, including demographics, physiology, and information on seldom-seen species. Ideally, biologists want to be able to check bird condition in various habitats and areas and at different stages of migration. Body condition basically measures the amount of fat and muscle standardizing for the overall size of the bird, and is calculated by dividing the wing length by the weight and multiplying by 100. Individuals differ according to their status as newly-arrived, in the process of generating fat stores, or as resident birds, and condition is a good estimate of their status. The generally-suggested methods of mist-netting are outlined in Hussell and Ralph (1998 and 2005) and specific protocols in Ralph et al. (1993).

Although it will be difficult to differentiate between different treatment areas through constant effort netting, biologists can compare use over time as habitats in or near capture stations are modified. Additionally, researchers such as those at University of Rhode Island and elsewhere could compare overall bird health (body composition) and associated vegetative composition to other sites in the region (P. Paton, pers. comm.).

Location of stations

While the greatest benefit would be locating the mist-netting stations either within the habitats of the "desired condition," near those habitats, or lastly, near the Refuges themselves, all would provide important information. If we do know that birds in the region of a Refuge and in similar habitat are in good condition, and appear to be foraging on a fruit of a plant species that is a major component of the habitat, we have learned a great deal.

Frequency of operations

As detailed in Hussell and Ralph (2005), while daily operations produce important information on surges of migrants and allows specific information on stopover ecology, less frequent operations can be very useful. A station operated once a week during migration will

give a general picture of the species and their status, and lay the foundation for future monitoring. A station operated every 2 or 3 days is a very useful interval for most analyses.

Vegetation and Habitat

It is essential that some metrics of vegetation composition and size be obtained from the study plots. Vegetation can be a tremendous time sink of field biologists, however, as the number of potential variables is almost unlimited. We have attempted to minimize the number of metrics to predict or confirm bird usages.

Density of vegetation

Many methods have been used; however, rather few are as parsimonious of time as relevé counts (pp. 37-39 in Ralph et al. 1993; Appendix A4). With this, an observer can obtain very good estimates of cover of the various species of trees and shrubs in an area approximately 50 m in radius within 15 minutes. Even simpler methods could be used, such as the vertical density cover at two levels of shrubs (e.g., <1.2 m and from 1.2 to 2 meters, O'Brien et al. 2008). In both these methods, biologists can use diversity of foliage height or species (H'), or an average cover of an area. In each study plot of 4 ha, we would recommend 9 stations, at each of the corners of the four 1-ha plots. Computer generated estimates from digital photos can also be used to contrast under and overstory density.

Fruit production

Fruit production has been quantified by many methods, including transects through treatment areas, recording individual species and reproductive status. While this data taken on a single date is useful for comparing between plots, sampling on multiple dates will capture the phenology of all fruiting species, including invasive species. Biologists can use the number of shrubs in various stages, or count individual binocular fields, or a unit area (e.g., 0.5 m^2).

The excellent method of Smith and McWilliams (2008-MS), uses less than 10 quadrats per refuge. The sizes of the quadrats are nested 4 m^2 for dense shrub species, and 10 m^2 quadrats for scattered tree species of interest. Within each quadrat, an index of fruit abundance and ripeness for each individual of each species is tallied.

An alternative method has been proposed by Jennifer McCabe (pers. comm.). In this method, each plot will be visited weekly to assess fruiting status and fruit availability. Researchers should note the species of fruiting plant (a simple list), the state of fruit ripeness, and the rough abundance of fruit (by plant species). To assess "fruit state" for each plot, the rough percentage of fruit that falls into each of the following four categories should be noted: Unripe; Ripe; Past Ripe (visual blight, wrinkling or drying); and Bare Stems (on plants that still possess fruit in some state).

To assess fruit abundance, the number of individual fruits should be estimated for each species using the scale developed by Smith and McWilliams (2008-MS): <10; 11-25; 26-100; 101-250; 251-1000; 1001-3000; 301-10000; and >10000.

A similar index method that assays fruits (and flowers) on shrubs and trees on a larger plot is contained in Ralph et al. (1977- MS; Appendix A5). By quickly counting fruit in binocular fields, in each of four directions and at set distances (e.g., for shrubs at 10 m (~300 m^2), and trees at 20-25 m (~1500 m^2)), site bias of fruiting can be reduced by sampling shrubs and trees from a much wider area. Another difference is that estimates of the actual number of fruits within a binocular field allow a somewhat more precise calculation of variance.

Invertebrate sampling

Total invertebrate biomass can be collected within all shrubland experimental and control plots as well as the inland migration station's shrub habitat not used in the experimental study with a method proposed by Jennifer McCabe (pers. comm.). This would not only allow us to compare arthropod biomass in experimental plots, but across all unaltered shrub habitat along transects. Invertebrate sampling methods include ground sampling (Berlese funnel and/or pitfall traps), and understory vegetation sampling (bowl traps). A subsample of every three invertebrates removed from each trap will be identified to family for a more in-depth picture of the invertebrate community at each site. Invertebrates can be sampled three times for 3-5 days each during the fall migration season, depending on the weather.

SUGGESTED SCHEDULE OF METHODS

We suggest a field schedule of two and a half months, from 15 August to 31 October, to encompass the main periods of migration. Based on these conclusions, our overall recommendations would be a tiered approach to monitoring based on available time, personnel and management questions (Table A1). One might also select one protocol above others depending upon monitoring needs.

Table A1. Recommendations based on personnel and budget availability for data collection as well as refuge management questions.

Budget	Protocol	Expenses	Information obtained	Training required
None	eBird only	Free	Distribution of species over the landscape and over time.	None
$	Area search	Relatively low cost to survey (mostly personnel)	Above information plus abundance and trends between years.	Bird identification using field guides and song tapes
$$$	Area search and banding	Above cost and substantial additional costs for banding material and personnel	Above information plus bird demographics and health condition.	Banding requires specialized training (see North American Banding Council website)
$$$$	Area search, banding, and activity budget	Additional cost of personnel for the activity budget	Above information plus birds' use of habitat.	Minor additional to the above
$$$$$	Area search, banding, activity budget, and vegetation (relevé and fruit)	Additional cost of personnel for vegetation	Above information plus how the bird's use of habitat relates to the available habitat and food resources (plant species, structure, etc).	Modest additional to the above

Weekly Monitoring

Core bird survey

20 minute Area Search– One observer counts all birds seen during four 20-minute searches, walking around in each ha of a 4-ha plot, returning to the center at the end of each survey, according to a protocol (Appendix A1).

Optional bird surveys

Mobbing Audiotape Protocol (Appendix A2)

Banding station - preferably in 'desired' habitat on or near refuge. List birds by species, age, sex, and condition, according to a protocol. For details, see Ralph et al. (1993) and Hussell and Ralph (1998, 2005).

Once a Season Monitoring

Core metrics

Activity Budget: Observe feeding behavior of up to 25 birds of single species, according to a protocol (Appendix A3).

Vegetation Composition, Density and Fruiting Plants Protocol: We suggest that biologists estimate vegetation composition, density, and fruit production at 9 locations within the 4-ha plot (Appendices A4 and A5 provide possible methods). Alternatively, O'Brien et al. (2008) and Smith and McWilliams (2008-MS) can be used if sampling designs correspond with the bird abundance data.

Possible Schedule for a Single Field Day

7 -10 a.m. Conduct area searches on two 4-ha plots.
10-11:30 a.m. Conduct behavioral observations throughout the 4-ha plot.
12:30 – 2 p.m. Employ attraction tape
2:30 – 4 p.m. Conduct vegetation and fruit surveys at 9 points (Can combine vegetation monitoring and behavioral observations, if someone on vegetation crew has birding skills.)
If you can add a second field day in a week – run the banding station. Alternatively, you can have the banding station run by volunteers or a different crew.

Suggestions for Training of Observers

As mentioned in sections above, training requirements in the fall are different from the more usual methods employed in the breeding season. Overall, training is somewhat less demanding than during the breeding season when the premium is on vocalizations and the array of species can be larger. For example, the Area Search technique enables personnel with lower levels of expertise to contribute good data, since it allows biologists to pursue flocking birds. For this season, visual observations make up a much larger proportion of detections of birds. While song recordings are commonly used during the breeding season, they are less valuable during this non-breeding season when calls are the predominate vocalization and are usually not given on recordings.

While banding requires a more intensive or specialized level of training than censuses, truly informative data can be gathered by partnering with nearby stations and have personnel operate stations on the Refuges once or twice a week.

Data Compilation and Analyses

The analysis methods described in the report of the data gathered in the pilot seasons (Ralph et al. 2011) will serve as good examples of how such data can be analyzed. The principal method that we suggest is simple tabular compilation of the data to demonstrate how many birds were detected per unit effort (e.g., per 20-minute Area Search or per 100 net-hours). This sort of compilation, coupled with simple statistics such as t-tests, will give much insight into the processes. Once the data are thoroughly understood, then the biologist will have some idea of hypotheses that could be tested from the data. At this point a statistician can be consulted for the next level of analyses, if desired. Often, however, the first step outlined above will prove to be fully sufficient for understanding of the basic phenomena examined.

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APPENDIX A1. Area Search Protocol (adapted from Ralph et al. 1993)

Background and Aims

The area search method has been adopted for a nation-wide survey, the Australian Bird Count (Ambrose 1989), and was chosen over several others because of its appeal to volunteers. It uses a method that, while quantitative, mimics the method that a birder would use while searching for birds in a given area. Essentially this is a series of four 20-minute point counts in which the observer can move around in a somewhat restricted area. In this way, unfamiliar calls can be tracked down and quiet birds can be found.

Methods

Preparation

The observer should be reasonably familiar with most (if not all) bird species likely to be encountered at the plot. This method allows the observer to track down unfamiliar birds, but walking the plot before a survey with a person familiar with the birds allows the observer to be more efficient.

Choosing a Plot

The plot should allow relatively easy detection and identification of birds (by sight or calls) and allow the observer to move about freely. We plan that the 4 areas are continuous, as shown in Figure A1. The search areas in this case would have adjoining boundaries.

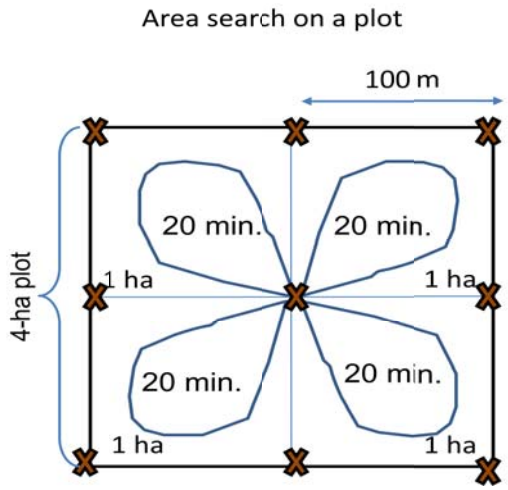
Time of Day

Because of the intensive nature of this method, it can be carried out longer into the morning than other methods. However, it should usually continue no later than five hours after dawn.

Field Work

One observer counts all birds seen during four 20-minute searches, walking around in each ha of a 4-ha plot, returning to the center at the end of each survey (Figure A1). Walk for exactly 20 minutes throughout each 1-ha search area, stopping or moving to investigate sightings or calls when appropriate. Record numbers of birds of each species seen, heard, or both seen and heard in the search area during this time. Record birds outside the search area separately, but concentrate on finding as many birds as possible within the search area. Birds in adjacent 1-ha search areas would be recorded as "outside" every time they were seen or heard. The observer may find it easier to tape record observations and then transfer results onto paper soon after the survey. An accompanying person can serve as a recorder. Total time per plot = 80 minutes, time of day for optimal counting = 1 hr after sunrise to 11 a.m., in order to let things warm up and allow for migrants to arrive.

Figure A1. Diagram of plot and general path of observer during area search for birds.



Recording

A standard form is suggested (Figure A2), listing the species found and a running tally of the number of birds, both on and off the area. These tallies can be totaled on the right of each area for each species.

Figure A2. Area search data form.

Refuge_____Treatment Unit_____ Plot Number_____Date_____
Observer 1_____Temp____C Cloud Cover(%)_____ Ppt_____
Observer 2 _____Wind_____Start Time _____ End Time _____

Species Name	4-letters Code	Within Search Area		Outside Search Area		Comments
		Detection Type	Total	Detection Type	Total	
Song Sp.	SOSP	2S, 1V	3			

Precipitation (Ppt): N=None, F=Fog, M=Mist, D=Drizzle, R=Rain
Wind: 0= Calm; 1= Light air, 2= leaves moving; 3= small branches moving; 4= mod breeze
Detection Type: S= Song, C=Call, V=Visual, W=Wing, D=Drumming, F=Flyover

Data Entry: Name_____ Date Entered _____
Date Verified_____

APPENDIX A2. Mobbing Audiotape Protocol

Objective

One observer uses mobbing audio tapes (chickadees after an owl) to attract birds, with sound emanating from the center of the 4-ha plot (Figure A3). Count all birds observed. Time of day is anytime from 1 hr after sunrise to 1 hr before sunset.

Background

Censusing of landbirds in North America for population size is largely concentrated in the breeding season, primarily May and June, because of the number of vocalizations during that period. In the post-breeding period and thereafter in the fall and winter, most species become much more secretive and detection rates decline dramatically, remaining low until early the next spring.

It is vital to have good detection rates of birds in the non-breeding seasons, as birds are then experiencing their highest mortality rates and are often more habitat specific. Other methods that have been shown to be effective to monitoring population size are 20-minute Area Searches, constant effort mist-netting, or a combination of both. Both allow for better identification of more secretive birds.

Testing of the responses of landbirds to the calls of owls and the calls of chickadees mobbing an owl have been shown to be an effective method of luring birds close to the observer (Gunn et al. 2000). This method is effective in the breeding season as birds will often come in with food in their mouths, confirming breeding status. In the post-breeding, fall, and winter the response was very high when used for the US Forest Service-funded project "Birds in Forested Landscapes" (K. Rosenberg, pers. com.).

We tested this method to determine its efficacy in detecting birds during the fall and into the winter (Ralph et al. 2011). In addition, it would be best to test the method at all times of the day, and in as many sites as possible. The principal metric of comparison is the number of detections and different species at various distances, in the three 5-minute periods of census, as detailed below.

An audio track we obtained from Cornell has a 5-minute Eastern Screech Owl with Black-capped Chickadees mobbing. This is the recording we supplied to researchers as an MPEG audio file (4.8MB). Rosenberg suggests placing the speaker either on the ground or hanging on a low branch, usually under some clearly visible branches in good light. It is often difficult to hear birds during this playing period, so stay well away from the player. This is why we have the final 5-minute listening period, because many birds will start vocalizing or resume singing after the mobbing has stopped.

Methods

Equipment

An MP3 player (a MPEG-1 Audio Layer 3), a popular digital audio encoding format, as in the commonly-used Apple iPod and a speaker (such as the $15-dollar Radio Shack #40-1441 speaker, or the impact resistant iMainGo at $50 through Amazon).

Procedure

At any time and place:

- Do a standard 5-minute point count using the mobbing audiotape data form - a variation on the standard point count form (Figure A4), recording number of birds and distances to the bird (or at least to 0-50 m, 50-100 m, and 100+ m bins). Use a notes column and/or a "Protocol Type" column to record that this count was prior to using an audio lure (e.g. Protocol = "N" [Normal]).
- Immediately after the first count, place the player/speaker under a tree or shrub face up, at least 10-25 m away from the observer.
- Start the second 5-minute census, playing the tape that contains an owl with chickadees mobbing at a loudness that is clearly audible at 25 m. Use a notes column and/or a "Protocol Type" column to record that which audio lure track was used (e.g. Protocol = "E" [Eastern Mobbing from Cornell].
- Turn the tape off and do a final, third, 5-minute census. Use a notes column and/or a "Protocol Type" column to record that this count followed the use of an audio lure (e.g. Protocol = "P" [Post-Audio Lure].

Figure A3. Speaker with mobbing tape is placed in the center of the 4-ha plot.

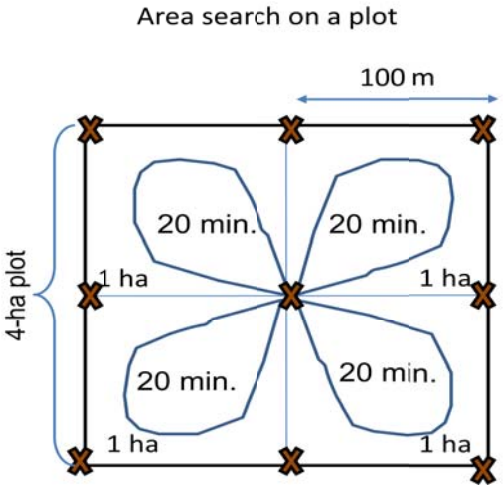


Figure A4. Mobbing audiotape data form.

Refuge_____Treatment Unit_____ Plot Number_____Date_____
Observer 1_____Temp____C Cloud Cover(%)_____ Ppt_____
Observer 2 _____Wind_____Start Time _____ End Time _____ Noise _____

Species	4-letter Code	5-min pre-audio			5-min audio playback			5-min post audio		
		0-50m	50-100m	>100m	0-50m	50-100m	>100m	0-50m	50-100m	>100m
Song Sp.	SOSP	3,1,1	2	1,1,1						

Precipitation (Ppt): N=None, F=Fog, M=Mist, D=Drizzle, R=Rain
Noise Level: 0= No appreciable effect on sampling: 1=slight effect (distant traffic); 2=moderate effect (intermittent traffic, waves)
Wind: 0= Calm; 1= Light air, 2= leaves moving; 3= small branches moving; 4= mod breeze

Data Entry: Name_____ Date Entered _____ Date Verified_____

APPENDIX A3. Activity Budget Protocol

Objective

To determine utilized habitat and potential competition between species by recording location and activities of foraging birds.

Methods

The Refuge will target 5-6 bird species for initial monitoring, species that have been observed foraging on fruit. However, the number of individuals present, the observers' ability to spot birds, and other factors may require any bird the observer sees to be targeted.

The observer, with a timer and data sheet (Figure A5), will walk through the entire 4-ha plot, and out about an additional 100 m around the 4-ha plot, making a 16-ha plot for this protocol (Figure A6). It is often possible for an observer to recall accurately most of the data below and a tape recorder will not usually be necessary. Estimation of the number of activities and other measurements (and even the length of observation), rather than a precise count, will generally provide excellent data. The most important data taken is the substrate (see below) and the species of plant.

While it is best if no more than one individual per species per 100 m is followed (assuring samples from the entire area), often birds are sparse between flocks, and individuals are recorded when and where they are encountered. The objective is to get at least 10 seconds of observation on an individual. We have found that a maximum of 30 seconds is sufficient.

Upon sighting and identification of a bird, the observer will turn on the timer and follow the bird's activity for 10-30 seconds and as the bird moves record one of the codes below:

ACTIVITY CODES:

CODE	ACTIVITY	CODE	ACTIVITY
HO	Hop, not using wings except for balance	FL	Fly, using wings
PR	Probe, beak placed into an opening, including flowers	GL	Glean, beak tip touched to surface of leaf, bark, fruit, etc.
FC	Flycatch, pursues aerial prey	HV	Hover, in flight, takes stationary prey
PE	Peck, forceful blow struck at substrate; includes flaking	SI	Sit, quietly on perch
AS	Sit, actively moving body, e.g. wings	PL	Pluck, removes fruit from substrate
CA	Call note	SG	Sing, starts a song bout
CH	Chatter, begins a chattering bout	PN	Starts a preening bout
AL	Active look, stationary, but actively looking about	CS	Chase, active pursuit of or by another bird
D	Defecate	OT	Other

If the bird changes its substrate during the observation, the observer will say "change" so that the activity type and duration in each substrate can be separated.

After the cessation of the 10-30 second observation, the observer will record the following:

1. Total time of observation and distance traveled by hops and flights, or both, during the observation.
2. The percent of time spent in each substrate towards which the bird directed its attention, as evidenced by probes, viewing, etc. If the bird changes its substrate during the observation, the observer will give the approximate percentage of time spent on each substrate type. The substrate can be classified as one of the following:

SUBSTRATE CODES:

CODE	SUBSTRATE	CODE	SUBSTRATE
FL	flowers	TB	terminal buds
TW	twigs (less than 1 cm)	SB	small branch (1-5 cm)
MB	medium branch (5-15 cm)	LB	large branch (greater than 15 cm)
TR	trunk (main support of tree and with characteristic bark)	FR	Fruit
SA	sap	FL, FT, FB	fallen log (or twigs, branches, etc.)
GR	ground	GA	Grass
OT	other		

Note will be taken of other noteworthy activity. These will be placed in the "notes" boxes.

3. The location of the bird will be recorded giving the height of the bird; height of the substrate that bird is in or on; if a plant, the species of plant (using as a code the first two letters of the common name); and time of day that the observation was taken.
4. Also entered on the data sheet will be the age and sex, if known, and if the bird was banded.
5. The number of activities will be recorded in the case of probes, hops, plucks, flights, gleans, flycatches, pecks, calls, and defecations. In the case of hover, sit, active sit, sing, preen, active look, chatter, and chase, an estimate of the amount of time spent in each activity will be recorded.

When 25 foraging (i.e., not singing, resting, etc.) individuals of a species have been tabulated in a month, these observations will end on this species for this month.

Analysis

Analysis of a compilation of these data will result in a description of the utilization of various substrates by the species of birds involved. An analysis over time will reveal seasonal changes. Both these approaches will help to define required habitat components and substrates or times of potential competition.

Figure A5. Activity budget data form.

Refuge_____Treatment Unit_____ Plot Number_____Date_____
Observer 1_____Temp____C Cloud Cover(%)_____ Ppt_____
Observer 2 _____Wind_____Start Time _____ End Time _____

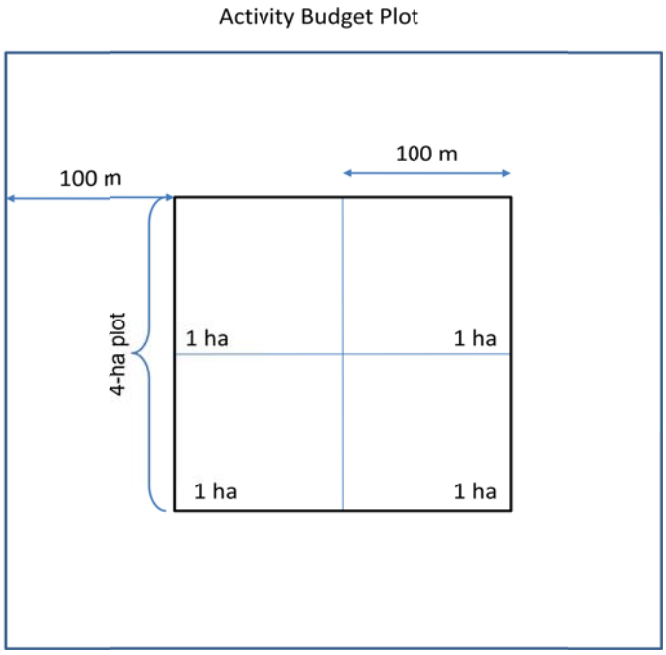
Note: one activity per line; note time you started following the bird; see example below.

Start Time	End Time	BIRD					PLANT			Notes
		Species (Code)	Sex	Age	Activity	Height of Bird (m)	Plant Species	Sub-strate	Height of Plant (m)	
00:00	*00:05*	*GRCA*	*F*	*AHY*	*CH*	*2.0*	*BLCH*	*SB*	*3*	Start 6:05a
00:05	*00:08*	*--*	*--*	*--*	*PL*	*1.5*	*BLCH*	*FR*	*--*	

Precipitation (Ppt): N=None, F=Fog, M=Mist, D=Drizzle, R=Rain
Wind: 0= Calm; 1= Light air, 2= leaves moving; 3= small branches moving; 4= mod breeze

Data Entry: Name_____ Date Entered _____
Date Verified_____

Figure A6. Search area for recording bird activity.



APPENDIX A4. Vegetation Composition and Density Protocol
(adapted from Ralph et al. 1993, pp. 37-39).

Estimation of Stand Characteristics

Objectives

This is a system for assessing habitat characteristics in an efficient and timely fashion at vertebrate monitoring stations. It is taken from a method developed by Bruce Bingham and C.J. Ralph.

Considerations

The information collected will provide enough data to determine the vegetation formation, association, and major structural characteristics. The types of data are those which have some logical relationship with bird requirements for feeding or nesting. The method provides enough quantitative information for correlative analyses and ordinations. It is flexible so that it can be applied to any vegetation formation, including deserts, grasslands, and forests.

Procedures

Establish a relevé, a variable radius plot centered, for example, on a census point. In each study plot of 4 ha, we would recommend 9 stations, at each of the corners of the four 1-ha plots. The size of the plot will vary, depending on the homogeneity of the vegetation composition, and the density of the vegetation. Generally, this would be a radius of less than 50 m, and often about 25 m. Walk around the point for no more than 5-10 minutes, or until you stop adding new species, whichever is less. Once the search is stopped, the distance from the stopping point, or the outermost boundary of vegetation that the observer can see from the point center, is the radius of the plot and is treated as a boundary for estimating relative abundance.

If the point has more than one vegetation type, then establish two relevés. An example would be along a road, with a clearcut on one side, and a mature forest on the other. No more than two relevés should be established at a point.

Determine the number of major layers of vegetation within your relevé by their dominant growth form: tree layer (T), shrub layer (S), herb (H), and the ground cover (moss and lichen) layer (G).

In a forest with all layers, the tree layer is the uppermost stratum, dominated by mature trees. It may be a single layer, or consist of two or more sublayers recognizable by changes in density and canopy status (see below). The shrub layer is dominated by shrubs or small trees. The herb layer is dominated by low-growing plants, typically non-woody, although seedlings and other reproduction of trees and shrubs may be present. The ground layer is dominated by such plants as mosses, lichens, and liverworts. Bare ground and litter are ignored for this classification scheme.

We recommend the use of the following height classes for each stratum, if they are appropriate, because they can make the process less subjective. For example, the tree layer could include any plants taller than 5 m (in shorter forests, this might be lowered to 3 or 4 m, as appropriate). The shrub layer could then be established at between 50 cm to 5 m. The herb layer includes any plants less than 50 cm tall. The moss/lichen layer refers to a ground-appressed, low carpet, less than 10 cm high.

For purposes of bird-habitat association, only species of trees and shrubs need be identified and recorded in the data below. For other plants, a common name such as FERN,

HERB, MOSS, or LICH will suffice for most purposes. Plant ecologists have used some species in the herb or ground cover layers as indicative of a particular plant association. In this case, the species should be recorded.

Determine the average height of each major layer present and dominant plant species. It is desirable to have additional information on structure, such as the maximum and minimum d.b.h. of canopy trees and total percent cover value of each layer.

Determine relative importance of species in each layer present. Importance can be expressed as either abundance or cover. Percent cover is probably the most common, and we suggest using it.

Below is a detailed description of the data we suggest be recorded on the data form (Figure A7). The data are separated into Location Data and Vegetation Data.

Location Data

State or province

The 2-column code for the state or province.

Region

An 8-column code, designated by the investigator. Often, the name of the USGS quad, a prominent landmark, or a nearby town will provide the best code name.

Site data

- Latitude and longitude—For each point, latitude and longitude should be recorded as the southeast corner of the 1-minute block containing the point, as determined from accurate topographic maps. For example, 40°53’20"N, 124°08’45"W would be reduced to 4053-12408.
- Elevation to nearest meter, by using an altimeter.
- Aspect of the slope (the compass direction the observer faces when looking down hill) to the nearest degree, with a compass.
- Percent slope, with a clinometer.
- Presence (+) or absence (-) of water within the relevé.
- Plot radius, distance from the center to the edge of the relevé.

Vegetation Data

Vegetation structure and composition

- Total cover—Estimate the cover of each of the four layers, according to the established scale such as Braun-Blanquet (Mueller-Dombois and Ellenberg 1974) or Daubenmire (1968). We recommend the Braun-Blanquet Cover Abundance Scale, which is: 5 => 75 percent cover; 4 = 50-75 percent cover; 3 = 25-50 percent cover; 2 = 5-25 percent cover; 1 = numerous, but less than 5 percent cover, or scattered, with cover up to 5 percent; + = few, with small cover; and r = rare, solitary, with small cover.
- Height—Record to the nearest decimeter (0.1 m) the *average* height of the lower and upper bounds of each of the four layers.
- Species—Record the species by a 4-letter code (using the first two letters of the genus and the first two of the species) with the greatest cover (foliage or crown cover) within each layer’s boundary.

- D.B.H.—For each layer where trees are present, record the diameter at breast height to the nearest centimeter of the largest tree in the layer and also for the smallest trees.
- Species—Record the species of trees used for minimum and maximum d.b.h. measurements
- Number of sublayers—Sublayers are useful to give the plant ecologist a quick overview of the structure of a layer, and are primarily relevant to the tree layer, although sometimes seen in the shrub layer. Record the number of sublayers visible in each primary layer. Record "1" if the layer is uniform and "2" or more if more than a single layer is divided into sublayers. In a primary layer, sublayers are sometimes obvious because of one or more species with shorter heights than the dominant species of the upper portion of the layer. In addition, sublayers are sometimes formed by cohorts of one or more size classes, possibly related to some event. For example, the tallest trees in a stand may form an open (low-density) layer of emergent individuals. Beneath that may be a denser layer of trees forming the main body of the tree layer. Below this denser layer may be another open or closed layer of trees that are intermediate to the main body of the canopy. This layer may consist of shade tolerant species or reproduction. Biologists should be cautioned that extreme precision is not required for this estimation, and unless sublayers are very obvious, they should not be recorded.

Species composition data

- Sublayer—For layers where sublayers have been recognized, record the sublayers with a letter designating the primary layer, followed by a number (e.g., T1, T2, T3, S1, etc.), indicating the sublayers by decreasing heights.
- Cover or cover abundance value, as above, using the Braun-Blanquet method—Because of the difficulty of determining crown covers independently for species of trees in a canopy, sometimes basal area cover of stems (trunks) has been used for tree layer species and crown cover for species in other layers. We suggest the cover abundance value for consistency.
- Species—Record the species' name for each plant species making up at least 10 percent of the cover.

Additional/optional information can be integrated into the method, if desired:

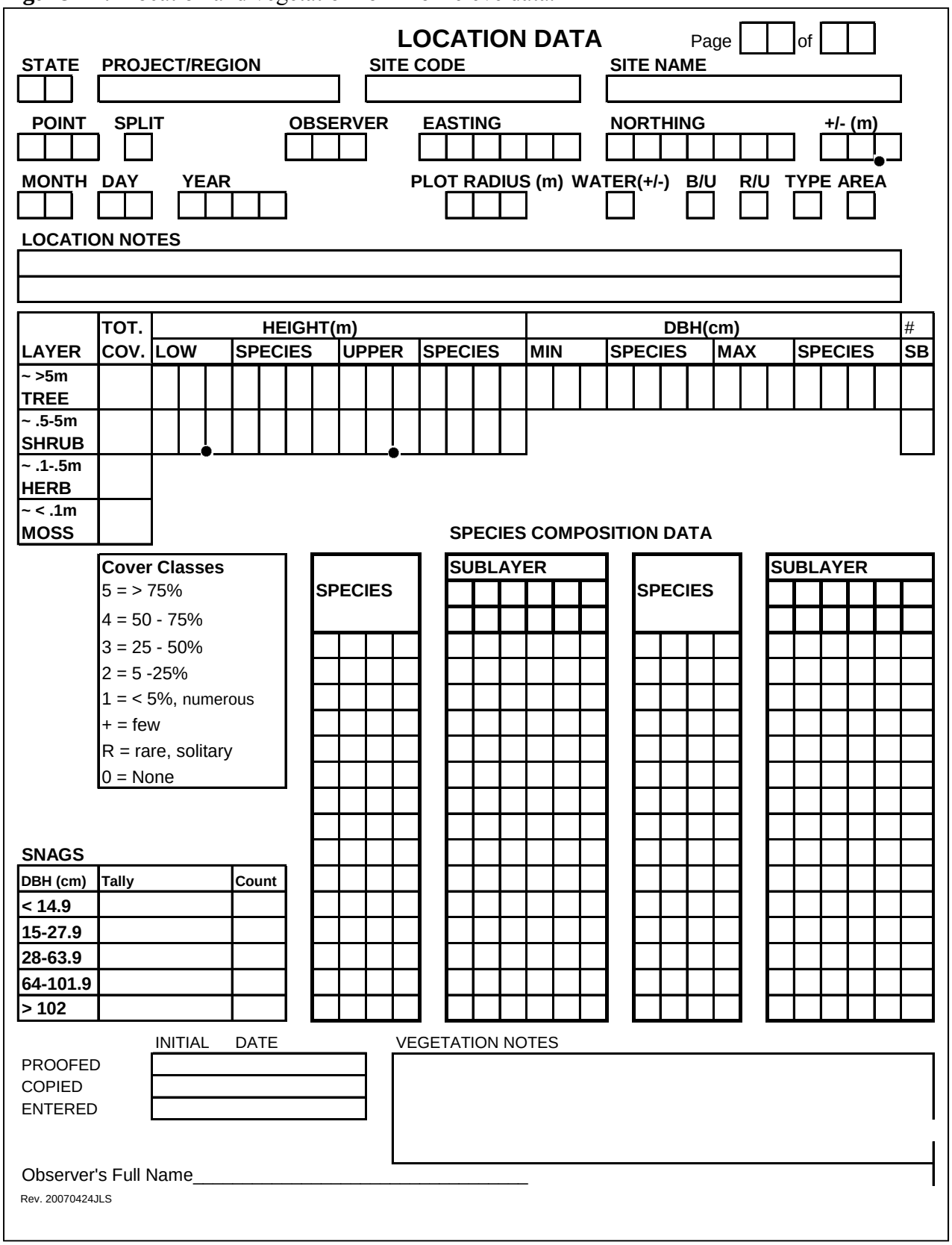
- Snags—List layers with snags present; separate into those with a d.b.h. of less than 10 cm and those larger.
- Logs—List those less than 10 cm diameter at large end by abundance or cover class, and those greater than 10 cm.

Comments—This type of vegetation assessment is limited by the size of the plot and the amount of estimation required. For example, a plot of even 50 m in radius obviously does not include all vegetation inhabited by birds heard or seen from a census point. This would require a plot of 200 m or more radius. However, most birds detected at a point are within 100 m, and many are within 50 m. Further, time limitations would require much more time spent monitoring vegetation than spent counting birds.

When observers are required to estimate, a substantial amount of error is introduced. What effect the degree of observer error likely with estimation would have on conclusions should be established. The principal source of error in this method of vegetation assessment is

the determination of percent cover and heights. Intensive training can moderate this source of error, enabling each vegetation assessment to be placed into at least broad categories or plant associations.

Figure A7. Location and vegetation form for relevé data.



LOCATION DATA Page ___ of ___

STATE | PROJECT/REGION | SITE CODE | SITE NAME

POINT | SPLIT | OBSERVER | EASTING | NORTHING | +/- (m)

MONTH | DAY | YEAR | PLOT RADIUS (m) | WATER(+/-) | B/U | R/U | TYPE | AREA

LOCATION NOTES

LAYER	TOT. COV.	HEIGHT(m) LOW	SPECIES	UPPER	SPECIES	DBH(cm) MIN	SPECIES	MAX	SPECIES	# SB
~ >5m TREE										
~ .5-5m SHRUB										
~ .1-.5m HERB										
~ < .1m MOSS										

Cover Classes
5 = > 75%
4 = 50 - 75%
3 = 25 - 50%
2 = 5 -25%
1 = < 5%, numerous
\+ = few
R = rare, solitary
0 = None

SPECIES COMPOSITION DATA

SPECIES	SUBLAYER	SPECIES	SUBLAYER

SNAGS

DBH (cm)	Tally	Count
< 14.9		
15-27.9		
28-63.9		
64-101.9		
> 102		

	INITIAL	DATE
PROOFED		
COPIED		
ENTERED		

VEGETATION NOTES

Observer's Full Name_____

Rev. 20070424JLS

APPENDIX A5. Fruiting Plants Protocol

Objective

To quantify and determine the abundance and periodicity of the fruiting of species of plants utilized by birds.

Methods

The abundance of fruit (and flowers, in the appropriate season) of plants can tell us a great deal about the success of restoration of habitat and its potential for migratory birds. Selecting the tree or shrub species to quantify will involve, in this first season, the judgment of the biologists involved. The phenology of the species (the change over time of fruit abundance) is important; however, at this stage in the monitoring we feel that it is sufficient to record the abundance of fruit only once in the season. We would suggest sometime in the first two weeks of October, as possible and appropriate. In future seasons, a more frequent sampling could be done.

Plants can be sampled at stations on the four 1-ha plots, and in eight 10-m wide transects between the stations. Each sampling station will be a corner of a 1-ha plot, 100 meters apart (Figure A8). At the sampling station, the location will be recorded in the first columns on the data form (Figure A9). Each refuge can select the 3-5 species of the commonest or most important fruit-producing plant species ("primary species"), and 3-5 less common (but major fruit-producing) species that the Refuge wishes to quantify. The species should be divided into those which are tall trees (5 m or more, if present), understory trees (which may be of the same or other species) (1-5 m tall), and shrubs (0.5-3 m).

We suggest that the fruits of the species selected be counted at each of the nine sampling stations. Here, the observer will mentally divide the area into four quadrats (NE, NW, SE, and SW). In each quadrat, fruits on trees or shrubs will be counted on an individual plant present at or near the correct distance, determined by using a range finder. The tall trees will be between 20-25 m distant, short trees 10 m away, and shrubs at approximately 2 meters. If a tree or shrub is not present in a quadrat, then none would be counted. The observer can adjust their position to get a good view of the target plant (for example, if you have decided to sample species A and B). You will record data for each species at the appropriate distance for its physiognomy within each quadrant.

To sample the selected tree, the observer can use binoculars (preferably 8 power; the power and field of view would be recorded; the area surveyed can be calibrated from this information) to focus on the middle third down from the top of the tree, estimate the percent of the field of view filled by the leaf area of the subject, and count the fruit present. The percent field will be recorded to the nearest 10 percent and the number of fruit recorded, and their degree of ripeness (unripe, ripe, shriveled and overripe) estimated, if possible. An example would be blackberry where unripe would be green, and ripe could be brownish/reddish to black. For shrubs at 2 m, count leaf area and fruits within an approximate 1 m^2 area of the shrub.

Upon completion of the station sampling, the observer can move along the line to the next station and, while traversing the line, can count fruit on a defined set of species of rarer bushes and small trees. Individuals of these plant species, if present within 10 m on either side of the line between sampling stations, can be permanently marked with flagging, or, preferably, spray paint, and their positions mapped so they can be located easily (this is helpful if you plan to sample the same plots in succeeding years). On the survey, the observer will count all the

berries present on each of these plants. If other species of plants are found to be used by birds, they can be added to the tally. Each plant species will be chosen according to the criteria involving height or basal diameter, as appropriate for that species.

Analysis

These data will be tabulated by sampling station over time, as well as for the entire study plot. These data will then be correlated with the abundance of birds for the Observation unit and Census Technique Unit. The analysis of the Activity Budget Unit will provide information on the use of the resources by birds relative to the abundance of the resources.

Figure A8. Suggested layout of nine phenology stations in four 1-ha plots.

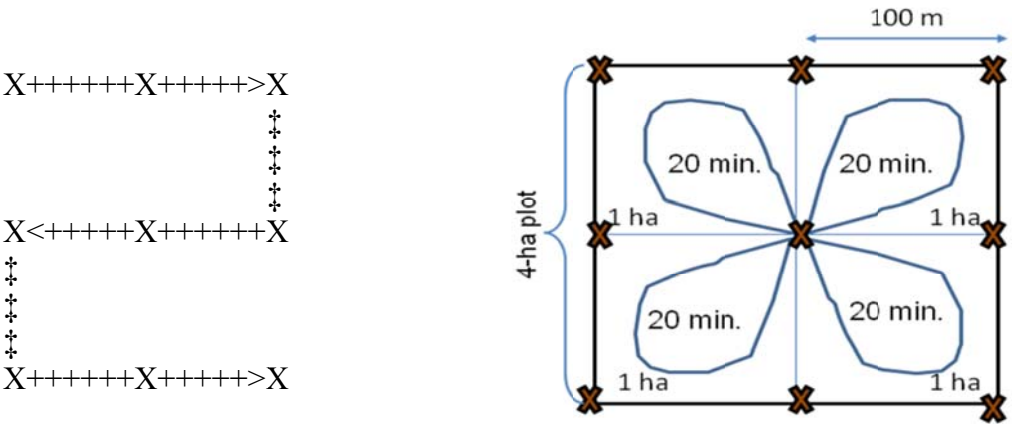


Figure A9. Phenology data form.

PHENOLOGY OF FRUTING

Page ____ of ____

State ____ Refuge/Unit ____ Site Code ____ Site Name ____

Observer Initials ____ Observer Name ____ Month ____ Day ____ Year ____

Station	Quadrat	Height	Species	Distance (m)			Number Berries		
				20+	10	2	Unripe	Ripe	Over ripe

Notes: ____

Checked_____ Copied_____ Entered_____

APPENDIX B. COMPARISON OF ESTIMATES OF ABUNDANCE BY REFUGE AND PROTOCOL

For each Refuge and protocol, we calculated estimates of abundance for data gathered from 2008 to 2010, end of August to end of November, by four protocols: area search, banding mobbing surveys, and eBird. We combined the results into one table per Refuge to compare the effectiveness of the different protocol types for each species (Tables B1-B6). Refuges are listed in alphabetical order. The percent variable represents the percent of individuals detected per species within the protocol (ex: 61 Canada Goose represent 6.15 % of Canaan Valley's birds counted during the area searches surveys). Select species are discussed in more detail in the earlier section "Degree of agreement and effectiveness of various monitoring protocols."

Canaan Valley NWR

Table B1. Comparison of species count and percentage found in Canaan Valley NWR.

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Canada Goose	61	6.15	.	.	17	6.23	56	.
Tundra Swan	.	.	.	.	.	.	36	.
Wood Duck	.	.	.	.	.	.	3	.
Mallard	.	.	.	.	.	.	29	.
Blue-winged Teal	.	.	.	.	.	.	1	.
Wild Turkey	.	.	.	.	.	.	24	1.71
Pied-billed Grebe	.	.	.	.	.	.	4	.
Great Blue Heron	2	0.2	.	.	1	0.37	4	.
Green Heron	1	0.1	.	.	.	.	.	.
Black Vulture	.	.	.	.	.	.	3	0.21
Turkey Vulture	4	0.4	.	.	.	.	18	1.28
Bald Eagle	.	.	.	.	.	.	1	0.07
Northern Harrier	5	0.5	.	.	.	.	3	0.21
Sharp-shinned Hawk	.	.	.	.	1	0.37	2	0.14
Cooper's Hawk	.	.	.	.	.	.	6	0.43
Red-shouldered Hawk	.	.	.	.	.	.	1	0.07
Broad-winged Hawk	.	.	.	.	.	.	2	0.14
Red-tailed Hawk	.	.	.	.	1	0.37	9	0.64
Golden Eagle	.	.	.	.	.	.	1	0.07
American Kestrel	1	0.1	.	.	.	.	4	0.29
Killdeer	1	0.1	.	.	1	0.37	1	.
Mourning Dove	8	0.81	.	.	6	2.2	7	0.5
Yellow-billed Cuckoo	.	.	.	.	.	.	3	0.21
Black-billed Cuckoo	.	.	.	.	.	.	1	0.07
Great Horned Owl	.	.	.	.	.	.	4	0.29
Barred Owl	.	.	.	.	.	.	1	0.07
Common Nighthawk	1	0.1	.	.	.	.	.	.
Chimney Swift	.	.	.	.	.	.	1	0.07
Ruby-throated Hummingbird	.	.	.	.	.	.	2	0.14
Belted Kingfisher	.	.	.	.	1	0.37	2	0.14
Red-bellied Woodpecker	.	.	.	.	.	.	5	0.36

Table B1. (contd).

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Yellow-bellied Sapsucker	.	.	.	.	.	.	4	0.29
Downy Woodpecker	.	.	.	.	1	0.37	9	0.64
Hairy Woodpecker	.	.	.	.	.	.	5	0.36
Northern Flicker	11	1.11	.	.	4	1.47	29	2.07
Pileated Woodpecker	1	0.1	.	.	.	.	6	0.43
Eastern Phoebe	11	1.11	.	.	2	0.73	14	1
Great Crested Flycatcher	.	.	.	.	.	.	2	0.14
Blue-headed Vireo	.	.	.	.	.	.	5	0.36
Philadelphia Vireo	.	.	.	.	.	.	1	0.07
Red-eyed Vireo	.	.	.	.	.	.	9	0.64
Blue Jay	38	3.83	.	.	29	10.62	112	7.98
American Crow	170	17.14	.	.	64	23.44	338	24.09
Common Raven	1	0.1	.	.	1	0.37	21	1.5
Tree Swallow	30	3.02	.	.	.	.	.	.
Black-capped Chickadee	15	1.51	.	.	25	9.16	82	5.84
Tufted Titmouse	9	0.91	.	.	4	1.47	41	2.92
Red-breasted Nuthatch	.	.	.	.	.	.	9	0.64
White-breasted Nuthatch	3	0.3	.	.	4	1.47	25	1.78
Carolina Wren	.	.	.	.	.	.	4	0.29
House Wren	.	.	.	.	2	0.73	2	0.14
Marsh Wren	1	0.1	.	.	.	.	.	.
Golden-crowned Kinglet	.	.	.	.	.	.	8	0.57
Ruby-crowned Kinglet	.	.	.	.	.	.	1	0.07
Eastern Bluebird	56	5.65	.	.	.	.	3	0.21
Swainson's Thrush	.	.	.	.	.	.	1	0.07
Hermit Thrush	.	.	.	.	.	.	8	0.57
Wood Thrush	.	.	.	.	.	.	1	0.07
American Robin	.	.	.	.	5	1.83	35	2.49
Gray Catbird	1	0.1	.	.	.	.	5	0.36
Brown Thrasher	.	.	.	.	.	.	4	0.29
European Starling	86	8.67	.	.	.	.	94	6.7
Cedar Waxwing	35	3.53	.	.	.	.	29	2.07
Ovenbird	.	.	.	.	.	.	1	0.07
Black-and-white Warbler	.	.	.	.	.	.	3	0.21
Tennessee Warbler	.	.	.	.	.	.	1	0.07
Nashville Warbler	.	.	.	.	.	.	1	0.07
Common Yellowthroat	122	12.3	.	.	13	4.76	10	0.71
American Redstart	.	.	.	.	.	.	9	0.64
Cape May Warbler	.	.	.	.	.	.	3	0.21
Magnolia Warbler	.	.	.	.	.	.	12	0.86
Bay-breasted Warbler	.	.	.	.	.	.	1	0.07
Blackburnian Warbler	.	.	.	.	.	.	3	0.21
Chestnut-sided Warbler	.	.	.	.	.	.	2	0.14
Blackpoll Warbler	.	.	.	.	.	.	3	0.21
Black-throated Blue Warbler	.	.	.	.	.	.	5	0.36
Palm Warbler	10	1.01	.	.	2	0.73	10	0.71

Table B1. (contd).

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Pine Warbler	.	.	.	.	.	.	1	0.07
Yellow-rumped Warbler	.	.	.	.	.	.	21	1.5
Black-throated Green Warbler	.	.	.	.	.	.	27	1.92
Eastern Towhee	2	0.2	.	.	.	.	11	0.78
Chipping Sparrow	2	0.2	.	.	.	.	2	0.14
Field Sparrow	.	.	.	.	.	.	16	1.14
Vesper Sparrow	3	0.3	.	.	1	0.37	1	0.07
Savannah Sparrow	54	5.44	.	.	.	.	1	0.07
Song Sparrow	8	0.81	.	.	7	2.56	15	1.07
Lincoln's Sparrow	24	2.42	.	.	.	.	.	.
Swamp Sparrow	25	2.52	.	.	15	5.49	16	1.14
White-throated Sparrow	.	.	.	.	.	.	5	0.36
Slate-colored Junco	.	.	.	.	.	.	70	4.99
Scarlet Tanager	.	.	.	.	.	.	1	0.07
Northern Cardinal	.	.	.	.	.	.	10	0.71
Rose-breasted Grosbeak	.	.	.	.	.	.	2	0.14
Indigo Bunting	.	.	.	.	.	.	3	0.21
Red-winged Blackbird	.	.	.	.	.	.	15	1.07
Eastern Meadowlark	17	1.71	.	.	1	0.37	9	0.64
Common Grackle	.	.	.	.	.	.	9	0.64
House Finch	.	.	.	.	.	.	3	0.21
Pine Siskin	.	.	.	.	.	.	13	0.93
American Goldfinch	173	17.44	.	.	65	23.81	81	5.77
Totals	992	99.99	0	0	273	100.03	1537	99.94

Eastern Shore of Virginia NWR

Table B2. Comparison of species count and percentage found in Eastern Shore of Virginia NWR.

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Mute Swan	.	.	.	.	.	.	24	.
Tundra Swan	.	.	.	.	.	.	31	.
Wood Duck	30	0.35	.	.	.	.	21	.
Gadwall	.	.	.	.	.	.	3	.
American Black Duck	.	.	.	.	.	.	97	.
Mallard	.	.	.	.	.	.	22	.
Blue-winged Teal	.	.	.	.	.	.	4	.
Green-winged Teal	.	.	.	.	.	.	31	.
Ring-necked Duck	.	.	.	.	.	.	1	.
Common Eider	.	.	.	.	.	.	1	.
Surf Scoter	.	.	.	.	.	.	74	.
White-winged Scoter	.	.	.	.	.	.	5	.
Black Scoter	.	.	.	.	.	.	28	.
Bufflehead	.	.	.	.	.	.	88	.
Hooded Merganser	.	.	.	.	.	.	10	.
Red-breasted Merganser	.	.	.	.	.	.	4	.
Ruddy Duck	.	.	.	.	.	.	1	.
Northern Bobwhite	26	0.3	.	.	5	0.27	4	0.01
Wild Turkey	2	0.02	.	.	.	.	5	0.01
Red-throated Loon	.	.	.	.	.	.	4	.
Common Loon	.	.	.	.	2	0.11	56	.
Pied-billed Grebe	.	.	.	.	.	.	11	.
Horned Grebe	.	.	.	.	.	.	7	.
Northern Gannet	.	.	.	.	.	.	275	.
Double-crested Cormorant	3	0.04	.	.	16	0.85	3757	.
Great Cormorant	.	.	.	.	.	.	4	.
American White Pelican	.	.	.	.	.	.	4	.
Brown Pelican	.	.	.	.	.	.	1443	.
American Bittern	1	0.01	.	.	.	.	1	.
Great Blue Heron	.	.	.	.	.	.	246	.
Great Egret	.	.	.	.	.	.	256	.
Snowy Egret	.	.	.	.	.	.	220	.
Little Blue Heron	.	.	.	.	.	.	36	.
Tricolored Heron	.	.	.	.	.	.	30	.
Green Heron	1	0.01	1	0.01	.	.	9	.
Black-crowned Night-Heron	.	.	.	.	.	.	13	.
Yellow-crowned Night-Heron	.	.	.	.	.	.	11	.
White Ibis	.	.	.	.	.	.	1151	.
Glossy Ibis	.	.	.	.	.	.	10	.
Black Vulture	25	0.29	.	.	3	0.16	678	1
Turkey Vulture	66	0.77	.	.	23	1.22	1976	2.92
Osprey	3	0.04	.	.	1	0.05	415	0.61
Bald Eagle	3	0.04	.	.	5	0.27	243	0.36

Table B2 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Northern Harrier	13	0.15	.	.	6	0.32	157	0.23
Sharp-shinned Hawk	39	0.46	110	0.56	24	1.27	948	1.4
Cooper's Hawk	24	0.28	11	0.06	7	0.37	400	0.59
Northern Goshawk	1	0.01	.	.	.	.	.	.
Red-shouldered Hawk	.	.	.	.	.	.	26	0.04
Broad-winged Hawk	10	0.12	1	0.01	2	0.11	245	0.36
Swainson's Hawk	.	.	.	.	.	.	1	0
Red-tailed Hawk	6	0.07	.	.	.	.	167	0.25
Golden Eagle	.	.	.	.	.	.	2	0
American Kestrel	15	0.18	.	.	2	0.11	567	0.84
Merlin	10	0.12	.	.	7	0.37	141	0.21
Peregrine Falcon	7	0.08	.	.	4	0.21	114	0.17
Clapper Rail	2	0.02	.	.	.	.	133	.
Virginia Rail	.	.	.	.	.	.	2	.
American Coot	.	.	.	.	66	3.5	.	.
Black-bellied Plover	.	.	.	.	.	.	38	.
Semipalmated Plover	.	.	.	.	.	.	9	.
Killdeer	3	0.04	.	.	1	0.05	156	.
American Oystercatcher	.	.	.	.	.	.	38	.
Spotted Sandpiper	.	.	.	.	.	.	8	.
Greater Yellowlegs	.	.	.	.	1	0.05	92	.
Willet	.	.	.	.	.	.	266	.
Lesser Yellowlegs	.	.	.	.	.	.	29	.
Marbled Godwit	.	.	.	.	.	.	111	.
Ruddy Turnstone	.	.	.	.	.	.	26	.
Sanderling	.	.	.	.	.	.	150	.
Semipalmated Sandpiper	.	.	.	.	.	.	1	.
Western Sandpiper	.	.	.	.	.	.	1	.
Least Sandpiper	.	.	.	.	.	.	41	.
Pectoral Sandpiper	.	.	.	.	.	.	1	.
Purple Sandpiper	.	.	.	.	.	.	28	.
Dunlin	.	.	.	.	.	.	30	.
Short-billed Dowitcher	.	.	.	.	.	.	3	.
Long-billed Dowitcher	.	.	.	.	.	.	1	.
Wilson's Snipe	1	0.01	.	.	1	0.05	3	.
American Woodcock	5	0.06	8	0.04	.	.	3	.
Bonaparte's Gull	.	.	.	.	.	.	25	.
Laughing Gull	.	.	.	.	.	.	2587	.
Ring-billed Gull	.	.	.	.	.	.	1002	.
Herring Gull	.	.	.	.	.	.	787	.
Lesser Black-backed Gull	.	.	.	.	.	.	1	.
Great Black-backed Gull	.	.	.	.	.	.	1159	.
Least Tern	.	.	.	.	.	.	1	.
Gull-billed Tern	.	.	.	.	.	.	1	.
Caspian Tern	.	.	.	.	1	0.05	32	.
Black Tern	.	.	.	.	.	.	6	.

Table B2 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Common Tern	.	.	.	.	.	.	13	.
Forster's Tern	.	.	.	.	.	.	271	.
Royal Tern	.	.	.	.	.	.	79	.
Sandwich Tern	.	.	.	.	.	.	5	.
Black Skimmer	.	.	.	.	.	.	20	.
Rock Pigeon	.	.	.	.	.	.	5243	7.75
Eurasian Collared-Dove	.	.	.	.	.	.	69	0.1
Mourning Dove	15	0.18	4	0.02	3	0.16	408	0.6
Yellow-billed Cuckoo	6	0.07	32	0.16	.	.	8	0.01
Black-billed Cuckoo	.	.	1	0.01	.	.	.	.
Eastern Screech-Owl	.	.	2	0.01	2	0.11	13	0.02
Great Horned Owl	.	.	.	.	.	.	11	0.02
Common Nighthawk	.	.	.	.	.	.	2	0
Chuck-will's-widow	.	.	.	.	.	.	1	0
Chimney Swift	.	.	.	.	.	.	22	0.03
Ruby-throated Hummingbird	6	0.07	.	.	.	.	36	0.05
Belted Kingfisher	1	0.01	.	.	2	0.11	57	0.08
Red-headed Woodpecker	.	.	.	.	.	.	8	0.01
Red-bellied Woodpecker	8	0.09	.	.	1	0.05	66	0.1
Yellow-bellied Sapsucker	1	0.01	9	0.05	.	.	27	0.04
Downy Woodpecker	4	0.05	1	0.01	1	0.05	52	0.08
Hairy Woodpecker	.	.	.	.	.	.	11	0.02
Northern Flicker	82	0.96	13	0.07	33	1.75	979	1.45
Pileated Woodpecker	7	0.08	.	.	3	0.16	22	0.03
Olive-sided Flycatcher	.	.	.	.	.	.	1	0
Eastern Wood-Pewee	.	.	6	0.03	.	.	10	0.01
Yellow-bellied Flycatcher	.	.	3	0.02	.	.	.	.
Acadian Flycatcher	.	.	2	0.01	.	.	1	0
Traill's Flycatcher	2	0.02	76	0.39	.	.	.	.
Eastern Phoebe	29	0.34	19	0.1	1	0.05	90	0.13
Great Crested Flycatcher	4	0.05	1	0.01	.	.	4	0.01
Western Kingbird	.	.	.	.	.	.	2	0
Eastern Kingbird	2	0.02	2	0.01	.	.	187	0.28
Loggerhead Shrike	.	.	.	.	.	.	1	0
White-eyed Vireo	12	0.14	11	0.06	.	.	6	0.01
Bell's Vireo	.	.	1	0.01	.	.	.	.
Yellow-throated Vireo	.	.	.	.	.	.	2	0
Blue-headed Vireo	.	.	5	0.03	.	.	3	0
Warbling Vireo	2	0.02	.	.	.	.	.	.
Philadelphia Vireo	1	0.01	8	0.04	.	.	1	0
Red-eyed Vireo	19	0.22	279	1.43	1	0.05	46	0.07
Blue Jay	109	1.27	12	0.06	34	1.8	424	0.63
American Crow	57	0.67	.	.	1	0.05	881	1.3
Fish Crow	.	.	.	.	.	.	206	0.3
Horned Lark	.	.	.	.	.	.	7	0.01
Purple Martin	.	.	.	.	.	.	16	0.02

Table B2 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Tree Swallow	811	9.48	1	0.01	105	5.57	10342	15.29
Northern Rough-winged Swallow	.	.	.	.	.	.	12	0.02
Bank Swallow	.	.	.	.	.	.	1	0
Cave Swallow	.	.	.	.	.	.	7	0.01
Barn Swallow	.	.	.	.	.	.	75	0.11
Carolina Chickadee	74	0.87	13	0.07	18	0.95	181	0.27
Tufted Titmouse	.	.	1	0.01	.	.	66	0.1
Red-breasted Nuthatch	7	0.08	4	0.02	1	0.05	132	0.2
White-breasted Nuthatch	.	.	.	.	.	.	4	0.01
Brown-headed Nuthatch	.	.	.	.	.	.	25	0.04
Brown Creeper	.	.	22	0.11	.	.	9	0.01
Carolina Wren	233	2.72	40	0.21	97	5.14	257	0.38
House Wren	120	1.4	125	0.64	18	0.95	44	0.07
Winter Wren	1	0.01	45	0.23	.	.	8	0.01
Sedge Wren	3	0.04	1	0.01	.	.	17	0.03
Marsh Wren	1	0.01	3	0.02	.	.	13	0.02
Blue-gray Gnatcatcher	22	0.26	4	0.02	2	0.11	20	0.03
Golden-crowned Kinglet	30	0.35	180	0.92	1	0.05	84	0.12
Ruby-crowned Kinglet	67	0.78	116	0.59	14	0.74	229	0.34
Eastern Bluebird	12	0.14	.	.	7	0.37	301	0.44
Veery	1	0.01	63	0.32	.	.	.	.
Gray-cheeked Thrush	.	.	17	0.09	.	.	2	0
Bicknell's Thrush	.	.	3	0.02	.	.	.	.
Swainson's Thrush	1	0.01	28	0.14	.	.	7	0.01
Hermit Thrush	5	0.06	188	0.96	.	.	27	0.04
Wood Thrush	.	.	1	0.01	.	.	.	.
American Robin	137	1.6	117	0.6	67	3.55	4585	6.78
Gray Catbird	209	2.44	1272	6.52	52	2.76	324	0.48
Northern Mockingbird	53	0.62	22	0.11	24	1.27	226	0.33
Brown Thrasher	32	0.37	26	0.13	3	0.16	35	0.05
European Starling	53	0.62	.	.	1	0.05	3681	5.44
American Pipit	.	.	.	.	.	.	91	0.13
Cedar Waxwing	58	0.68	2	0.01	57	3.02	170	0.25
Snow Bunting	.	.	.	.	.	.	2	0
Ovenbird	2	0.02	66	0.34	.	.	8	0.01
Worm-eating Warbler	.	.	1	0.01	.	.	1	0
Louisiana Waterthrush	.	.	.	.	.	.	1	0
Northern Waterthrush	12	0.14	193	0.99	2	0.11	7	0.01
Blue-winged Warbler	.	.	.	.	.	.	2	0
Black-and-white Warbler	12	0.14	92	0.47	2	0.11	40	0.06
Tennessee Warbler	.	.	7	0.04	.	.	1	0
Orange-crowned Warbler	1	0.01	13	0.07	.	.	.	.
Nashville Warbler	3	0.04	9	0.05	.	.	3	0
Connecticut Warbler	.	.	12	0.06	.	.	4	0.01
Mourning Warbler	.	.	1	0.01	.	.	1	0

Table B2 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Kentucky Warbler	.	.	.	.	.	.	1	0
Common Yellowthroat	217	2.54	505	2.59	25	1.33	103	0.15
Hooded Warbler	.	.	2	0.01	.	.	1	0
American Redstart	77	0.9	568	2.91	7	0.37	183	0.27
Cape May Warbler	2	0.02	13	0.07	.	.	3	0
Northern Parula	24	0.28	327	1.68	2	0.11	84	0.12
Magnolia Warbler	9	0.11	102	0.52	2	0.11	45	0.07
Bay-breasted Warbler	.	.	6	0.03	.	.	3	0
Blackburnian Warbler	.	.	.	.	.	.	3	0
Yellow Warbler	3	0.04	41	0.21	2	0.11	7	0.01
Chestnut-sided Warbler	.	.	5	0.03	.	.	1	0
Blackpoll Warbler	2	0.02	127	0.65	.	.	18	0.03
Black-throated Blue Warbler	11	0.13	107	0.55	.	.	311	0.46
Palm Warbler	184	2.15	228	1.17	55	2.92	529	0.78
Pine Warbler	.	.	1	0.01	.	.	61	0.09
Yellow-rumped Warbler	2745	32.09	12409	63.65	763	40.46	6521	9.64
Prairie Warbler	5	0.06	17	0.09	.	.	8	0.01
Black-throated Green Warbler	1	0.01	10	0.05	.	.	17	0.03
Canada Warbler	.	.	7	0.04	.	.	.	.
Wilson's Warbler	1	0.01	4	0.02	.	.	.	.
Yellow-breasted Chat	3	0.04	19	0.1	.	.	1	0
Eastern Towhee	39	0.46	24	0.12	.	.	21	0.03
American Tree Sparrow	.	.	.	.	.	.	2	0
Chipping Sparrow	1	0.01	27	0.14	.	.	100	0.15
Clay-colored Sparrow	.	.	2	0.01	.	.	.	.
Field Sparrow	177	2.07	41	0.21	14	0.74	27	0.04
Vesper Sparrow	5	0.06	.	.	.	.	.	.
Lark Sparrow	.	.	.	.	.	.	1	0
Savannah Sparrow	468	5.47	4	0.02	105	5.57	36	0.05
Grasshopper Sparrow	10	0.12	2	0.01	.	.	5	0.01
Nelson's Sparrow	.	.	.	.	.	.	29	0.04
Saltmarsh Sparrow	.	.	.	.	.	.	11	0.02
Seaside Sparrow	.	.	2	0.01	.	.	35	0.05
Fox Sparrow	3	0.04	17	0.09	.	.	5	0.01
Song Sparrow	512	5.99	298	1.53	1	0.05	224	0.33
Lincoln's Sparrow	3	0.04	2	0.01	.	.	3	0
Swamp Sparrow	286	3.34	430	2.21	1	0.05	70	0.1
White-throated Sparrow	204	2.38	504	2.59	1	0.05	171	0.25
White-crowned Sparrow	.	.	5	0.03	.	.	.	.
White-crowned Sparrow	1	0.01	2	0.01	.	.	8	0.01
Slate-colored Junco	19	0.22	88	0.45	.	.	239	0.35
Summer Tanager	.	.	4	0.02	.	.	9	0.01
Scarlet Tanager	2	0.02	1	0.01	.	.	3	0
Northern Cardinal	289	3.38	118	0.61	35	1.86	249	0.37
Rose-breasted Grosbeak	.	.	8	0.04	.	.	2	0

Table B2 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Blue Grosbeak	5	0.06	9	0.05	1	0.05	31	0.05
Indigo Bunting	60	0.7	59	0.3	12	0.64	74	0.11
Dickcissel	.	.	.	.	.	.	1	0
Bobolink	202	2.36	1	0.01	9	0.48	92	0.14
Red-winged Blackbird	102	1.19	.	.	57	3.02	19586	28.95
Eastern Meadowlark	87	1.02	.	.	11	0.58	73	0.11
Rusty Blackbird	.	.	.	.	.	.	12	0.02
Common Grackle	48	0.56	.	.	.	.	1428	2.11
Boat-tailed Grackle	.	.	.	.	.	.	120	0.18
Brown-headed Cowbird	3	0.04	.	.	6	0.32	305	0.45
Orchard Oriole	.	.	.	.	.	.	2	0
Baltimore Oriole	3	0.04	18	0.09	1	0.05	34	0.05
Purple Finch	.	.	5	0.03	.	.	26	0.04
House Finch	30	0.35	17	0.09	.	.	96	0.14
Pine Siskin	.	.	.	.	.	.	94	0.14
American Goldfinch	78	0.91	5	0.03	46	2.44	451	0.67
House Sparrow	.	.	.	.	.	.	29	0.04
Totals	8544	99.89	19497	100.12	1886	100	82809	99.94

Great Meadows NWR

Table B3. Comparison of species count and percentage found in Great Meadows NWR.

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Pink-footed Goose	.	.	.	.	.	.	43	.
Greater White-fronted Goose	.	.	.	.	.	.	10	.
Snow Goose	.	.	.	.	.	.	36	.
Canada Goose	101	2.76	.	.	.	.	14148	.
Canada Goose	6	0.16	.	.	.	.	14148	.
Mute Swan	.	.	.	.	.	.	26	.
Wood Duck	.	.	.	.	.	.	493	.
Gadwall	.	.	.	.	.	.	5	.
American Wigeon	.	.	.	.	.	.	7	.
American Black Duck	.	.	.	.	.	.	88	.
Mallard	3	0.08	.	.	.	.	1143	.
Hawaiian Duck	2	0.05	.	.	.	.	.	.
Blue-winged Teal	.	.	.	.	.	.	45	.
Northern Shoveler	2	0.05	.	.	.	.	2	.
Northern Pintail	.	.	.	.	.	.	28	.
Green-winged Teal	.	.	.	.	.	.	271	.
Ring-necked Duck	.	.	.	.	.	.	86	.
Greater Scaup	.	.	.	.	.	.	1	.
Surf Scoter	.	.	.	.	.	.	9	.
Bufflehead	.	.	.	.	.	.	26	.
Hooded Merganser	.	.	.	.	.	.	4	.
Red-breasted Merganser	.	.	.	.	.	.	2	.
Ruddy Duck	.	.	.	.	.	.	21	.
Ruffed Grouse	1	0.03	.	.	.	.	.	.
Wild Turkey	8	0.22	.	.	.	.	25	0.09
Pied-billed Grebe	.	.	.	.	.	.	17	.
Double-crested Cormorant	1	0.03	.	.	.	.	234	.
American Bittern	.	.	.	.	.	.	5	.
Least Bittern	.	.	.	.	.	.	3	.
Great Blue Heron	3	0.08	.	.	.	.	223	.
Great Egret	.	.	.	.	.	.	85	.
Snowy Egret	.	.	.	.	.	.	17	.
Little Blue Heron	.	.	.	.	.	.	2	.
Green Heron	1	0.03	.	.	.	.	16	.
Black-crowned Night-Heron	.	.	.	.	.	.	10	.
Turkey Vulture	.	.	.	.	.	.	29	0.1
Osprey	2	0.05	.	.	.	.	26	0.09
Bald Eagle	.	.	.	.	.	.	3	0.01
Northern Harrier	2	0.05	.	.	.	.	42	0.15
Sharp-shinned Hawk	3	0.08	.	.	.	.	19	0.07
Cooper's Hawk	2	0.05	.	.	.	.	36	0.13
Red-shouldered Hawk	.	.	.	.	.	.	3	0.01
Broad-winged Hawk	.	.	.	.	.	.	101	0.35
Short-tailed Hawk	1	0.03	.	.	.	.	.	.

Table B3 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Red-tailed Hawk	1	0.03	.	.	.	.	93	0.33
American Kestrel	.	.	.	.	.	.	2	0.01
Merlin	.	.	.	.	.	.	4	0.01
Peregrine Falcon	.	.	.	.	.	.	1	0
Virginia Rail	.	.	.	.	.	.	4	.
Sora	.	.	.	.	.	.	6	.
Common Moorhen	.	.	.	.	.	.	6	.
American Coot	.	.	.	.	.	.	183	.
Semipalmated Plover	.	.	.	.	.	.	23	.
Killdeer	.	.	.	.	.	.	107	.
Spotted Sandpiper	.	.	.	.	.	.	20	.
Solitary Sandpiper	.	.	.	.	.	.	48	.
Greater Yellowlegs	.	.	.	.	.	.	24	.
Lesser Yellowlegs	.	.	.	.	.	.	57	.
Semipalmated Sandpiper	.	.	.	.	.	.	77	.
Least Sandpiper	.	.	.	.	.	.	256	.
Pectoral Sandpiper	.	.	.	.	.	.	24	.
Short-billed Dowitcher	.	.	.	.	.	.	2	.
Wilson's Snipe	.	.	.	.	.	.	15	.
American Woodcock	.	.	.	.	.	.	8	.
Bonaparte's Gull	.	.	.	.	.	.	4	.
Ring-billed Gull	.	.	.	.	.	.	127	.
Herring Gull	.	.	.	.	.	.	74	.
Rock Pigeon	.	.	.	.	.	.	8	0.03
Mourning Dove	17	0.47	.	.	.	.	1076	3.78
Eastern Screech-Owl	.	.	.	.	.	.	16	0.06
Great Horned Owl	.	.	.	.	.	.	8	0.03
Barred Owl	.	.	.	.	.	.	2	0.01
Short-eared Owl	1	0.03	.	.	.	.	1	0
Common Nighthawk	.	.	.	.	.	.	16	0.06
Chimney Swift	2	0.05	.	.	.	.	220	0.77
Ruby-throated Hummingbird	1	0.03	.	.	.	.	14	0.05
Belted Kingfisher	.	.	.	.	.	.	24	0.08
Red-headed Woodpecker	.	.	.	.	.	.	1	0
Red-bellied Woodpecker	23	0.63	.	.	.	.	93	0.33
Yellow-bellied Sapsucker	1	0.03	.	.	.	.	3	0.01
Downy Woodpecker	43	1.18	.	.	.	.	262	0.92
Hairy Woodpecker	12	0.33	.	.	.	.	87	0.31
Northern Flicker	15	0.41	.	.	.	.	141	0.5
Pileated Woodpecker	1	0.03	.	.	.	.	4	0.01
Eastern Wood-Pewee	.	.	.	.	.	.	22	0.08
Willow Flycatcher	1	0.03	.	.	.	.	2	0.01
Least Flycatcher	.	.	.	.	.	.	1	0
Eastern Phoebe	27	0.74	.	.	.	.	129	0.45
Great Crested Flycatcher	.	.	.	.	.	.	3	0.01
Eastern Kingbird	.	.	.	.	.	.	30	0.11

Table B3 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Blue-headed Vireo	.	.	.	.	.	.	10	0.04
Warbling Vireo	.	.	.	.	.	.	16	0.06
Red-eyed Vireo	.	.	.	.	.	.	42	0.15
Blue Jay	243	6.65	.	.	.	.	719	2.53
American Crow	143	3.91	.	.	.	.	1536	5.4
Common Raven	1	0.03	.	.	.	.	6	0.02
Horned Lark	.	.	.	.	.	.	4	0.01
Tree Swallow	.	.	.	.	.	.	335	1.18
Northern Rough-winged Swallow	.	.	.	.	.	.	73	0.26
Bank Swallow	.	.	.	.	.	.	63	0.22
Cliff Swallow	.	.	.	.	.	.	1	0
Barn Swallow	.	.	.	.	.	.	761	2.67
Black-capped Chickadee	131	3.59	.	.	.	.	868	3.05
Tufted Titmouse	1	0.03	.	.	.	.	363	1.28
Tufted Titmouse	39	1.07	.	.	.	.	363	1.28
Red-breasted Nuthatch	1	0.03	.	.	.	.	13	0.05
White-breasted Nuthatch	53	1.45	.	.	.	.	255	0.9
Brown Creeper	.	.	.	.	.	.	18	0.06
Carolina Wren	15	0.41	.	.	.	.	140	0.49
House Wren	18	0.49	.	.	.	.	112	0.39
Winter Wren	6	0.16	.	.	.	.	1	0
Marsh Wren	.	.	.	.	.	.	42	0.15
Blue-gray Gnatcatcher	.	.	.	.	.	.	29	0.1
Golden-crowned Kinglet	1	0.03	.	.	.	.	70	0.25
Ruby-crowned Kinglet	8	0.22	.	.	.	.	27	0.09
Eastern Bluebird	42	1.15	.	.	.	.	237	0.83
Gray-cheeked Thrush	1	0.03	.	.	.	.	.	.
Swainson's Thrush	1	0.03	.	.	.	.	.	.
Hermit Thrush	1	0.03	.	.	.	.	13	0.05
Wood Thrush	.	.	.	.	.	.	14	0.05
American Robin	1109	30.35	.	.	.	.	2930	10.3
Gray Catbird	111	3.04	.	.	.	.	615	2.16
Northern Mockingbird	4	0.11	.	.	.	.	87	0.31
Brown Thrasher	.	.	.	.	.	.	3	0.01
European Starling	11	0.3	.	.	.	.	1067	3.75
American Pipit	1	0.03	.	.	.	.	63	0.22
Cedar Waxwing	73	2	.	.	.	.	338	1.19
Snow Bunting	.	.	.	.	.	.	6	0.02
Northern Waterthrush	.	.	.	.	.	.	1	0
Blue-winged Warbler	.	.	.	.	.	.	3	0.01
Black-and-white Warbler	.	.	.	.	.	.	8	0.03
Tennessee Warbler	.	.	.	.	.	.	2	0.01
Nashville Warbler	.	.	.	.	.	.	1	0
Mourning Warbler	3	0.08	.	.	.	.	.	.
Common Yellowthroat	21	0.57	.	.	.	.	127	0.45

Table B3 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
American Redstart	.	.	.	.	.	.	39	0.14
Northern Parula	.	.	.	.	.	.	12	0.04
Magnolia Warbler	.	.	.	.	.	.	1	0
Bay-breasted Warbler	.	.	.	.	.	.	1	0
Blackburnian Warbler	.	.	.	.	.	.	1	0
Yellow Warbler	1	0.03	.	.	.	.	11	0.04
Chestnut-sided Warbler	.	.	.	.	.	.	1	0
Blackpoll Warbler	3	0.08	.	.	.	.	42	0.15
Black-throated Blue Warbler	.	.	.	.	.	.	3	0.01
Palm Warbler	17	0.47	.	.	.	.	15	0.05
Pine Warbler	.	.	.	.	.	.	5	0.02
Yellow-rumped Warbler	59	1.61	.	.	.	.	324	1.14
Black-throated Green Warbler	.	.	.	.	.	.	10	0.04
Wilson's Warbler	.	.	.	.	.	.	3	0.01
Yellow-breasted Chat	.	.	.	.	.	.	1	0
Spotted Towhee	1	0.03	.	.	.	.	.	.
Eastern Towhee	5	0.14	.	.	.	.	8	0.03
American Tree Sparrow	3	0.08	.	.	.	.	77	0.27
Chipping Sparrow	31	0.85	.	.	.	.	194	0.68
Clay-colored Sparrow	.	.	.	.	.	.	2	0.01
Field Sparrow	.	.	.	.	.	.	6	0.02
Savannah Sparrow	1	0.03	.	.	.	.	446	1.57
Nelson's Sparrow	.	.	.	.	.	.	1	0
Fox Sparrow	2	0.05	.	.	.	.	42	0.15
Song Sparrow	262	7.17	.	.	.	.	986	3.46
Lincoln's Sparrow	3	0.08	.	.	.	.	34	0.12
Swamp Sparrow	104	2.85	.	.	.	.	529	1.86
White-throated Sparrow	208	5.69	.	.	.	.	541	1.9
White-crowned Sparrow	.	.	.	.	.	.	55	0.19
Slate-colored Junco	19	0.52	.	.	.	.	440	1.55
Scarlet Tanager	.	.	.	.	.	.	3	0.01
Northern Cardinal	77	2.11	.	.	.	.	459	1.61
Rose-breasted Grosbeak	.	.	.	.	.	.	29	0.1
Indigo Bunting	8	0.22	.	.	.	.	40	0.14
Dickcissel	.	.	.	.	.	.	7	0.02
Bobolink	.	.	.	.	.	.	192	0.67
Red-winged Blackbird	145	3.97	.	.	.	.	1769	6.22
Eastern Meadowlark	.	.	.	.	.	.	1	0
Rusty Blackbird	7	0.19	.	.	.	.	146	0.51
Common Grackle	145	3.97	.	.	.	.	5514	19.38
Brown-headed Cowbird	1	0.03	.	.	.	.	27	0.09
Baltimore Oriole	.	.	.	.	.	.	48	0.17
Purple Finch	18	0.49	.	.	.	.	309	1.09
House Finch	47	1.29	.	.	.	.	392	1.38
White-winged Crossbill	.	.	.	.	.	.	1	0
Common Redpoll	.	.	.	.	.	.	1	0

Table B3 (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Pine Siskin	1	0.03	.	.	.	.	129	0.45
American Goldfinch	162	4.43	.	.	.	.	1102	3.87
House Sparrow	.	.	.	.	.	.	891	3.13
Totals	3651	99.94	0	0	0	0	61138	101.27

Ninigret NWR

Table B4. Comparison of species count and percentage found in Ninigret NWR.

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Brant	.	.	.	.	.	.	2	.
Canada Goose	.	.	.	.	.	.	256	.
American Black Duck	.	.	.	.	.	.	20	.
Mallard	.	.	.	.	.	.	4	.
Bufflehead	.	.	.	.	.	.	280	.
Hooded Merganser	.	.	.	.	.	.	24	.
Common Merganser	.	.	.	.	.	.	4	.
Red-breasted Merganser	.	.	.	.	.	.	30	.
Wild Turkey	.	.	.	.	.	.	8	0.22
Red-throated Loon	.	.	.	.	.	.	2	.
Common Loon	.	.	.	.	.	.	2	.
Northern Gannet	.	.	.	.	.	.	8	.
Double-crested Cormorant	.	.	.	.	.	.	84	.
Great Cormorant	.	.	.	.	.	.	4	.
Great Blue Heron	5	0.1	.	.	.	.	6	.
Great Egret	1	0.02	.	.	.	.	2	.
Turkey Vulture	9	0.18	.	.	.	.	.	.
Osprey	2	0.04	.	.	.	.	6	0.16
Northern Harrier	1	0.02	.	.	.	.	.	.
Sharp-shinned Hawk	1	0.02	4	0.1	.	.	2	0.05
Cooper's Hawk	.	.	.	.	.	.	6	0.16
Red-tailed Hawk	.	.	.	.	.	.	6	0.16
Merlin	.	.	.	.	.	.	4	0.11
Killdeer	.	.	.	.	.	.	16	.
Spotted Sandpiper	.	.	.	.	.	.	6	.
Solitary Sandpiper	.	.	.	.	.	.	2	.
Laughing Gull	.	.	.	.	.	.	16	.
Ring-billed Gull	.	.	.	.	.	.	26	.
Herring Gull	.	.	.	.	.	.	68	.
Lesser Black-backed Gull	.	.	.	.	.	.	2	.
Great Black-backed Gull	.	.	.	.	.	.	30	.
Mourning Dove	1	0.02	.	.	.	.	16	0.44
Yellow-billed Cuckoo	1	0.02	1	0.03	.	.	.	.
Black-billed Cuckoo	.	.	.	.	.	.	4	0.11
Barred Owl	2	0.04	.	.	.	.	.	.
Ruby-throated Hummingbird	1	0.02	.	.	.	.	.	.
Belted Kingfisher	.	.	.	.	.	.	4	0.11
Red-bellied Woodpecker	1	0.02	.	.	.	.	12	0.33
Downy Woodpecker	9	0.18	5	0.13	2	2.5	24	0.66
Hairy Woodpecker	.	.	.	.	.	.	4	0.11
Northern Flicker	10	0.21	.	.	.	.	40	1.09
Traill's Flycatcher	1	0.02	25	0.64	.	.	.	.
Least Flycatcher	.	.	1	0.03	.	.	.	.
Eastern Phoebe	2	0.04	18	0.46	.	.	6	0.16

Table B4. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
White-eyed Vireo	4	0.08	16	0.41	.	.	.	.
Blue-headed Vireo	.	.	4	0.1	.	.	.	.
Philadelphia Vireo	.	.	1	0.03	.	.	.	.
Red-eyed Vireo	3	0.06	25	0.64	2	2.5	4	0.11
Blue Jay	76	1.56	12	0.31	.	.	78	2.13
American Crow	5	0.1	.	.	.	.	54	1.47
Tree Swallow	1261	25.91	119	3.06	14	17.5	2208	60.26
Black-capped Chickadee	147	3.02	76	1.95	18	22.5	148	4.04
Tufted Titmouse	16	0.33	17	0.44	2	2.5	42	1.15
Red-breasted Nuthatch	.	.	1	0.03	.	.	6	0.16
White-breasted Nuthatch	5	0.1	.	.	.	.	38	1.04
Brown Creeper	.	.	3	0.08	.	.	.	.
Carolina Wren	6	0.12	2	0.05	.	.	10	0.27
House Wren	.	.	9	0.23	.	.	.	.
Marsh Wren	.	.	3	0.08	.	.	.	.
Golden-crowned Kinglet	3	0.06	14	0.36	.	.	4	0.11
Ruby-crowned Kinglet	.	.	12	0.31	.	.	4	0.11
Veery	.	.	7	0.18	.	.	2	0.05
Swainson's Thrush	.	.	6	0.15	.	.	.	.
Hermit Thrush	.	.	15	0.39	.	.	2	0.05
American Robin	12	0.25	7	0.18	4	5	100	2.73
Gray Catbird	141	2.9	455	11.69	22	27.5	10	0.27
Northern Mockingbird	.	.	.	.	.	.	6	0.16
Brown Thrasher	2	0.04	2	0.05	.	.	.	.
European Starling	.	.	.	.	.	.	44	1.2
Cedar Waxwing	9	0.18	4	0.1	.	.	44	1.2
Ovenbird	.	.	1	0.03	.	.	.	.
Northern Waterthrush	.	.	3	0.08	.	.	.	.
Golden-winged Warbler	.	.	1	0.03	.	.	.	.
Blue-winged Warbler	.	.	5	0.13	.	.	.	.
Black-and-white Warbler	.	.	7	0.18	.	.	6	0.16
Orange-crowned Warbler	.	.	.	.	.	.	2	0.05
Nashville Warbler	.	.	1	0.03	.	.	.	.
Connecticut Warbler	.	.	3	0.08	.	.	.	.
Mourning Warbler	.	.	1	0.03	.	.	.	.
Common Yellowthroat	10	0.21	78	2	.	.	.	.
American Redstart	3	0.06	23	0.59	.	.	.	.
Northern Parula	.	.	1	0.03	.	.	2	0.05
Magnolia Warbler	.	.	4	0.1	.	.	.	.
Yellow Warbler	.	.	4	0.1	.	.	.	.
Blackpoll Warbler	1	0.02	29	0.75	2	2.5	4	0.11
Black-throated Blue Warbler	.	.	1	0.03	.	.	.	.
Palm Warbler	.	.	10	0.26	.	.	.	.
Pine Warbler	.	.	.	.	.	.	2	0.05
Yellow-rumped Warbler	2959	60.8	2671	68.63	.	.	492	13.43
Prairie Warbler	1	0.02	4	0.1	.	.	.	.

Table B4. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Black-throated Green Warbler	1	0.02	2	0.05	.	.	2	0.05
Wilson's Warbler	.	.	3	0.08	.	.	.	.
Yellow-breasted Chat	1	0.02	10	0.26	.	.	.	.
Eastern Towhee	70	1.44	34	0.87	14	17.5	4	0.11
American Tree Sparrow	.	.	.	.	.	.	22	0.6
Chipping Sparrow	.	.	2	0.05	.	.	26	0.71
Field Sparrow	4	0.08	12	0.31	.	.	12	0.33
Savannah Sparrow	.	.	6	0.15	.	.	.	.
Fox Sparrow	.	.	.	.	.	.	4	0.11
Song Sparrow	16	0.33	41	1.05	.	.	18	0.49
Lincoln's Sparrow	.	.	1	0.03	.	.	.	.
Swamp Sparrow	.	.	40	1.03	.	.	.	.
White-throated Sparrow	11	0.23	10	0.26	.	.	26	0.71
White-crowned Sparrow	.	.	2	0.05	.	.	.	.
Slate-colored Junco	2	0.04	8	0.21	.	.	20	0.55
Northern Cardinal	20	0.41	7	0.18	.	.	34	0.93
Red-winged Blackbird	.	.	.	.	.	.	28	0.76
Baltimore Oriole	.	.	3	0.08	.	.	.	.
Purple Finch	.	.	.	.	.	.	2	0.05
House Finch	.	.	.	.	.	.	4	0.11
American Goldfinch	31	0.64	.	.	.	.	8	0.22
Totals	4867	99.98	3892	100.05	80	100	4558	99.96

Parker River NWR

Table B5. Comparison of species count and percentage found in Parker River NWR.

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Snow Goose	.	.	.	.	.	.	262	.
Brant	.	.	.	.	.	.	604	.
Cackling Goose	.	.	.	.	.	.	8	.
Canada Goose	.	.	.	.	.	.	18605	.
Mute Swan	.	.	.	.	.	.	837	.
Wood Duck	.	.	.	.	.	.	35	.
Gadwall	.	.	.	.	.	.	8518	.
Eurasian Wigeon	.	.	.	.	.	.	31	.
American Wigeon	.	.	.	.	.	.	9729	.
American Black Duck	.	.	.	.	.	.	35401	.
Mallard	.	.	.	.	.	.	11507	.
Blue-winged Teal	.	.	.	.	.	.	375	.
Northern Shoveler	.	.	.	.	.	.	1427	.
Northern Pintail	.	.	.	.	.	.	9242	.
Green-winged Teal	.	.	.	.	.	.	32187	.
Redhead	.	.	.	.	.	.	18	.
Ring-necked Duck	.	.	.	.	.	.	28	.
Greater Scaup	.	.	.	.	.	.	440	.
Lesser Scaup	.	.	.	.	.	.	87	.
Common Eider	.	.	.	.	.	.	4176	.
Surf Scoter	.	.	.	.	.	.	2062	.
White-winged Scoter	.	.	.	.	.	.	8785	.
Black Scoter	.	.	.	.	.	.	6585	.
Long-tailed Duck	.	.	.	.	.	.	666	.
Bufflehead	.	.	.	.	.	.	1770	.
Common Goldeneye	.	.	.	.	.	.	76	.
Hooded Merganser	.	.	.	.	.	.	1165	.
Common Merganser	.	.	.	.	.	.	43	.
Red-breasted Merganser	.	.	.	.	.	.	1001	.
Ruddy Duck	.	.	.	.	.	.	84	.
Northern Bobwhite	.	.	.	.	.	.	1	0
Ring-necked Pheasant	.	.	.	.	.	.	1	.
Wild Turkey	.	.	.	.	.	.	8	0
Red-throated Loon	.	.	.	.	.	.	2070	.
Common Loon	.	.	.	.	.	.	1543	.
Pied-billed Grebe	.	.	.	.	.	.	99	.
Horned Grebe	.	.	.	.	.	.	256	.
Red-necked Grebe	.	.	.	.	.	.	147	.
Cory's Shearwater	.	.	.	.	.	.	14	.
Great Shearwater	.	.	.	.	.	.	118	.
Wilson's Storm-Petrel	.	.	.	.	.	.	1	.
Northern Gannet	.	.	.	.	.	.	8194	.
Double-crested Cormorant	.	.	.	.	.	.	32134	.
Great Cormorant	.	.	.	.	.	.	82	.

Table B5. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Anhinga	.	.	.	.	.	.	1	.
American Bittern	.	.	.	.	.	.	62	.
Least Bittern	.	.	.	.	.	.	1	.
Great Blue Heron	.	.	.	.	.	.	2052	.
Great Egret	.	.	.	.	.	.	5262	.
Snowy Egret	.	.	.	.	.	.	4003	.
Little Blue Heron	.	.	.	.	.	.	10	.
Tricolored Heron	.	.	.	.	.	.	2	.
Cattle Egret	.	.	.	.	.	.	15	.
Green Heron	.	.	.	.	.	.	9	.
Black-crowned Night-Heron	.	.	.	.	.	.	397	.
Yellow-crowned Night-Heron	.	.	.	.	.	.	10	.
Glossy Ibis	.	.	.	.	.	.	11	.
Turkey Vulture	.	.	.	.	.	.	1340	0.46
Osprey	1	0.05	.	.	.	.	235	0.08
Bald Eagle	.	.	.	.	.	.	43	0.01
Northern Harrier	3	0.16	.	.	.	.	1575	0.54
Sharp-shinned Hawk	2	0.11	5	0.12	.	.	83	0.03
Cooper's Hawk	.	.	.	.	.	.	149	0.05
Northern Goshawk	.	.	.	.	.	.	2	0
Red-shouldered Hawk	.	.	.	.	.	.	3	0
Broad-winged Hawk	1	0.05	.	.	.	.	5	0
Red-tailed Hawk	.	.	.	.	.	.	192	0.07
Rough-legged Hawk	1	0.05	.	.	.	.	89	0.03
Golden Eagle	.	.	.	.	.	.	5	0
American Kestrel	.	.	.	.	.	.	27	0.01
Merlin	.	.	.	.	.	.	237	0.08
Gyrfalcon	.	.	.	.	.	.	1	0
Peregrine Falcon	1	0.05	.	.	.	.	465	0.16
Virginia Rail	.	.	.	.	.	.	13	.
Sora	.	.	.	.	.	.	4	.
American Coot	.	.	.	.	.	.	25	.
Sandhill Crane	.	.	.	.	.	.	1	.
Black-bellied Plover	.	.	.	.	.	.	14405	.
American Golden-Plover	.	.	.	.	.	.	174	.
Semipalmated Plover	.	.	.	.	.	.	25255	.
Piping Plover	.	.	.	.	.	.	47	.
Killdeer	.	.	.	.	.	.	482	.
American Avocet	.	.	.	.	.	.	1	.
Spotted Sandpiper	.	.	.	.	.	.	100	.
Solitary Sandpiper	.	.	.	.	.	.	9	.
Greater Yellowlegs	.	.	.	.	.	.	6109	.
Willet	.	.	.	.	.	.	55	.
Lesser Yellowlegs	.	.	.	.	.	.	1503	.
Whimbrel	.	.	.	.	.	.	508	.

Table B5. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Hudsonian Godwit	.	.	.	.	.	.	120	.
Marbled Godwit	.	.	.	.	.	.	24	.
Ruddy Turnstone	.	.	.	.	.	.	68	.
Red Knot	.	.	.	.	.	.	297	.
Sanderling	.	.	.	.	.	.	22227	.
Semipalmated Sandpiper	.	.	.	.	.	.	24735	.
Western Sandpiper	.	.	.	.	.	.	51	.
Least Sandpiper	.	.	.	.	.	.	2788	.
White-rumped Sandpiper	.	.	.	.	.	.	2630	.
Baird's Sandpiper	.	.	.	.	.	.	59	.
Pectoral Sandpiper	.	.	.	.	.	.	242	.
Purple Sandpiper	.	.	.	.	.	.	44	.
Dunlin	.	.	.	.	.	.	18033	.
Curlew Sandpiper	.	.	.	.	.	.	24	.
Stilt Sandpiper	.	.	.	.	.	.	180	.
Buff-breasted Sandpiper	.	.	.	.	.	.	42	.
Short-billed Dowitcher	.	.	.	.	.	.	1368	.
Long-billed Dowitcher	.	.	.	.	.	.	126	.
Wilson's Snipe	.	.	.	.	.	.	15	.
American Woodcock	.	.	.	.	.	.	32	.
Wilson's Phalarope	.	.	.	.	.	.	4	.
Red-necked Phalarope	.	.	.	.	.	.	2	.
Black-legged Kittiwake	.	.	.	.	.	.	13	.
Bonaparte's Gull	.	.	.	.	.	.	2228	.
Black-headed Gull	.	.	.	.	.	.	5	.
Little Gull	.	.	.	.	.	.	1	.
Laughing Gull	.	.	.	.	.	.	468	.
Franklin's Gull	.	.	.	.	.	.	1	.
Ring-billed Gull	.	.	.	.	.	.	4931	.
Herring Gull	.	.	.	.	.	.	10967	.
Iceland Gull	.	.	.	.	.	.	8	.
Lesser Black-backed Gull	.	.	.	.	.	.	12	.
Glaucous Gull	.	.	.	.	.	.	1	.
Great Black-backed Gull	.	.	.	.	.	.	3559	.
Least Tern	.	.	.	.	.	.	150	.
Gull-billed Tern	.	.	.	.	.	.	15	.
Caspian Tern	.	.	.	.	.	.	27	.
Black Tern	.	.	.	.	.	.	4	.
Roseate Tern	.	.	.	.	.	.	5	.
Common Tern	.	.	.	.	.	.	603	.
Forster's Tern	.	.	.	.	.	.	39	.
Royal Tern	.	.	.	.	.	.	2	.
Black Skimmer	.	.	.	.	.	.	345	.
Pomarine Jaeger	.	.	.	.	.	.	5	.
Dovekie	.	.	.	.	.	.	2	.
Common Murre	.	.	.	.	.	.	1	.

Table B5. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Razorbill	.	.	.	.	.	.	43	.
Black Guillemot	.	.	.	.	.	.	6	.
Rock Pigeon	.	.	.	.	.	.	825	0.28
Mourning Dove	14	0.76	.	.	.	.	1088	0.37
Yellow-billed Cuckoo	.	.	1	0.02	.	.	10	0
Black-billed Cuckoo	.	.	.	.	.	.	1	0
Eastern Screech-Owl	.	.	.	.	.	.	1	0
Great Horned Owl	.	.	.	.	.	.	7	0
Snowy Owl	.	.	.	.	.	.	51	0.02
Barred Owl	.	.	.	.	.	.	1	0
Short-eared Owl	.	.	.	.	.	.	14	0
Northern Saw-whet Owl	.	.	.	.	.	.	1	0
Common Nighthawk	.	.	.	.	.	.	4	0
Eastern Whip-poor-will	.	.	.	.	.	.	13	0
Chimney Swift	.	.	.	.	.	.	50	0.02
Ruby-throated Hummingbird	.	.	.	.	.	.	43	0.01
Belted Kingfisher	.	.	.	.	.	.	183	0.06
Red-bellied Woodpecker	.	.	.	.	.	.	61	0.02
Yellow-bellied Sapsucker	1	0.05	15	0.36	.	.	138	0.05
Downy Woodpecker	8	0.43	22	0.53	.	.	495	0.17
Hairy Woodpecker	.	.	1	0.02	.	.	12	0
Northern Flicker	3	0.16	10	0.24	.	.	451	0.15
Pileated Woodpecker	.	.	.	.	.	.	1	0
Olive-sided Flycatcher	.	.	.	.	.	.	1	0
Eastern Wood-Pewee	.	.	2	0.05	.	.	13	0
Yellow-bellied Flycatcher	.	.	14	0.34	.	.	4	0
Acadian Flycatcher	.	.	1	0.02	.	.	.	.
Traill's Flycatcher	.	.	9	0.22	.	.	.	.
Willow Flycatcher	.	.	.	.	.	.	4	0
Least Flycatcher	.	.	6	0.15	.	.	7	0
Eastern Phoebe	22	1.19	41	0.99	.	.	448	0.15
Say's Phoebe	.	.	.	.	.	.	8	0
Great Crested Flycatcher	.	.	1	0.02	.	.	31	0.01
Western Kingbird	.	.	.	.	.	.	2	0
Eastern Kingbird	.	.	1	0.02	.	.	429	0.15
Scissor-tailed Flycatcher	.	.	.	.	.	.	3	0
Northern Shrike	.	.	.	.	.	.	25	0.01
White-eyed Vireo	.	.	3	0.07	.	.	3	0
Yellow-throated Vireo	.	.	.	.	.	.	3	0
Blue-headed Vireo	.	.	30	0.73	.	.	68	0.02
Warbling Vireo	.	.	1	0.02	.	.	31	0.01
Philadelphia Vireo	.	.	9	0.22	.	.	21	0.01
Red-eyed Vireo	2	0.11	70	1.69	.	.	217	0.07
Blue Jay	76	4.12	5	0.12	.	.	2649	0.91
American Crow	7	0.38	.	.	.	.	3758	1.29

Table B5. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Fish Crow	.	.	.	.	.	.	2	0
Common Raven	.	.	.	.	.	.	2	0
Horned Lark	.	.	.	.	.	.	800	0.27
Purple Martin	.	.	.	.	.	.	8	0
Tree Swallow	.	.	20	0.48	.	.	205320	70.49
Northern Rough-winged Swallow	.	.	.	.	.	.	5	0
Bank Swallow	.	.	.	.	.	.	650	0.22
Cliff Swallow	.	.	.	.	.	.	12	0
Cave Swallow	.	.	.	.	.	.	7	0
Barn Swallow	.	.	.	.	.	.	607	0.21
Black-capped Chickadee	72	3.9	54	1.31	8	53.33	2869	0.99
Tufted Titmouse	.	.	2	0.05	.	.	58	0.02
Red-breasted Nuthatch	8	0.43	6	0.15	.	.	584	0.2
White-breasted Nuthatch	.	.	2	0.05	.	.	59	0.02
Brown Creeper	2	0.11	103	2.49	.	.	98	0.03
Carolina Wren	.	.	3	0.07	.	.	120	0.04
House Wren	1	0.05	5	0.12	.	.	27	0.01
Winter Wren	.	.	6	0.15	.	.	19	0.01
Marsh Wren	4	0.22	.	.	.	.	127	0.04
Blue-gray Gnatcatcher	.	.	.	.	.	.	8	0
Golden-crowned Kinglet	10	0.54	240	5.81	.	.	1023	0.35
Ruby-crowned Kinglet	6	0.33	100	2.42	.	.	332	0.11
Eastern Bluebird	.	.	.	.	.	.	10	0
Veery	.	.	12	0.29	.	.	6	0
Gray-cheeked Thrush	.	.	1	0.02	.	.	.	.
Swainson's Thrush	.	.	15	0.36	.	.	11	0
Hermit Thrush	.	.	123	2.98	.	.	139	0.05
Wood Thrush	.	.	2	0.05	.	.	4	0
American Robin	87	4.72	164	3.97	4	26.67	7649	2.63
Gray Catbird	61	3.31	618	14.95	.	.	2528	0.87
Northern Mockingbird	4	0.22	1	0.02	.	.	1369	0.47
Brown Thrasher	12	0.65	29	0.7	.	.	402	0.14
European Starling	1060	57.48	.	.	.	.	18986	6.52
American Pipit	.	.	.	.	.	.	953	0.33
Cedar Waxwing	12	0.65	7	0.17	.	.	2601	0.89
Lapland Longspur	.	.	.	.	.	.	82	0.03
Snow Bunting	.	.	.	.	.	.	2729	0.94
Ovenbird	.	.	22	0.53	.	.	3	0
Northern Waterthrush	.	.	29	0.7	.	.	5	0
Blue-winged Warbler	.	.	3	0.07	.	.	.	.
Black-and-white Warbler	1	0.05	45	1.09	.	.	96	0.03
Prothonotary Warbler	.	.	.	.	.	.	1	0
Tennessee Warbler	.	.	4	0.1	.	.	9	0
Orange-crowned Warbler	.	.	9	0.22	.	.	12	0
Nashville Warbler	.	.	13	0.31	.	.	37	0.01

Table B5. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Connecticut Warbler	.	.	3	0.07	1	6.67	4	0
Mourning Warbler	.	.	5	0.12	.	.	.	.
Kentucky Warbler	.	.	1	0.02	.	.	.	.
Common Yellowthroat	16	0.87	133	3.22	.	.	255	0.09
Hooded Warbler	.	.	2	0.05	.	.	1	0
American Redstart	.	.	76	1.84	.	.	82	0.03
Cape May Warbler	.	.	2	0.05	.	.	8	0
Northern Parula	.	.	9	0.22	.	.	59	0.02
Magnolia Warbler	.	.	32	0.77	.	.	48	0.02
Bay-breasted Warbler	.	.	.	.	.	.	5	0
Blackburnian Warbler	.	.	.	.	.	.	8	0
Yellow Warbler	.	.	44	1.06	.	.	75	0.03
Chestnut-sided Warbler	.	.	3	0.07	.	.	5	0
Blackpoll Warbler	4	0.22	138	3.34	.	.	283	0.1
Black-throated Blue Warbler	.	.	41	0.99	.	.	57	0.02
Palm Warbler	6	0.33	10	0.24	.	.	136	0.05
Pine Warbler	.	.	.	.	.	.	29	0.01
Yellow-rumped Warbler	134	7.27	978	23.66	2	13.33	5977	2.05
Prairie Warbler	.	.	2	0.05	.	.	20	0.01
Black-throated Green Warbler	1	0.05	13	0.31	.	.	113	0.04
Canada Warbler	.	.	7	0.17	.	.	5	0
Wilson's Warbler	1	0.05	23	0.56	.	.	39	0.01
Yellow-breasted Chat	.	.	3	0.07	.	.	3	0
Eastern Towhee	39	2.11	58	1.4	.	.	1396	0.48
American Tree Sparrow	.	.	2	0.05	.	.	736	0.25
Chipping Sparrow	.	.	.	.	.	.	342	0.12
Clay-colored Sparrow	.	.	.	.	.	.	22	0.01
Field Sparrow	4	0.22	6	0.15	.	.	104	0.04
Vesper Sparrow	.	.	.	.	.	.	1	0
Lark Sparrow	.	.	.	.	.	.	8	0
Savannah Sparrow	.	.	1	0.02	.	.	1709	0.59
Grasshopper Sparrow	.	.	.	.	.	.	1	0
Nelson's Sparrow	.	.	.	.	.	.	16	0.01
Saltmarsh Sparrow	.	.	.	.	.	.	77	0.03
Seaside Sparrow	.	.	.	.	.	.	3	0
Fox Sparrow	.	.	2	0.05	.	.	.	.
Song Sparrow	82	4.45	98	2.37	.	.	2183	0.75
Lincoln's Sparrow	.	.	2	0.05	.	.	24	0.01
Swamp Sparrow	.	.	24	0.58	.	.	157	0.05
White-throated Sparrow	24	1.3	337	8.15	.	.	1862	0.64
White-crowned Sparrow	.	.	3	0.07	.	.	225	0.08
Slate-colored Junco	33	1.79	122	2.95	.	.	2743	0.94
Summer Tanager	.	.	.	.	.	.	31	0.01
Scarlet Tanager	.	.	1	0.02	.	.	6	0

Table B5. (contd.)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Northern Cardinal	7	0.38	27	0.65	.	.	1010	0.35
Rose-breasted Grosbeak	.	.	2	0.05	.	.	12	0
Indigo Bunting	.	.	.	.	.	.	26	0.01
Dickcissel	.	.	.	.	.	.	5	0
Bobolink	.	.	.	.	.	.	133	0.05
Red-winged Blackbird	.	.	.	.	.	.	359	0.12
Eastern Meadowlark	.	.	.	.	.	.	58	0.02
Rusty Blackbird	.	.	.	.	.	.	5	0
Common Grackle	.	.	.	.	.	.	555	0.19
Brown-headed Cowbird	.	.	.	.	.	.	56	0.02
Orchard Oriole	.	.	1	0.02	.	.	.	.
Baltimore Oriole	1	0.05	22	0.53	.	.	143	0.05
Purple Finch	.	.	13	0.31	.	.	173	0.06
House Finch	.	.	.	.	.	.	508	0.17
Red Crossbill	.	.	.	.	.	.	2	0
White-winged Crossbill	.	.	.	.	.	.	157	0.05
Common Redpoll	.	.	.	.	.	.	5	0
Pine Siskin	.	.	.	.	.	.	186	0.06
American Goldfinch	8	0.43	2	0.05	.	.	2315	0.79
House Sparrow	.	.	.	.	.	.	689	0.24
Totals	1842	99.85	4133	99.93	15	100	648750	99.89

Rappahannock NWR

Table B6. Comparison of species count and percentage found in Rappahannock NWR.

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Snow Goose	66	2.05	.	.	.	.	15	.
Cackling Goose	.	.	.	.	.	.	13	.
Canada Goose	184	5.7	.	.	.	.	35309	.
Canada Goose	40	1.24	.	.	.	.	35309	.
Mute Swan	.	.	.	.	.	.	16	.
Tundra Swan	.	.	.	.	.	.	285	.
Wood Duck	49	1.52	.	.	.	.	266	.
Gadwall	.	.	.	.	.	.	1033	.
American Wigeon	.	.	.	.	.	.	390	.
American Black Duck	.	.	.	.	.	.	68	.
Mallard	6	0.19	.	.	.	.	1614	.
Blue-winged Teal	.	.	.	.	.	.	9	.
Northern Shoveler	.	.	.	.	.	.	84	.
Northern Pintail	.	.	.	.	.	.	7	.
Green-winged Teal	.	.	.	.	.	.	679	.
Canvasback	.	.	.	.	.	.	49	.
Redhead	.	.	.	.	.	.	5	.
Ring-necked Duck	.	.	.	.	.	.	20056	.
Greater Scaup	.	.	.	.	.	.	10	.
Lesser Scaup	.	.	.	.	.	.	382	.
Surf Scoter	.	.	.	.	.	.	505	.
Long-tailed Duck	.	.	.	.	.	.	14	.
Bufflehead	.	.	.	.	.	.	730	.
Common Goldeneye	.	.	.	.	.	.	25	.
Hooded Merganser	.	.	.	.	.	.	267	.
Common Merganser	.	.	.	.	.	.	3	.
Ruddy Duck	.	.	.	.	.	.	5308	.
Northern Bobwhite	1	0.03	.	.	.	.	48	0.07
Wild Turkey	1	0.03	.	.	.	.	69	0.1
Red-throated Loon	.	.	.	.	.	.	66	.
Common Loon	.	.	.	.	.	.	40	.
Pied-billed Grebe	.	.	.	.	.	.	195	.
Horned Grebe	.	.	.	.	.	.	7	.
Northern Gannet	.	.	.	.	.	.	388	.
Double-crested Cormorant	.	.	.	.	.	.	1982	.
Brown Pelican	.	.	.	.	.	.	23	.
American Bittern	.	.	.	.	.	.	2	.
Great Blue Heron	9	0.28	.	.	.	.	188	.
Great Egret	1	0.03	.	.	.	.	30	.
Little Blue Heron	.	.	.	.	.	.	2	.
Green Heron	.	.	.	.	.	.	12	.
Black Vulture	14	0.43	.	.	.	.	243	0.36
Turkey Vulture	37	1.15	.	.	1	0.14	931	1.38
Osprey	.	.	.	.	.	.	26	0.04

Table B6. (contd)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Bald Eagle	14	0.43	.	.	.	.	389	0.57
Northern Harrier	.	.	.	.	.	.	58	0.09
Sharp-shinned Hawk	2	0.06	.	.	.	.	19	0.03
Cooper's Hawk	2	0.06	.	.	.	.	24	0.04
Red-shouldered Hawk	17	0.53	.	.	.	.	52	0.08
Broad-winged Hawk	.	.	.	.	.	.	1	0
Red-tailed Hawk	4	0.12	.	.	.	.	82	0.12
Rough-legged Hawk	.	.	.	.	.	.	1	0
American Kestrel	5	0.15	.	.	.	.	69	0.1
Merlin	.	.	.	.	.	.	5	0.01
Peregrine Falcon	.	.	.	.	.	.	2	0
Virginia Rail	.	.	.	.	.	.	4	.
Sora	.	.	.	.	.	.	10	.
American Coot	.	.	.	.	.	.	1028	.
American Golden-Plover	.	.	.	.	.	.	36	.
Semipalmated Plover	.	.	.	.	.	.	36	.
Killdeer	2	0.06	.	.	.	.	1288	.
American Avocet	.	.	.	.	.	.	5	.
Spotted Sandpiper	.	.	.	.	.	.	9	.
Solitary Sandpiper	.	.	.	.	.	.	7	.
Greater Yellowlegs	.	.	.	.	.	.	45	.
Lesser Yellowlegs	.	.	.	.	.	.	38	.
Hudsonian Godwit	.	.	.	.	.	.	4	.
Ruddy Turnstone	.	.	.	.	.	.	2	.
Semipalmated Sandpiper	.	.	.	.	.	.	39	.
Least Sandpiper	.	.	.	.	.	.	87	.
White-rumped Sandpiper	.	.	.	.	.	.	5	.
Baird's Sandpiper	.	.	.	.	.	.	2	.
Pectoral Sandpiper	.	.	.	.	.	.	7	.
Dunlin	.	.	.	.	.	.	49	.
Buff-breasted Sandpiper	.	.	.	.	.	.	2	.
Long-billed Dowitcher	.	.	.	.	.	.	3	.
Wilson's Snipe	.	.	.	.	.	.	15	.
American Woodcock	.	.	.	.	.	.	7	.
Bonaparte's Gull	.	.	.	.	.	.	30	.
Laughing Gull	.	.	.	.	.	.	43169	.
Ring-billed Gull	.	.	.	.	.	.	6341	.
Herring Gull	.	.	.	.	.	.	593	.
Lesser Black-backed Gull	.	.	.	.	.	.	1	.
Great Black-backed Gull	.	.	.	.	.	.	35	.
Caspian Tern	.	.	.	.	.	.	4	.
Black Tern	.	.	.	.	.	.	2	.
Forster's Tern	.	.	.	.	.	.	276	.
Royal Tern	.	.	.	.	.	.	22	.
Rock Pigeon	.	.	.	.	.	.	132	0.2
Mourning Dove	82	2.54	.	.	.	.	1423	2.1

Table B6. (contd)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Yellow-billed Cuckoo	2	0.06	.	.	.	.	25	0.04
Eastern Screech-Owl	.	.	.	.	.	.	5	0.01
Great Horned Owl	.	.	.	.	.	.	19	0.03
Barred Owl	.	.	.	.	.	.	6	0.01
Short-eared Owl	.	.	.	.	.	.	8	0.01
Common Nighthawk	.	.	.	.	.	.	1	0
Chimney Swift	.	.	.	.	.	.	5	0.01
Ruby-throated Hummingbird	3	0.09	.	.	1	0.14	27	0.04
Belted Kingfisher	11	0.34	.	.	2	0.28	55	0.08
Red-headed Woodpecker	11	0.34	.	.	2	0.28	18	0.03
Red-bellied Woodpecker	133	4.12	.	.	17	2.4	226	0.33
Yellow-bellied Sapsucker	7	0.22	.	.	2	0.28	39	0.06
Downy Woodpecker	45	1.39	.	.	8	1.13	133	0.2
Hairy Woodpecker	9	0.28	.	.	1	0.14	49	0.07
Northern Flicker	105	3.25	.	.	11	1.56	364	0.54
Pileated Woodpecker	37	1.15	.	.	3	0.42	66	0.1
Eastern Wood-Pewee	22	0.68	.	.	8	1.13	56	0.08
Acadian Flycatcher	.	.	.	.	.	.	16	0.02
Eastern Phoebe	37	1.15	.	.	11	1.56	79	0.12
Great Crested Flycatcher	.	.	.	.	.	.	5	0.01
Eastern Kingbird	.	.	.	.	.	.	23	0.03
White-eyed Vireo	26	0.81	.	.	2	0.28	46	0.07
Yellow-throated Vireo	1	0.03	.	.	.	.	10	0.01
Blue-headed Vireo	.	.	.	.	.	.	1	0
Red-eyed Vireo	17	0.53	.	.	2	0.28	48	0.07
Blue Jay	174	5.39	.	.	66	9.34	391	0.58
American Crow	184	5.7	.	.	34	4.81	1168	1.73
Fish Crow	4	0.12	.	.	2	0.28	33	0.05
Horned Lark	.	.	.	.	.	.	238	0.35
Purple Martin	.	.	.	.	.	.	61	0.09
Tree Swallow	140	4.34	.	.	15	2.12	1244	1.84
Northern Rough-winged Swallow	.	.	.	.	.	.	13	0.02
Bank Swallow	.	.	.	.	.	.	38	0.06
Barn Swallow	.	.	.	.	.	.	203	0.3
Carolina Chickadee	81	2.51	.	.	25	3.54	279	0.41
Tufted Titmouse	120	3.72	.	.	27	3.82	323	0.48
Red-breasted Nuthatch	3	0.09	.	.	.	.	1	0
White-breasted Nuthatch	9	0.28	.	.	.	.	50	0.07
Brown Creeper	2	0.06	.	.	2	0.28	15	0.02
Carolina Wren	170	5.27	.	.	25	3.54	515	0.76
House Wren	4	0.12	.	.	.	.	9	0.01
Winter Wren	1	0.03	.	.	.	.	42	0.06
Marsh Wren	.	.	.	.	.	.	1	0
Blue-gray Gnatcatcher	.	.	.	.	2	0.28	55	0.08
Golden-crowned Kinglet	17	0.53	.	.	2	0.28	126	0.19

Table B6. (contd)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Ruby-crowned Kinglet	22	0.68	.	.	2	0.28	170	0.25
Eastern Bluebird	22	0.68	.	.	.	.	416	0.61
Veery	.	.	.	.	.	.	5	0.01
Gray-cheeked Thrush	2	0.06	.	.	.	.	1	0
Swainson's Thrush	.	.	.	.	.	.	6	0.01
Hermit Thrush	11	0.34	.	.	7	0.99	160	0.24
Wood Thrush	5	0.15	.	.	.	.	2	0
American Robin	42	1.3	.	.	.	.	1147	1.69
Gray Catbird	32	0.99	.	.	3	0.42	80	0.12
Northern Mockingbird	7	0.22	.	.	.	.	229	0.34
Brown Thrasher	40	1.24	.	.	7	0.99	72	0.11
European Starling	1	0.03	.	.	.	.	19991	29.53
American Pipit	.	.	.	.	.	.	151	0.22
Cedar Waxwing	10	0.31	.	.	.	.	271	0.4
Lapland Longspur	.	.	.	.	.	.	4	0.01
Ovenbird	.	.	.	.	.	.	14	0.02
Northern Waterthrush	.	.	.	.	.	.	12	0.02
Blue-winged Warbler	.	.	.	.	.	.	1	0
Black-and-white Warbler	3	0.09	.	.	1	0.14	11	0.02
Prothonotary Warbler	.	.	.	.	.	.	6	0.01
Nashville Warbler	1	0.03	.	.	.	.	2	0
Mourning Warbler	.	.	.	.	.	.	1	0
Common Yellowthroat	40	1.24	.	.	3	0.42	138	0.2
Hooded Warbler	.	.	.	.	.	.	10	0.01
American Redstart	.	.	.	.	1	0.14	25	0.04
Cape May Warbler	.	.	.	.	.	.	15	0.02
Northern Parula	.	.	.	.	.	.	19	0.03
Magnolia Warbler	1	0.03	.	.	.	.	11	0.02
Bay-breasted Warbler	.	.	.	.	.	.	2	0
Yellow Warbler	.	.	.	.	.	.	19	0.03
Chestnut-sided Warbler	.	.	.	.	.	.	2	0
Blackpoll Warbler	.	.	.	.	.	.	9	0.01
Black-throated Blue Warbler	.	.	.	.	.	.	4	0.01
Palm Warbler	2	0.06	.	.	1	0.14	25	0.04
Pine Warbler	4	0.12	.	.	5	0.71	86	0.13
Yellow-rumped Warbler	202	6.26	.	.	142	20.08	684	1.01
Yellow-throated Warbler	.	.	.	.	.	.	4	0.01
Prairie Warbler	1	0.03	.	.	.	.	11	0.02
Black-throated Green Warbler	.	.	.	.	.	.	4	0.01
Eastern Towhee	47	1.46	.	.	13	1.84	36	0.05
Chipping Sparrow	3	0.09	.	.	.	.	205	0.3
Field Sparrow	29	0.9	.	.	.	.	242	0.36
Savannah Sparrow	.	.	.	.	.	.	506	0.75
Grasshopper Sparrow	.	.	.	.	.	.	9	0.01
Fox Sparrow	.	.	.	.	.	.	10	0.01

Table B6. (contd)

Species	Area search count	Area search percent	Banding count	Banding percent	Mobbing count	Mobbing percent	eBird count	eBird percent
Song Sparrow	75	2.32	.	.	8	1.13	1378	2.04
Lincoln's Sparrow	.	.	.	.	.	.	3	0
Swamp Sparrow	6	0.19	.	.	.	.	616	0.91
White-throated Sparrow	172	5.33	.	.	42	5.94	1069	1.58
White-crowned Sparrow	.	.	.	.	.	.	234	0.35
Slate-colored Junco	3	0.09	.	.	.	.	443	0.65
Summer Tanager	2	0.06	.	.	.	.	19	0.03
Scarlet Tanager	1	0.03	.	.	.	.	12	0.02
Northern Cardinal	120	3.72	.	.	29	4.1	707	1.04
Rose-breasted Grosbeak	2	0.06	.	.	.	.	3	0
Blue Grosbeak	2	0.06	.	.	1	0.14	57	0.08
Indigo Bunting	56	1.74	.	.	1	0.14	147	0.22
Bobolink	6	0.19	.	.	.	.	25	0.04
Red-winged Blackbird	66	2.05	.	.	.	.	13618	20.12
Eastern Meadowlark	42	1.3	.	.	.	.	200	0.3
Yellow-headed Blackbird	.	.	.	.	.	.	1	0
Rusty Blackbird	.	.	.	.	.	.	449	0.66
Common Grackle	190	5.89	.	.	170	24.05	10209	15.08
Brown-headed Cowbird	6	0.19	.	.	.	.	3004	4.44
Orchard Oriole	.	.	.	.	.	.	4	0.01
Baltimore Oriole	.	.	.	.	.	.	8	0.01
Purple Finch	.	.	.	.	.	.	25	0.04
House Finch	7	0.22	.	.	.	.	91	0.13
Pine Siskin	.	.	.	.	.	.	24	0.04
American Goldfinch	30	0.93	.	.	.	.	764	1.13
House Sparrow	.	.	.	.	.	.	42	0.06
Totals	3224	99.88	0	0	707	99.96	226276	100.02

APPENDIX C. ACTIVITY BUDGET SUMMARY OF SPECIES AND ACTIVITIES.

Table C1. Summary of the number of observations and activities by species observed during activity budget surveys.

Species	Number of observations	Number of activities
Canada Goose	1	1
Great Blue Heron	2	2
Killdeer	1	1
Mourning Dove	3	3
Turkey Vulture	2	2
Northern Harrier	2	2
Cooper's Hawk	1	1
Yellow-billed Cuckoo	4	7
Hairy Woodpecker	1	5
Downy Woodpecker	13	31
Red-bellied Woodpecker	7	13
Yellow-shafted Flicker	4	7
Northern Flicker	9	12
Eastern Kingbird	2	3
Great Crested Flycatcher	2	4
Eastern Phoebe	32	61
Eastern Wood-Pewee	6	11
Blue Jay	22	40
Common Raven	1	1
American Crow	4	4
European Starling	3	3
Eastern Meadowlark	7	9
Baltimore Oriole	1	2
Purple Finch	2	3
House Finch	8	14
American Goldfinch	29	47
Vesper Sparrow	3	3
Savannah Sparrow	21	26
Grasshopper Sparrow	2	2
White-crowned Sparrow	5	9
White-throated Sparrow	70	184
Chipping Sparrow	6	7
Field Sparrow	27	40
Slate-colored Junco	39	64
Dark-eyed Junco	2	8
Song Sparrow	125	250
Lincoln's Sparrow	8	14
Swamp Sparrow	75	157
Eastern Towhee	59	71
Northern Cardinal	59	110

Table C1. (contd)

Species	Number of observations	Number of activities
Rose-breasted Grosbeak	1	9
Indigo Bunting	3	4
Scarlet Tanager	1	3
Summer Tanager	2	6
Tree Swallow	16	16
Cedar Waxwing	13	17
Red-eyed Vireo	49	82
Philadelphia Vireo	3	5
Solitary Vireo	4	7
White-eyed Vireo	3	6
Black-and-White Warbler	45	77
Prothonotary Warbler	4	4
Tennessee Warbler	5	8
Northern Parula	71	128
Yellow Warbler	4	4
Black-throated Blue Warbler	10	18
Myrtle Warbler	1102	1827
Magnolia Warbler	34	58
Chestnut-sided Warbler	1	2
Blackpoll Warbler	14	20
Yellow-throated Warbler	2	3
Black-throated Green Warbler	1	1
Western Palm Warbler	64	87
Yellow Palm Warbler	66	112
Prairie Warbler	7	12
Ovenbird	3	5
Northern Waterthrush	5	9
Common Yellowthroat	129	216
Wilson's Warbler	1	1
American Redstart	89	158
Northern Mockingbird	92	150
Gray Catbird	196	296
Brown Thrasher	7	13
Carolina Wren	28	46
House Wren	63	107
Brown Creeper	5	7
White-breasted Nuthatch	3	17
Red-breasted Nuthatch	3	5
Eastern Tufted Titmouse	7	13
Black-capped Chickadee	108	160
Carolina Chickadee	5	9
Golden-crowned Kinglet	20	30
Ruby-crowned Kinglet	40	65

Table C1. (contd)

Species	Number of observations	Number of activities
Blue-gray Gnatcatcher	11	25
Wood Thrush	1	2
Veery	4	4
Swainson's Thrush	1	2
Hermit Thrush	11	15
American Robin	42	86
Eastern Bluebird	3	3
Totals	3,072	5,194

APPENDIX D. CONTRIBUTORS

Table D1. List of contributors to this project, either contributing data for analysis and/or comments to the protocol or report.

Contributor	Organization
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