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Suggestions for collecting additional data during point count surveys conducted by paid Breeding Bird Atlas crews in Canada

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Executive summary

The Boreal Avian Modelling Project (BAM) recently asked the Breeding Bird Atlas Committee of Canada (committee) to consider having future atlases conduct point count surveys relative to two time intervals (0–3, 3–5 min) and two distance intervals (0–50 m, > 50 m; 2 x 2 design). The committee thought it was feasible to have their paid survey crews collect the data in this manner but asked BAM to first more clearly articulate why they needed these data and how much data would be required. In this white paper we address this request.

- The additional data from the 2 x 2 design will help us (1) measure roadside bias in avian surveys and thereby allow us to combine data from roadside and off-road surveys in our analyses of distribution and abundance and (2) control for differences in detectability among habitats for a wider array of species and habitat types.
- A general summary of the BAM data indicated that if atlas crews were able to conduct surveys at 1,000–2,000 points following the 2 x 2 design, then we would be able to correct these data for detectability for 36–49 species of passerines.
- The number of surveys needed to compute detection rates of species at risk are reduced if wetlands (Rusty Blackbird), recent burns (Rusty Blackbird and Olive-sided Flycatcher), and deciduous and mixed forests (Canada Warbler) are targeted for sampling.
- Overall, we feel that the collection of data following the 2 x 2 design is relatively easy to perform in the field and minimize errors associated with estimating distances to singing birds. We provide examples of how these data can be quite useful in accounting for variation in avian detection probabilities relative to time-of-day, time-of-year, migratory strategy, habitat, and the total number of birds encountered at point count surveys.
- Thus, the extra data in the 2 x 2 design will be quite useful to BAM for a variety of reasons. It is our sincerely hope that the atlas committee will be able to accommodate our request to collect this information during future atlases.

Introduction

The Boreal Avian Modelling Project (BAM) recently requested that the Breeding Bird Atlas Committee for Canada (committee) consider collecting additional data during point count surveys conducted as part of Breeding Bird Atlases in Canada (atlas) to make the survey data more useful for our continental analyses of boreal forest birds. More specifically, we asked the committee whether observers might be able to tally the birds they detect during point count surveys into two or more distance and time intervals which would help BAM 1) sort out issues of detection bias during the surveys, 2) make data more comparable to 3-minute surveys conducted as part of the North American Breeding Bird Survey (BBS), and 3) help us measure and thereby correct for roadside bias in analyses that combine on- and off-road surveys.

The committee had well substantiated concerns with how the collection of this additional data would potentially introduce new sources of error to the surveys (Simons et al. 2009). For example, particular concerns were voiced about inaccuracies in estimating distances to singing birds (Alldredge et al. 2007) and the overall confusions created for atlas volunteers in conducting surveys relative to time and distance intervals. However, the committee was willing to have paid Atlas surveyors collect the additional data during point count surveys if BAM could make a convincing case for the need of this additional information and the number of surveys required for analysis. In this white paper we address this request from the committee by outlining (1) the specific information we would like collected and how it will help us address challenges with analyzing the BAM data for avian abundance and (2) how we are using the additional information to analyze point count data and why these data are relevant to atlases.

How additional information from atlases will help

It would be ideal for our analyses of boreal bird populations if future atlases were able to tally avian detections during point count surveys relative to two time intervals (0-3, 3-5 min) and two distance intervals (0-50 m, >50 m; 2 x 2 design). This would allow us to calculate detection probabilities directly from the data rather than assuming that detection rates from other areas apply to the atlas data. Such data have been used to adjust survey counts for the two components of the detection process: (1) the probability that a bird is giving a detectable cue and is thereby available for detection (P_{avail}), using a time-of-removal model, and (2) the probability of detecting a bird given that it is available for detection (P_{detect}), using a simple binomial distance sampling model (Farnsworth et al. 2005). For example, the 2nd Pennsylvania Breeding Bird Atlas had their paid observers record the birds they detected relative to five time intervals and two distance bands which allow their program to estimate population sizes for the state (Farnsworth et al. 2010).

Aside from general abundance estimation, there are two specific areas where the collection of additional data in the 2 x 2 design at atlas point counts would greatly help BAM's analyses of boreal birds: (1) measuring roadside bias in counts which will allow us to combine data from roadside and off-road surveys and (2) estimating detectability for a wider range of habitats and species. We will address each of these below, with an emphasis on the roadside issue.

Roadside bias.—BAM is currently working towards incorporating data from the North American Breeding Bird Survey into our analyses of boreal bird abundance and distribution. In order to do so, we need to adequately account for roadside bias in survey counts which we have found to be pervasive (significant for 79% of 85 species) in our recent analyses. However, there are two issues that we need to resolve in order to be able to control for roadside bias when we combine roadside and off-road survey data in our analyses of avian abundance. First, we cannot calculate detection probabilities using BBS data because we do not have time-interval or distance-interval data from roadside surveys. Roadsides have large open areas that may increase detectability because birds can be seen and heard at greater distances across roadway clearings than through dense vegetation. Thus we expect a positive bias in detectability along roadsides, but can only speculate on this until we have data to estimate bird detection rates from roadside counts. The collection of the survey data relative to the distance bands will address this.

Second, we cannot efficiently adjust surveys for variation in count duration (i.e., 3, 5, 10 min) when we combine the off-road surveys with the BBS data. For example, we expect that counts of birds should always increase or remain the same with increases in the duration of surveys. However, when we analyzed the BAM + BBS data in a generalized linear model, we find that only 65% of 75 species showed this pattern among 3, 5, and 10-min counts. For the remaining 35% of species, the model predicted the highest mean count during a 3-min interval. This was despite controlling for autocorrelation of counts in time and space as well as the fixed effects of habitat, time (day, season, year), and whether counts were conducted on or off of roads. However, all roadside surveys were 3-min in duration, so our findings in part reflect a confounding interaction (on/off-road survey x count duration) that could be removed if we had adequate numbers of roadside surveys where counts were partitioned into time intervals such as 0–3, 3–5, and possibly 5–10 min (Bayne et al. in prep.). Again the atlas surveys would be a tremendous help to us on this front.

Need for more data on detectability.—Of our two adjustments for detection probability, P_{detect} requires more data to calculate, generally a minimum of 75–100 detections (Buckland et al. 2001:241). If we wish to estimate detection probabilities by habitat, then this minimum sample size should be acquired for each habitat type. Thus, even in a large dataset like BAM, we quickly run out of samples to estimate habitat specific detection rates except for the more common species or for the most general of habitat classes (≤ 8 classes). To put this in perspective, we provide a gross estimate of the number of boreal point counts of 5-min duration that should be surveyed in order to obtain 75 detections for each of 80 species of passerine birds in 8 general habitat classes (Table 1). This is based on the distribution of surveys in the BAM dataset and a generalization of the 39 land cover types included in the Land Cover Map of Canada 2005 (Latifovic et al. 2008). Thus, regional estimates of sample size requirements would be more accurate if obtained using regional survey data. However, our data indicate that a sample of 1,000 and 2,000 point count stations (possible sample size by paid atlas crews) might yield sufficient numbers of detections to estimate detection probabilities for 36 and 49 passerine species, respectively—this would be quite useful for our program. Also, if atlases were interested in estimating densities of species at risk, then sampling might be focused on recent burns for Olive-sided Flycatcher (*Contopus cooperi*), wetlands and recent burns for Rusty Blackbird *(Euphagus carolinus*), and deciduous and mixed forests for Canada Warbler (*Wilsonia canadensis*, Table 1).

How and why we are using the additional information

The BAM team has recently built upon the analytical approach of Farnsworth et al. (2005) and can now simultaneously adjust the off-road survey counts for (1) incomplete detectability of birds both in terms of P_{avail} and P_{detect} and (2) variation in survey effort in terms of count duration (e.g., 3, 5, 10 min) and maximum distance that birds are counted to (e.g., 100 m versus unlimited distance). The detection rates, estimated from the subset of surveys with multiple time and or distance intervals, are then applied to the entire dataset, corrected for survey effort. We see several benefits to this approach, both for our national analyses and for atlases which we summarize below.

P_{avail}.—Our models of P_{avail} are relatively new to BAM and utilize the surveys where counts were tallied into ≥2 time intervals. Since most birds are detected aurally during point counts, P_{avail} might be thought of as an estimate of singing rate with birds that sing more often having higher P_{avail}. Our estimates of P_{avail} are positively correlated with singing rates in the literature (Fig. 1), a confirmation of this approach. Because singing rates, in relation to survey counts, are known to vary by time-of-day and time-of-year for many species (Farnsworth et al. 2002, Rosenberg and Blancher 2005, Thogmartin et al. 2006), we are modeling P_{avail} relative to these temporal covariates (Fig. 2) and are finding more support for models with these effects than models with no temporal covariates (Sólymos et al. in prep.).

A separate study found that estimates of P_{avail} during June surveys were much higher for migrants than residents birds (Handel et al. 2009). Thus models of P_{avail} might be helpful in accounting for disparities in the timing of boreal surveys relative to the peak singing period of long-distance migrants (well timed) versus resident birds (poorly timed). Estimating annual variation in P_{avail} may be particularly relevant for monitoring purposes because the timing of reproduction and thus peak singing is sensitive to annual shifts in weather for resident birds and short-distance migrants. Thus, accounting for annual variation in P_{avail} may help monitoring programs like atlases track changes in annual population size rather than shifts in the timing of breeding.

$\boldsymbol{P}_{\textbf{detect}}$.—The distance of animals from the observer's vantage point is one of the most ubiquitous sources of detection error in animal surveys. A simulation study recently found that distance sampling was the only abundance estimator the accurately accounts for this source of detection error when estimating population size from point counts. Other methods based on multiple observers, time intervals, or visits often produced estimates of abundance with bias >50% when used on their own (Efford and Dawson 2009).

We have used a binomial distance sampling model to estimate P_{detect}, which we express at the effective distance radius (EDR, m) and then use to define the effect area sampled by the survey. The binomial model requires that counts be tallied relative to two distance intervals which may minimize errors in estimating distances to birds (Buckland 1987) when the dividing point is chosen well. Many of the surveys in the BAM dataset have tallied birds relative to a 50-m dividing point which avoids the 65–85 m interval where it is difficult for trained observers to accurately estimate distances to singing birds (Alldredge et al. 2007). We have found these binomial models to provide equivalent estimates of EDR to those derived from distance sampling models with multiple distance bands. We have also found that EDR varies among general habitat types for 40% of species and with the total number of avian detection at the point for 60% of species. Thus accounting for such covariate effects will help improve estimates of abundance. Finally, we also found that EDR is negatively correlated with maximum song frequency of species which confirms the EDR approach since high frequency sound travel shorter distances than low frequency sound (Fig. 3; Matsuoka et al. in prep.).

$\boldsymbol{P}_{\textbf{avail}} \cdot \boldsymbol{P}_{\textbf{detect}}$.—Our preliminary models showed that the ranked abundance of 17 of 56 species changed by more than 10 places when ranks were based on densities versus raw counts. For example, Golden-crowned Kinglet (*Regulus satrapa*) was the 32^{th} most abundant species based on unadjusted counts but was the 8^{th} most abundant species after accounting for detectability (Table 1). This emphasizes the levels of bias in the raw counts, particularly when assessing the structure of breeding bird communities (Sólymos et al. in prep.).

Conclusions

The collection of the atlas point counts following the 2 x 2 design will benefit BAM's analyses in several different ways, from helping us measure roadside bias, to filling gaps in assessing detection rates by habitat type, and improving our overall estimates of detection rates in our analyses of continental populations of boreal forest birds. We also feel that the surveys conducted following the 2 x 2 design will be able to improve the information coming from the atlases as has been shown recently in the 2nd Pennsylvania Breeding Bird Atlas (Farnsworth et al. 2010). Thus it is our sincere hope that the atlas committee will be able to accommodate our request to collect the extra information during future atlas point count surveys. Finally, the current and upcoming atlases are filling large geographic gaps in avian surveys across North America's boreal forest region. Thus, the new survey data from the atlases will be incredibly valuable in our analyses of the avian abundance and distribution regardless to whether or not the point count data are collected following the 2 x 2 design. It is just that the data will be even more valuable if following the 2 x 2 design, the general recommended protocol for point count surveys since the early 1990s (Ralph et al. 1993).

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Table 1. Estimates of the number of survey points that need to sampled in order to meet the samples size requirements of 75 detections by species and general habitat type. Estimates are based the subsample of projects providing data to the Boreal Avian Modelling project that conducted counts of 5-min duration (n = 24,749 visits).

Species	Total detections	Habitats combined	Conifer	Deciduous	Mixed	Wetland	Non-forested	Recent burns	Agriculture	Urban
WTSP	25,445	73	103	62	68	85	77	42	78	165
REVI	14,959	124	187	85	125	286	211	196	93	165
OVEN	14,399	129	190	94	111	423	266	2,156	139	825
SWTH	13,750	135	113	177	111	145	173	227	853	
NAWA	11,965	155	173	169	109	479	201	160	525	
MAWA	11,428	162	180	164	127	236	239	308	488	825
YRWA	9,459	196	148	283	180	195	197	270	758	
HETH	7,889	235	290	232	197	271	242	117	1,138	
WIWR	7,056	263	243	277	230	355	377	308	758	
TEWA	6,894	269	233	540	191	186	278	863	1,365	
RCKI	5,868	316	198	759	285	197	412	288		
AMRO	5,098	364	560	302	447	354	225	184	74	63
CHSP	4,900	379	343	569	312	350	291	375	427	118
ALFL	4,361	426	754	319	463	448	346	173	569	
BTNW	4,274	434	871	220	690	2,223	1,197	8,625	569	825
YBFL	4,072	456	441	585	335	699	491	863	1,365	
DEJU	3,756	494	345	1,074	623	242	273	180	6,825	
CSWA	3,632	511	1,129	311	532	1,544	822	663	284	
GCKI	3,589	517	414	654	400	1,182	908	2,875	1,138	825
AMRE	3,549	523	791	372	490	1,195	926	1,232	401	825
LEFL	3,394	547	874	375	594	686	902	863	220	
CORA	3,167	586	703	590	642	445	481	2,875	55	275
MOWA	2,850	651	2,220	371	741	1,985	743	411	297	275
AMCR	2,664	697	891	530	1,216	588	500	1,438	99	69

Species	Total detections	Habitats combined	Conifer	Deciduous	Mixed	Wetland	Non-forested	Recent burns	Agriculture	Urban
COYE	2,644	702	1,685	473	742	817	739	663	171	825
SAVS	2,589	717	849	1,052	3,997	189	230	1,725	56	206
LISP	2,468	752	1,217	671	1,020	354	455	227	682	
BCCH	2,410	770	1,055	565	717	2,585	1,167	4,313	2,275	825
RBNU	2,409	771	631	964	616	1,249	1,274	958	2,275	
VEER	2,341	793	2,479	410	957	9,263	2,480	1,438	195	275
BBWA	2,196	845	640	1,274	664	1,020	1,251	4,313	6,825	
GRAJ	2,073	895	674	1,619	900	483	731	575	1,706	
WWCR	2,003	927	570	2,122	912	604	978	1,232	975	
BHVI	1,960	947	982	953	769	1,684	1,298	1,438	3,413	
BAWW	1,939	957	1,399	694	908	1,635	1,903	1,438	620	
CEDW	1,874	990	1,374	782	978	1,407	1,673	616	155	118
BLBW	1,841	1,008	988	798	999	4,117	2,354	4,313		
PAWA	1,625	1,142	1,116	1,606	1,419	316	1,432	507		
BLJA	1,566	1,185	1,889	863	1,043	5,052	1,654	2,875	682	
SWSP	1,559	1,191	1,227	1,439	1,068	594	1,929	1,438	569	
NOWA	1,538	1,207	802	2,668	1,591	401	1,197	616		
SOSP	1,505	1,233	1,928	785	2,992	958	1,286	1,232	116	63
BTBW	1,438	1,291	3,023	631	1,893	10,105	6,945	4,313	6,825	
WETA	1,224	1,516	1,424	4,538	875	1,090	1,634			
FOSP	1,207	1,538	1,280	4,378	2,335	416	723	332		
CAWA	1,074	1,728	2,285	1,360	1,388	5,850	4,630	8,625	3,413	
YWAR	1,059	1,753	1,748	1,961	4,714	421	1,736	1,232	525	206
WCSP	941	1,973	1,781	12,687	14,276	967	311	270		
PISI	890	2,086	1,469	3,657	1,586	3,004	3,307	1,438	6,825	
BRCR	794	2,338	1,415	3,289	2,221	3,970	6,614			
NOPA	777	2,389	3,003	1,527	3,047	5,052	5,342		3,413	
RBGR	705	2,633	6,507	1,741	2,282	6,538	3,655		3,413	
WIWA	675	2,750	2,772	3,573	4,759	1,170	1,120	1,078		

Species	Total detections	Habitats combined	Conifer	Deciduous	Mixed	Wetland	Non-forested	Recent burns	Agriculture	Urban
BOCH	658	2,821	1,679	6,344	2,602	3,176	2,621	8,625		
OSFL	540	3,437	3,904	3,885	2,855	3,269	3,655	663		
CMWA	533	3,483	2,101	8,074	2,888	2,850	7,717	4,313	6,825	
BLPW	483	3,843	2,965	20,723	7,348	1,170	1,111	1,232		
RWBL	481	3,859	4,984	3,593	7,241	2,097	2,525	8,625	201	413
EVGR	458	4,053	3,347	4,571	3,309	37,050	5,342		6,825	825
PUFI	453	4,098	6,693	2,892	3,997	8,550	4,961		6,825	825
AMGO	451	4,116	12,013	2,457	9,253	13,894	2,671	2,875	190	138
TRES	373	4,976	5,149	6,036	8,469	2,316	3,157	863	379	
PHVI	353	5,258	4,984	5,601	6,489	2,925	4,341		6,825	
LCSP	315	5,893	52,058	3,861	124,913	4,631	4,630	4,313	80	
OCWA	308	6,027	4,259	36,569	14,696	1,221	3,307	616		
BRBL	299	6,208		4,037			2,835		71	
WAVI	282	6,582	10,896	6,217	4,947	11,115	5,144		6,825	
CORE	274	6,774	5,512	14,458	21,724	1,853	2,277	4,313		
CONW	243	7,639	6,599	15,940	5,431	8,550	6,039	2,156	6,825	
RUBL	230	8,070	3,718	51,806	18,506	2,711	7,717	1,725	6,825	
EAWP	178	10,428	27,560	5,138	17,229	111,150	19,843		2,275	
CCSP	177	10,487	66,932	6,217	62,456	13,894	4,209	8,625	341	
VATH	134	13,852	5,784	207,225	29,391	10,105	6,945	4,313		
BARS	118	15,730	156,175	13,227	249,825	55,575	5,342		190	413
EAKI	86	21,583		12,687	62,456		17,363	2,156	401	
EAPH	65	28,557	58,566	20,054	71,379	55,575	11,575	8,625	1,706	
RECR	56	33,146	16,733	38,855	71,379	111,150	46,300	8,625		
WBNU	51	36,396	52,058	27,029	38,435	55,575	34,725			
BHCO	42	44,195	156,175	28,258	499,650		12,627		1,365	
HOWR	42	44,195	468,525	27,029	99,930	111,150	19,843	4,313	2,275	

Table 2. Ranked abundance of 56 species based on 10-min counts corrected for detection probability (density, birds / ha) and raw uncorrected counts (birds / point). The difference in the ranks (difference) indicates the degree that the uncorrected counts under (-) or overestimate (+) the ranked abundance among species.

	Corrected counts		Uncorrected counts		
Species	Density	Rank	Birds / point	Rank	Difference
YRWA	0.356	1	0.310	4	-3
TEWA	0.202	2	0.236	7	-5
REVI	0.190	3	0.433	3	0
WTSP	0.183	4	0.498	1	3
OVEN	0.182	5	0.459	2	3
AMRO	0.172	6	0.299	5	1
CHSP	0.168	7	0.214	8	-1
GCKI	0.167	8	0.058	32	-24
MAWA	0.136	9	0.154	12	-3
AMRE	0.120	10	0.123	17	-7
BCCH	0.117	11	0.114	19	-8
SOSP	0.113	12	0.201	9	3
YWAR	0.109	13	0.111	21	-8
SWTH	0.109	14	0.238	6	8
RBNU	0.097	15	0.093	26	-11
NAWA	0.095	16	0.152	13	3
BTNW	0.089	17	0.145	14	3
CEDW	0.089	18	0.062	30	-12
DEJU	0.088	19	0.079	28	-9
LEFL	0.085	20	0.112	20	0
RCKI	0.084	21	0.122	18	3
BLBW	0.075	22	0.050	35	-13
BBWA	0.074	23	0.036	43	-20
BOCH	0.074	24	0.016	50	-26
COYE	0.073	25	0.127	16	9
CSWA	0.069	26	0.104	22	4
BAWW	0.067	27	0.071	29	-2
MOWA	0.062	28	0.098	24	4

	Corrected counts		Uncorrected counts		
Species	Density	Rank	Birds / point	Rank	Difference
GRAJ	0.055	29	0.040	41	-12
WIWR	0.052	30	0.159	11	19
PISI	0.048	31	0.024	47	-16
RBGR	0.046	32	0.099	23	9
BHVI	0.044	33	0.051	34	-1
ALFL	0.044	34	0.090	27	7
HETH	0.043	35	0.136	15	20
VEER	0.043	36	0.097	25	11
BRCR	0.043	37	0.030	44	-7
LISP	0.042	38	0.058	31	7
YBFL	0.039	39	0.047	37	2
BLPW	0.037	40	0.010	56	-16
PUFI	0.037	41	0.017	49	-8
AMCR	0.034	42	0.198	10	32
CMWA	0.033	43	0.011	54	-11
TRES	0.032	44	0.049	36	8
SWSP	0.030	45	0.045	38	7
NOWA	0.027	46	0.040	40	6
CAWA	0.026	47	0.030	45	2
PHVI	0.023	48	0.025	46	2
PAWA	0.018	49	0.020	48	1
WIWA	0.015	50	0.012	51	-1
EAWP	0.015	51	0.040	39	12
OCWA	0.015	52	0.012	52	0
CONW	0.014	53	0.038	42	11
CORA	0.010	54	0.053	33	21
NOPA	0.008	55	0.010	55	0
OSFL	0.003	56	0.012	53	3

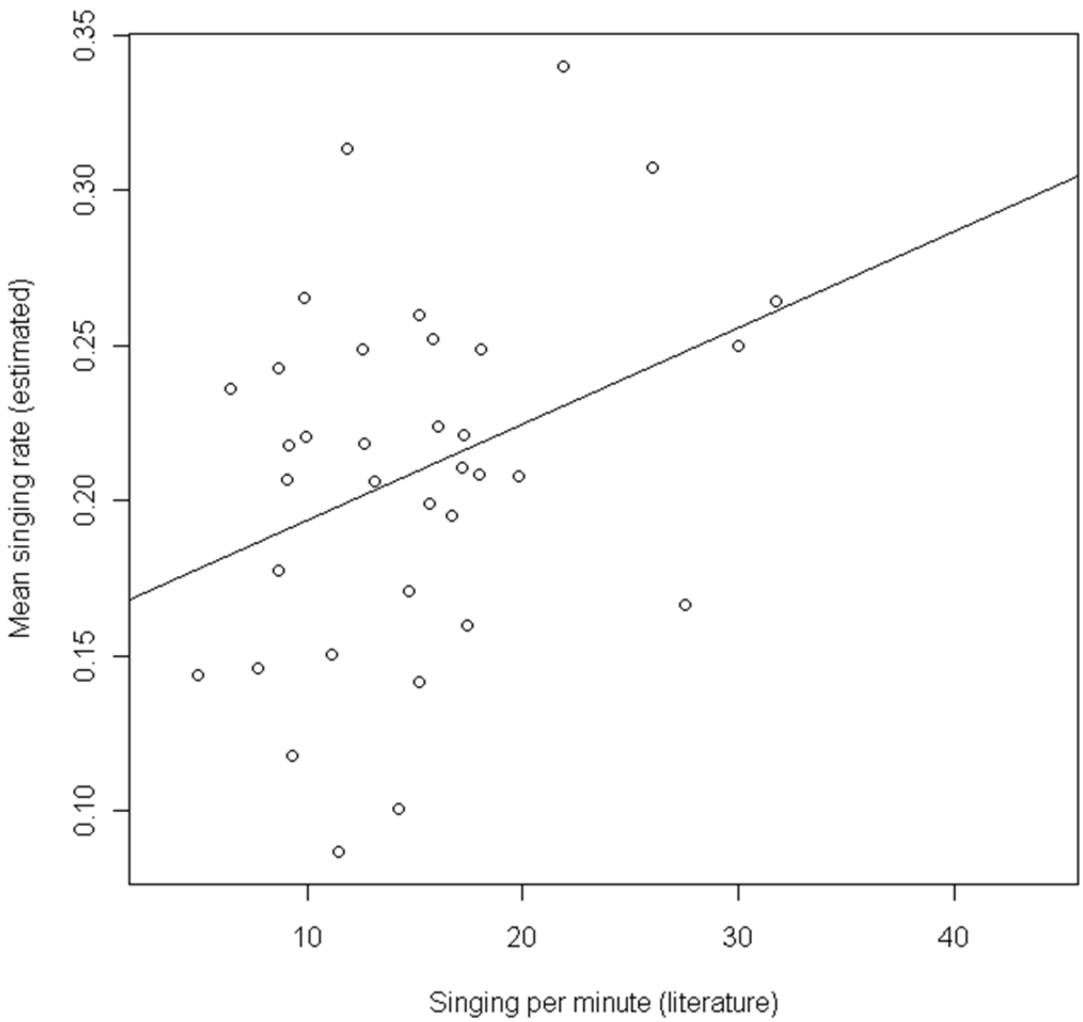

Figure 1. Relationship between estimated mean singing rate based on P_{avail} and singing rate from the literature.

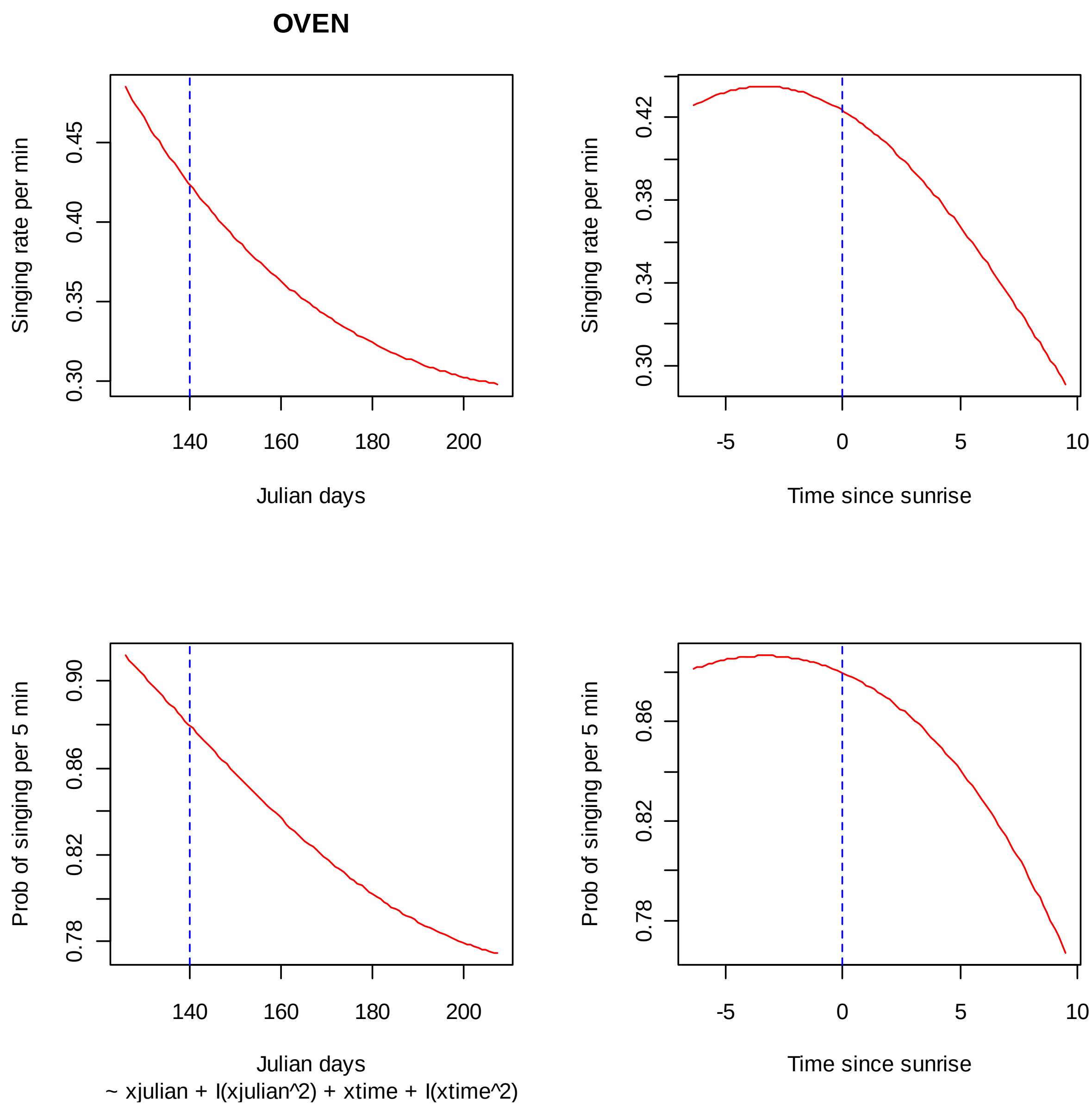

Figure 2. Time of day and date effects on singing rate and probability of singing per 5 minutes for Ovenbird.

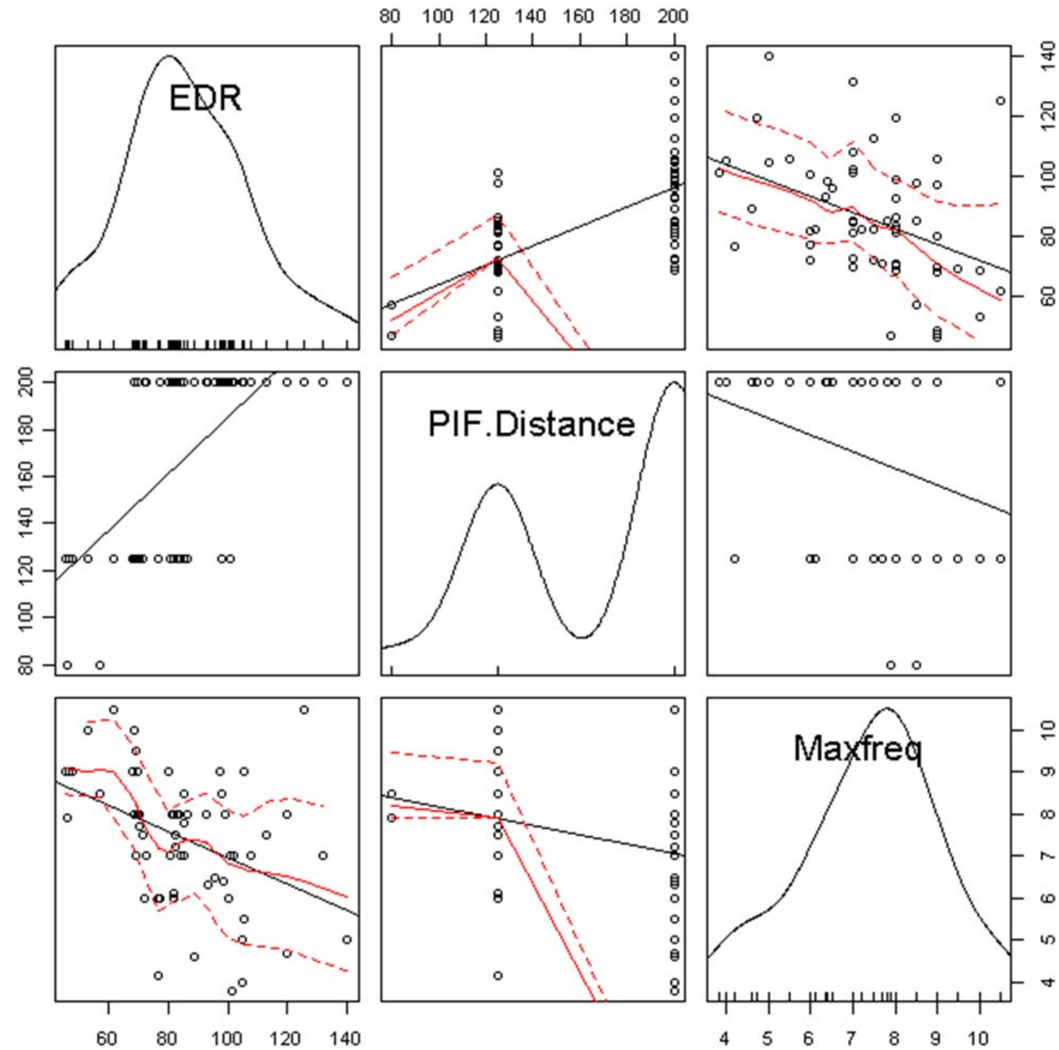

Figure 3. Scatter graphs of pairwise relationships among the effective detection radius of surveys (EDR, m), Partners in Flight maximum detection distances (PIF. Distance, m), and maximum song frequency from the Birds of North America accounts (Max freq, MHz). For example, the upper right box represents the relationship between EDR (y-axis) and Maxfreq (x-axis).