J. Field Ornithol., 72(2):228–235

USING POINT COUNTS TO ESTABLISH CONSERVATION PRIORITIES: HOW MANY VISITS ARE OPTIMAL?

RODNEY B. SIEGEL, DAVID F. DESANTE AND M. PHILIP NOTT
The Institute for Bird Populations
P.O. Box 1346
Point Reyes Station, California 94956-1346 USA

Abstract.—We conducted point counts three times during the 1994 breeding season at 48 stations across the northwestern United States, and used cumulative totals from the three visits to rank the sites by two potential indices of conservation value: species richness and overall abundance of birds. We then recalculated each of the indices (1) using data from only a single visit to each site and (2) using data from only two visits. Rankings based on only one or two visits revealed that eliminating one, and even two of the visits had relatively minor effects on species richness rankings but affected rankings based on overall abundance more substantially. We also evaluated how effectively one or two visits to each site detected particular species of management concern. We conclude that when resources are limited, species richness based on point counts conducted during just one or two visits to potential conservation sites may provide a reliable index for prioritizing conservation efforts. When the primary objective is to determine the presence or absence of a particular species, however, at least two visits may be warranted. Finally, we conclude that, in general, researchers must be careful when using overall abundance as an index for establishing conservation priorities, as values may fluctuate substantially throughout the season.

UTILIZACIÓN DE CONTEOS DE PUNTO PARA ESTABLECER PRIORIDADES DE CONSERVACIÓN: CUAL ES EL NÚMERO ÓPTIMO DE VISITAS?

Sinopsis.—Durante la época de reproducción del 1994 llevamos a cabo, en tres ocasiones, conteos de punto en 48 estaciones del noroeste de los Estados Unidos. Utilizamos los totales de los datos para colocar en categorías a las localidades, a base de dos índices de valor potencial para la conservación: riqueza de especies y abundancia total de aves. Luego recalculamos cada uno de los indices (1) utilizando los datos de una sola visita a una localidad y (2) utilizando los datos de dos visitas. El jerarquizar basándose solamente en una o dos visitas reveló que el eliminar una y hasta dos visitas tenía un efecto mínimo en categorizar la riqueza de especies, pero afectaba, de forma más sustancial, el jerarquizar la abundancia. Tambiér evaluamos que tan efectivo eran una o dos visitas para detectar especies en particular. Concluímos que cuando los recursos están limitados, el uso de conteo de puntos con una o dos visitas, puede proveer un índice confiable para determinar la riqueza de especies y priorizar los esfuerzos de conservación. Cuando el objetivo principal es determinar la presencia o ausencia de una especie en particular, al menos dos visitas suelen ser necesarias. Finalmente concluímos, que los investigadores deben ser cuidadosos al utilizar la abundancia total como índice para establecer prioridades de conservación, ya que los valores pueden fluctuar a través de la temporada.

In recent years researchers have made efforts to standardize point count protocols across studies and locales (Manley et al. 1993; Ralph et al. 1995; Hamel et al. 1996; Martin et al. 1997). Despite a growing literature debating the optimal duration of point counts (Dawson and Bull 1975; Svensson 1977; Fuller and Langslow 1984; Smith et al. 1993; Lynch 1995; Smith et al. 1998), few studies have explored the costs and benefits of intra-season repeated visits to point count sites (which encompass arrays of individual points), or how those costs and benefits may change, depending on study objectives. Just as the allocation of sampling effort involves a trade-off between time spent at each point and the number of points sampled at a given site (Barker et al. 1993); a similar tradeoff exists between the number of times each point count site is visited, and the number of sites that can be sampled.

The optimal protocol for conducting point counts, including the number of times to visit each site, will depend on the particular study objectives (Verner 1985; Barker et al. 1993; Ralph et al. 1995). Nevertheless, published studies provide little guidance for, determining whether repeated intra-season visits to the same point count site are warranted, and, when they are, how many visits are optimal.

Therefore, in this study we explore the optimization of point count sampling effort for producing site-specific indices of species richness and overall abundance of birds, indices that may be used to prioritize conservation efforts among a large number of potential sites. We use point count data from 48 sites to determine how site rankings change when they are based on only one or two intra-season visits, rather than three.

METHODS

We analyzed point count data from 48 MAPS (Monitoring Avian Productivity and Survivorship) stations (DeSante et al. 1996; Burton and DeSante 1998) located on seven national forests and one national park in the northwestern United States. The MAPS program is a continent-wide network of over 500 constant-effort mist netting and bird banding stations operated during the North American breeding season every year. All of the MAPS stations in this study were situated at least partially in montane forest, with 24 stations at forest–meadow edges, 10 at the interface of riparian and upland forest, and three at forest–marsh edges (DeSante and Burton 1994; DeSante et al. 1996).

During the 1994 breeding season, unlimited radius, 5-min point counts were conducted once at each MAPS station during each of the first three 10-d periods the station was operated. For stations operated in Oregon and California west of the Sierra–Cascade axis, these three periods were 21–30 May, 31 May–9 June, and 10 June–19 June. For stations in Washington and Montana and east of the Cascades in Oregon these periods were 31 May–9 June, 10–19 June, and 20–29 June. Operation of stations at higher elevations (generally above 2000 m) or in areas with heavy, late-lingering snowpacks were delayed by one or, rarely, two 10-d periods. Nine points spaced 150–200 m apart were established at each of the 48 stations, often in a 3 × 3 array. All adult birds seen or heard at unlimited distances from the point during the 5 min of counting were tallied, but individuals believed to have been seen or heard at previously counted points that day were tallied separately and included in this analysis only once. The counting of the first point each day began within 15 min of local sunrise, and the entire array of nine point counts took 2–2.5 h to complete. The sequence in which the points were counted was constant at each station, but the starting point for the counts differed for each replication. The same observer counted all three replications of point counts at the 5–8

TABLE 1. Mean number of species and individual birds detected during point counts conducted at three successive visits to 48 locations. Means that do not share letters are significantly different (*t*-test with Bonferroni adjustment, $P < 0.05$).

Index	Visit		
	First	Second	Third
Mean number of species detected	18.7[a] ± 5.7	20.5[a] ± 6.3	19.9[a] ± 6.0
Mean number of birds detected	74.8[b] ± 22.4	87.2[c] ± 25.5	93.4[c] ± 31.1

stations on each forest or park, but different observers counted on different forests or parks. All observers underwent a standardized two-week training program immediately prior to conducting the point counts.

Data analysis.—We tallied the number of species and the number of individual birds detected during three visits to each MAPS station (hereafter, site). Pooling point count totals from the three visits produced two potential indices of each site's importance to birds: 1) the cumulative number of species detected during the three visits and 2) the total number of individual bird detections during the three visits. We then ranked the sites from high to low based on each of these indices.

To see how well site rankings based on only two visits would approximate rankings based on all three visits, we again ranked sites by the indices described, but included data collected only during the first two visits to each site. Similarly, we used data from only the first visit to each site to examine the reliability of ranking sites based on a single visit.

Additionally, because conservation priorities are usually shaped by the presence of particular target species, rather than overall species richness or abundance, we tallied the number of sites at which U.S. Fish and Wildlife Service (USFWS) species of management concern for the Pacific Northwest Region (USFWS 1995) were recorded, using data from the first visit only, the first and second visits combined, and all three visits combined.

We used Kendall's coefficient of rank correlation to test the strength of correlation between site rankings based on three visits with rankings based on one or two visits. All statistical tests are two-tailed, and values are presented as means ± 1 SD.

RESULTS

Indices of species richness and overall abundance varied widely among the 48 sites. Pooling data from all three visits yielded a range of 13 to 45 species detected per site ($\bar{x} = 28.9 \pm 8.1$), and 91 to 474 individual birds detected per site ($\bar{x} = 255.4 \pm 68.1$). Species richness correlated significantly with overall abundance ($r^2 = 0.39$, $n = 48$, $P < 0.01$), although only nine sites were ranked in the top 16 (upper one third of all sites) in terms of both species richness and overall abundance. Mean species richness of all 48 sites did not vary significantly between the first, second and third visits, while mean overall abundance increased during the season (Table 1).

Site rankings for the number of species detected during two visits closely approximated rankings based on three visits ($\tau = 0.882$, $t_{48} = 8.842$, $P < 0.001$). Sites changed by an average of just 1.38 ± 0.93 ranks (maximum change in any site = 3 ranks) when data from the third visit were included (Table 2). Site ranks based on the number of species detected during one visit also approximated three-visit ranks fairly well, but not as well as ranking sites based on two visits ($\tau = 0.634$, $t_{48} = 6.360$, $P < 0.001$). Sites changed an average 3.67 ± 3.00 ranks (maximum change in any site = 11 ranks) when data from the second and third visits were included (Table 2).

Site rankings based on only one or two visits were less reliable when the ranking criteria was overall abundance of birds. Ranks based on the total number of birds tallied during two visits changed by an average of 3.83 ± 3.48 ranks (maximum change in any site = 17 ranks) when data from the third visit were included (Table 2), although the overall ranking of sites was still highly concordant with the ranking based on three visits ($\tau = 0.369$, $t_{48} = 3.701$, $P < 0.001$). Ranks based on the total number of birds encountered during one visit were much less effective in approximating three-visit ranks than were two-visit ranks, changing by an average of 6.79 ± 5.10 places (maximum change in any site rank = 21 places) when data from the remaining visits were included (Table 2), although the overall ranking was still significantly concordant with three-visit ranks ($\tau = 0.254$, $t_{48} = 2.548$, $P < 0.05$).

A total of eight USFWS Species of Management Concern was recorded among the various sites (Table 3). Over the course of three visits, at least one species of management concern was recorded at 40 sites. During the first two visits only, species of management concern were recorded at 37 of these 40 sites (92.5%). During just the first visit, at least one such species was recorded at 30 (75.0%) of the 40 sites. Averaging three-visit totals from each of the 48 sites yielded a mean of 1.69 species of management concern detected per site, compared to 1.48 when only data from the first two visits were included and 1.1 when only data from the first visit were considered.

DISCUSSION

When the goal of point counts is to compare relative species richness among sites, our results suggest that two visits or perhaps even just one visit may provide similar overall results to three visits. If we had wanted to target the 12 most species rich sites (upper quartile) for future conservation efforts, ranking sites based on two visits would have selected 11 of the sites chosen based on three visits. Ranking sites based on one visit would have selected nine of the top three-visit sites. Whether or not the concordance of one- or two-visit rankings with three-visit rankings is adequate will of course depend on the particular study objectives, but our

TABLE 2. Station ranks according to cumulative number of species and cumulative number of birds detected during one, two, or three visits to a site.

Station no.	Rank					
	Species richness			Total number of birds		
	3 visits	2 visits	1 visit	3 visits	2 visits	1 visit
107	1	1	1	1	1	1
157	1	2	2	8	7	7
905	2	1	3	13	12	16
160	3	6	11	31	30	33
161	4	5	6	32	28	25
906	5	3	5	19	2	2
162	5	4	7	28	29	29
907	5	3	5	6	5	8
136	6	6	7	21	22	19
153	7	7	4	3	3	5
154	7	9	11	22	24	30
152	7	8	8	7	6	9
902	7	8	13	5	9	18
158	7	8	9	15	16	21
198	8	10	8	33	31	32
155	8	11	9	12	15	17
199	9	10	5	15	10	4
151	10	10	10	20	18	23
148	11	11	8	14	10	5
169	11	13	11	30	26	19
904	11	12	7	10	13	6
145	11	12	13	11	11	15
147	12	15	9	17	27	13
137	12	11	7	21	10	14
159	12	11	14	38	37	37
173	12	13	11	36	38	35
150	12	11	7	27	21	24
156	13	14	12	23	16	12
167	13	13	7	2	4	3
172	13	16	14	25	17	17
149	14	17	13	26	20	11
163	15	18	12	24	25	15
170	16	18	13	29	23	11
903	16	16	14	9	14	30
134	17	19	13	18	19	20
165	18	16	14	4	8	10
171	18	20	15	37	32	28
174	19	18	13	39	33	29
135	20	18	11	29	22	20
166	20	19	14	15	26	31
138	21	22	16	35	35	38
908	22	21	16	34	32	30
168	22	20	12	16	19	26
144	23	20	12	42	39	36
140	24	24	15	43	40	34
139	25	24	17	41	36	33
133	25	23	16	40	34	26
143	26	25	18	44	41	39

TABLE 3. Number of stations at which USFWS Species of Management Concern were detected during all three visits ("3 visits"), the first and second visits only ("2 visits"), and the first visit only ("1 visit").

USFWS Species of Management Concern	No. stations where each species was detected		
	3 visits	2 visits[a]	1 visit[b]
Common Loon (*Gavia immer*)	1	1 (100)	0 (0)
Northern Goshawk (*Accipiter gentilis*)	1	1 (100)	0 (0)
Marbled Murrelet (*Brachyramphus marmoratus*)	1	0 (0)	0 (0)
Rufous Hummingbird (*Selasphorus rufus*)	10	9 (90)	6 (60)
Red-breasted Sapsucker (*Sphyrapicus ruber*)	13	11 (85)	6 (46)
Olive-sided Flycatcher (*Contopus cooperi*)	17	13 (76)	12 (71)
Western Flycatcher (*Empidonax dificilis*)	21	19 (90)	18 (86)
Hermit Warbler (*Dendroica occidentalis*)	16	16 (100)	12 (75)

[a] Number in parentheses indicates the percent of the three-visit total detected during the first two visits.

[b] Number in parentheses indicates the percent of the three-visit total detected during the first visit.

results suggest that two-visit species richness rankings in particular should be adequately reliable for most purposes.

When the goal is to compare relative abundance among sites, number of visits has a greater effect because some abundance rankings can be highly inflated by the presence of a flock of a single species. Evidence of an intra-seasonal increase in overall abundance (Table 1) further suggests that researchers must be cautious when using overall abundance as an index for establishing conservation priorities. The low overall abundance values tallied during the first visit should serve as a warning that single-visit point count assessments based on overall abundance may be fairly sensitive to seasonal timing, even within the most active month of the breeding season.

Site-specific conservation priorities in the United States are often likely to be determined by the presence of particular sensitive species, rather than by overall abundance of birds or species richness. Data from two visits in our study successfully identified sites with at least one species of management concern. Even if conservation priorities were to be based on the presence of a particular target species (rather than the presence of any of several target species), our data suggest that two visits during the breeding season may provide reliable presence/absence determinations, at least for some species. When the data set was restricted to just the first visit, however, the likelihood of detecting target species became inadequate for effectively prioritizing sites for conservation.

All the sites sampled in this study were MAPS stations, which were sited deliberately to catch large numbers of birds representative of the regional avifauna. Consequently, most sites had relatively high species richness and overall abundance of birds, and differed only slightly from the next highest and lowest ranked sites. In many cases, point count data may include more heterogeneous sites than our set of specially selected MAPS stations. Rankings of more heterogeneous sites based on only one or two visits will likely be even more reliable when there are greater differences among sites.

We conclude that when the objective is to rank potential sites for conservation, conducting point counts during just two visits, or even one visit, during the breeding season may be adequate to provide a reliable index of species richness. The resources necessary to repeatedly visit point count sites within a single season might be better spent conducting point counts at additional sites. On the other hand, when the objective is to determine the presence or absence of particular target species, at least two visits are warranted.

ACKNOWLEDGMENTS

Daniel Petit, C. J. Ralph, C. Ray Chandler, Stephen Hudman and two anonymous reviewers provided helpful commentary on this manuscript. We thank USDA Forest Service Region 6, Flathead National Forest, Confederated Salish and Kootenai Tribes, and the Yosemite Association for funding data collection at the MAPS stations. Danielle O'Grady and Eric (Zed) Ruhlen provided computer assistance. Ken Burton, Mark Hedrick, Zed Ruhlen, Hillary Smith, Cynthia Trombino, Brett Walker, and Orianne Williams established MAPS stations and point count locations, and trained and supervised those who conducted the point counts. Finally, we thank Jennifer Amiott, Brant Boelts, Tim Drew, Sarah Fox, Sherry Hudson, Pamela Moritz, Paul Radley, and Fred Wong for conducting the point counts. This is Contribution No. 105 of The Institute for Bird Populations.

LITERATURE CITED

BARKER, R. J., J. R. SAUER, AND W. A. LINK. 1993. Optimal allocation of point-count sampling effort. Auk 110:752–758.

BURTON, K., AND D. F. DESANTE. 1998. MAPS manual. The Institute for Bird Populations, Point Reyes Station, California.

DAWSON, D. G., AND P. C. BULL. 1975. Counting birds in New Zealand forests. Notornis 22: 257–278.

DESANTE, D. F., AND K. M. BURTON. 1994. The Monitoring Avian Productivity and Survivorship (MAPS) program third annual report (1992). Bird Pop. 2:62–89.

———, ———, AND D. R. O'GRADY. 1996. The Monitoring Avian Productivity and Survivorship (MAPS) program fourth and fifth annual report (1993 and 1994). Bird Pop. 3:67–120.

FULLER, R. J., AND D. R. LANGSLOW. 1984. Estimating numbers of birds by point counts: how long should counts last? Bird Study 31:195–202.

HAMEL, P. B., W. P. SMITH, D. J. TWEDT, J. R. WOEHR, E. MORRIS, R. H. HAMILTON, AND R. J. COOPER. 1996. A land manager's guide to point counts of birds in the Southeast. USDA Forest Service General Technical Report SO-120, Southern Resource Station, Asheville, North Carolina.

LYNCH, J. F. 1995. Effects of point count duration, time of day and aural stimulii on detectability of migratory and resident bird species in Quintana Roo, Mexico. Pp. 1–6, *in* C. J. Ralph, J. R. Sauer, and S. Droege, eds. Monitoring bird populations by point counts. USDA Forest Service General Technical Report PSW-GTR-149, Pacific Southwest Research Station, Albany, California.

MANLEY, P. N., W. M. BLOCK, F. R. THOMPSON, G. S. BUTCHER, C. PAIGE, L. H. SURING, D. S. WINN, D. ROTH, C. J. RALPH, E. MORRIS, C. H. FLATHER, AND K. BYFORD. 1993. Guidelines for monitoring populations of Neotropical migratory birds on National Forests system lands. USDA Forest Service Monitoring Task Group Report, Wildlife and Fisheries Staff, Washington, D.C.

MARTIN, T. E., C. PAINE, C. J. CONWAY, W. M. HOCHACHKA, P. ALLEN, AND W. JENKINS. 1997. BBIRD field protocol. Montana Cooperative Wildlife Research Unit, Missoula.

RALPH, C. J., S. DROEGE, AND J. R. SAUER. 1995. Managing and monitoring birds using point counts: standards and applications. Pp. 161–168, *in* C. J. Ralph, J. R. Sauer, and S. Droege, eds. Monitoring Bird Populations by Point Counts. Pacific Southwest Research Station, Albany, California.

SMITH, W. P., D. J. TWEDT, D. A. WIEDENFELD, P. B. HAMEL, R. P. FORD, AND R. J. COOPER. 1993. Point counts of birds in bottomland hardwood forests of the Mississippi Alluvial Valley: duration, minimum sample size, and points versus visits. USDA Forest Service Research Paper SO-274, Southern Forest Experiment Station, New Orleans, Louisiana.

———, ———, R. P. FORD, D. A. WIEDENFELD, AND R. J. COOPER. 1998. Increasing point count duration increases standard error. J. Field Ornithol. 69:450–456.

SVENSSON, S. 1977. Land use planning and bird census work with particular reference to the application of the point sampling method. Pol. Ecol. Stud. 3:99–117.

USFWS. 1995. Migratory nongame birds of management concern in the United States: the 1995 list. Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.

VERNER, J. 1985. Assessment of counting techniques. Curr. Ornithol. 2:247–302.

Received 10 November 1999; accepted 28 March 2000.