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Checklist and "Pollard Walk" Butterfly Survey Methods on Public Lands

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ABSTRACT.—Checklist and "Pollard Walk" butterfly survey methods were contemporaneously applied to seven public sites in North Dakota during the summer of 1995. Results were compared for effect of method and site on total number of butterflies and total number of species detected per hour. Checklist searching produced significantly more butterfly detections per hour than Pollard Walks at all sites. Number of species detected per hour did not differ significantly either among sites or between methods. Many species were detected by only one method, and at most sites generalist and invader species were more likely to be observed during checklist searches than during Pollard Walks. Results indicate that checklist surveys are a more efficient means for initial determination of a species list for a site, whereas for long-term monitoring the Pollard Walk is more practical and statistically manageable. Pollard Walk transects are thus recommended once a prairie butterfly fauna has been defined for a site by checklist surveys.

INTRODUCTION

Guidelines for management of native prairie butterfly populations have recently appeared in the literature (Moffat and McPhillips, 1993; Swengel, 1996). However, more precise information on which species are present at a particular site and how they might respond to management practices such as prescribed burning, weed control or grazing, is typically not available to personnel responsible for such operations. Gaining detailed local knowledge about butterfly populations on public lands is therefore crucial to the development of long-term conservation strategies, particularly for areas in which species may be declining or imperiled.

This situation is exacerbated by the fact that beyond our very basic recognition of their proclivity for natural conditions, we lack a clear understanding of many of the factors that influence the distribution and abundance of native prairie butterflies, particularly in the extensive public lands of the northern Great Plains. Until very recently, we have also lacked any systematic approach to monitoring their distributions and numbers. Recently, Stanford and Opler (1993) and Opler (1995) have provided a comprehensive picture of species distributions in the U.S., including the Great Plains states, through county-by-county (dot map) records of formally reported occurrences. The Fourth of July Butterfly Counts of the Xerces Society/North American Butterfly Association (Swengel, 1990) offer a basis for long-term monitoring of selected sites by volunteer groups. A standardized methodology for undertaking and sustaining local butterfly monitoring programs at public sites is now needed. Our objective in this study was to define more clearly the relative roles of unrestricted comprehensive search (hereafter "checklist") and restricted "Pollard Walk" (hereafter "transect") methods of butterfly counting at seven extensive, federally managed sites across North Dakota (*see* Fig. 1).

Checklist surveys.—Checklist surveys are employed primarily to confirm the presence of

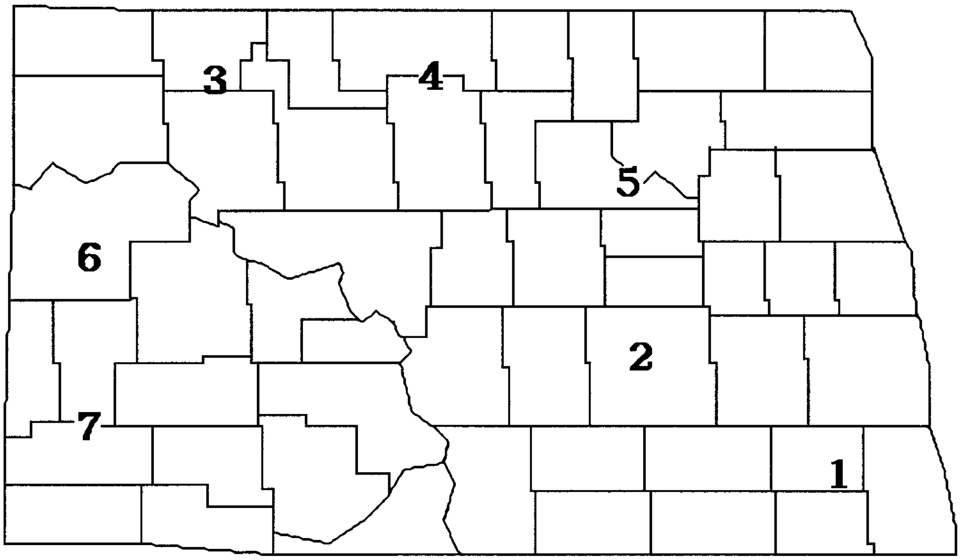

FIG. 1.—Distribution and location of study sites within North Dakota: 1. Sheyenne National Grassland (28,433 ha); 2. Chase Lake National Wildlife Refuge Complex (4248 ha); 3. Lostwood National Wildlife Refuge (10,824 ha); 4. J. Clark Salyer National Wildlife Refuge (23,756 ha); 5. Sullys Hill National Game Preserve (678 ha); 6. Summit Campground, McKenzie Unit, Little Missouri National Grassland (203,625 ha); 7. Burning Coal Vein Campground, Medora Unit, Little Missouri National Grassland (212,430 ha)

species and sometimes the number of individuals of each species for the survey site. Besides meteorological data and raw numbers, few other variables are taken formally into account. One important advantage of checklist counting is that an observer is free to search out places where butterflies typically would breed or congregate. Another is that checklist counting is procedurally simple; the recorder need merely identify and count without regard to other factors. As S. Droege (pers. comm.) has noted, such anecdotal data are far better than none at all and can easily be produced by informed volunteer amateurs and hobbyists.

Because it imposes few procedural constraints, checklist counting is also more flexible than transect sampling. For example, it allows immediate response to periodic changes in site condition (*e.g.,* daily changes in wind, or weekly, monthly or annual redistribution of larval host plants, nectar sources, etc.). Species presence may thus be confirmed without sophisticated research design or secondary data analysis and with a minimum of effort. This combination of procedural freedom and economy of effort is arguably the most important feature of checklisting.

As Hellawell (1991) has noted, however, such "open-ended" survey approaches frequently are "inadequate to meet the rigors of statistics." Patches covered and time spent in a given patch may differ by observer or from count to count, for example. Relative abundance is difficult to estimate accurately across a series of checklist data sets unless the total number of sets is very large (S. Droege, pers. comm.). Swengel (1990) has reviewed a variety of such problems with Christmas Bird Count data, including those stemming from year-to-year inconsistency in counting routes, differences in method and observer, differences in observer numbers, concern over accuracy in identification, locational biases related to where observers live, and problems with sample size in relation to statistical requirements. Since the Fourth of July Butterfly Counts are modeled after the Christmas Bird Count system, we reasoned that these problems are of similar relevance when counting butterflies.

Hellawell (1991) has also noted that "(difficulty with) open-ended monitoring strategy is avoidable, provided that clear objectives are set and a true monitoring yardstick is defined at the outset." If the purpose of checklist counting is merely to confirm the presence of certain species or to define the scope of a faunal list, strict control of variables may be of secondary concern. [Samways (1994) has emphasized the importance of "before" and "after" checklist documentation of species richness in rapidly declining environments, for example.] However, if continuous monitoring or indexing of actual or relative abundance is a concern, as for example in working with rare or endangered species, then a more carefully designed sampling model is essential. For this purpose, the transect method developed by Pollard *et al.* (1975), and later adapted by Pollard (1977, 1982), Pollard and Yates (1993), and others, has frequently been employed by butterfly counters, particularly in the United Kingdom.

Pollard Walk surveys.—"Pollard Walk" surveys employ fixed travel routes during counting. More rigorous statistical analysis of Pollard Walk transect data is possible because counts are conducted in a much more uniform manner with respect to area covered and time spent. Moreover, fixity of extent and location of transects allows subsequent or concurrent study of multiple factors (*e.g.,* floral and faunal studies on the same transect). Definite extent and permanent location also make frequent replication possible. This uniform delimitation of parameters, which allows confident longitudinal monitoring, is one of the most important features of transect sampling.

Unfortunately, the finite extent and precise location of a fixed transect also introduces the likelihood that some localized, sedentary species may never appear in a count. Given commitment to long-term sampling of a fixed transect, it may not be possible to account for periodic changes in larval habitat or adult nectar sources that occur off the transect. Since confirmation of the presence of a particular species is limited to the transect, the surveyor is less able to generalize the status of a given species across an entire site. These factors underscore the importance of original transect location and layout, especially in terms of habitats or microhabitats included and potential influences of day-to-day changes in wind, sunlight and other environmental factors.

Because both checklist and transect approaches have been in common use elsewhere, we wanted to define more clearly the difference between them in the numbers of species and individuals a surveyor would detect per equivalent unit of search time. Specifically, our null hypothesis was that there would be no significant difference between the two methods either in terms of (1) the number of individual butterflies detected per hour of effort, or (2) the number of butterfly species detected per hour of effort.

FIELD METHODS

Study sites.—Seven widely separated North Dakota sites were selected. They were chosen because they differed ecologically and because they represented substantial area under public control. One Pollard-style transect route was surveyed and mapped at each site. In accordance with the methods of Pollard (1977) and Pollard and Yates (1993), each route was designed to traverse a range of native habitats deemed most representative of the majority of terrain at the site. Routes were also designed to represent a variety of topographical and physical aspects. Following are brief descriptions of the seven sites and their transect configurations.

1. *Sheyenne National Grassland, Ransom County (28,433 ha)*.—An 800-m rectangular Pollard Walk route was laid out, beginning at the southwestern end of the unit's North Country Trail segment, lat 46°23′50″N, long 97°27′52″W. The entire transect included true native tall grass prairie, although it lacked the usual diversity of forbs expected of healthy prairies in this region and was intermittently invaded by Kentucky bluegrass (*Poa pratensis*). Patches of willow (*Salix* spp.) and drier, shorter prairie were interspersed along the route. This site was selected to include native prairie hesperiids and satyrids as well as the regal fritillary (*Speyeria idalia*), then a candidate for listing by the U.S. Fish and Wildlife Service under the Endangered Species Act.

2. *Chase Lake National Wildlife Refuge Complex, Stutsman County (4248 ha)*.—An 800-m rectangular Pollard Walk route was laid out, beginning at lat 47°03′16″N, long 99°25′08″W. It traversed relatively uniform rolling landscape representative of generally homogeneous native mid-grass prairie, which predominates throughout the complex.

3. *Lostwood National Wildlife Refuge, Burke County (10,824 ha)*.—A 700-m Pollard Walk route began NW of Thompson Lake at lat 48°39′10″N, long 102°24′42″W, thence leading to the E, between a service road and the western lake shore. It followed a prairie trail to the top of a rise, traversed a brushy area along the high ground W of the lake, and dropped into a wet meadow, as defined by Stewart and Kantrud (1971). The transect was representative of the majority of mesic mid-grass prairie microhabitats within the refuge.

4. *J. Clark Salyer National Wildlife Refuge, McHenry County (23,756 ha)*.—An 800-m Pollard Walk route was located in rolling aspen parkland SW of the refuge's popular Sandhills Walk. It began at lat 48°32′06″N, long 100°31′00″W, leading thence westward between the refuge's "scenic drive" and picnic area, through a rolling combination of sandy prairie and woodland margins that included quaking aspen (*Populus tremuloides*), serviceberry (*Amelanchier* sp.), leafy spurge (*Euphorbia esula*), wild cherry (*Prunus* sp.) and bur oak (*Quercus macrocarpa*). It included habitat for both prairie and woodland species indigenous to N-central North Dakota.

5. *Sullys Hill National Game Preserve, Benson County (678 ha)*.—A 1500-m Pollard Walk route was marked out along the exact path of the preserve's nature trail, beginning S of Sweetwater Lake, at lat 47°58′30″N, long 98°58′30″W, and ending on the NW shore of the lake near the preserve's amphitheater. The existing trail was judged to be the most logical and ecologically varied line of survey travel through woodland habitats, which cover nearly all the northern unit of the preserve. Hay meadows SW of the main preserve were not sampled by transect counting, but were subjected to occasional checklist surveys. The transect included dense bur oak and basswood (*Tilia americana*) woodland with occasional shaded openings, an area of woodland stream margin, several exposures of N-slope grassland clearing, and a section of oak parkland with dogbane (*Apocynum androsaemifolium*), serviceberry and beaked hazel (*Corylus cornuta*) in the understory. The wide variety of habitats along this route produced an array of species generally within the Upper Transition Zone woodland fauna.

6. *Summit Campground, Little Missouri National Grassland (McKenzie Unit), McKenzie County (203,625 ha)*.—An 800-m Pollard Walk route began at lat 47°32′36″N, long 103°14′36″W. It included the northern margin of a W-sloping wooded break, the southern margin of a 0.4-ha water impoundment, crossing the woodland proper to the southern margin of the break and passing thereafter along a ridge separating the woodland on the N and badlands on the S. The route included rocky mountain juniper (*Juniperus scopulorum*) and green ash (*Fraxinus pennsylvanica*) woodland, mixed grassland, wetland margin and badlands habitats.

7. *Burning Coal Vein (BCV) Campground, Little Missouri National Grassland (Medora*

Unit), Billings County (212,430 ha).—A 700-m Pollard Walk route began at lat 46°35′30″N, long 103°26′40″W, on the eastern end of the parking lot at the Columnar Junipers Overlook. The route included sage steppe, badlands terrain, and a shady wooded ravine. It included several hundred meters within habitat for Strecker's giant skipper (*Megathymus streckeri*), a species occurring in North Dakota only at this site, as well as habitat for a majority of upland species indigenous to prairie and sagebrush habitats of the Little Missouri River drainage.

Counting methods.—We intended that each site would be visited at least twice during each of the state's three episodes of butterfly emergence and activity, as outlined by McCabe and Post (1976) and Royer (1988). These periods are 15 May–5 June (spring emergents), 5 June–5 July (early summer and first-brood bivoltine emergents), and 25 July–15 August (late summer univoltine and second-brood bivoltine emergents). However, a delayed and somewhat rainy season required an adjustment of that schedule approximately 2 wk toward autumn.

During each visit to a site, the observer tallied number of individual butterflies and number of species using both checklist and transect survey methods. Protocols for counting and recording generally followed Pollard (1977) and Pollard and Yates (1993). These were essentially identical for both methods, with the exception that in the transect method the recorder walked only along the precisely marked route, whereas in the checklist method the recorder was free to wander at will in active search of productive habitats, nectar sites, etc. These two methods were alternated continuously on a 2-h schedule throughout the day.

Weather permitting, each sampling day extended from approximately 0900 CDT to generally not later than 1800 CDT. At the beginning of each day, a coin was flipped to determine which sampling method was to be employed first. During both methods, the recorder walked at a steady pace of approximately 35 m/min. While specific habitats were intentionally sought out during checklisting, only butterflies actually seen within an estimated 2.5 m on either side of the recorder, within 5 m above the ground, and within 5 m to the front were actually counted. Butterflies behind the recorder or otherwise outside these limits were never counted. No active pursuit was made during either method, nor was undue effort made to count butterflies that hid themselves from view or that perched out of sight of the recorder during counting. When individuals flew ahead of the recorder, if the recorder could be certain that they had already been counted, they were ignored; if the recorder could not be certain, they were counted. Counting was curtailed whenever cloud cover was estimated to be greater than 50% or when wind speed exceeded 25 km/h.

A net was carried, and when problem individuals could be netted without undue difficulty or active pursuit, they were netted and released as soon as identification had been made. In such cases, counting was stopped until the walk was resumed. Where distinction between two alternative species was not possible, the commoner of the two options was recorded. For the rare cases involving more than two alternatives, or when individuals eluded both identification and capture, identification was made to the lowest confident taxonomic level.

Between counting periods, voucher specimens were collected for any species not already on record for the county or the site. All such specimens bear the label designation "NBS Survey 1995" and are permanently on file in the North Dakota state voucher collection of the first author. To minimize the possible statistical effect of removal, no voucher was taken at any point closer than 100 m from the nearest point on a transect.

The generic taxonomy of Miller and Brown (1981), as amended by Ferris (1989), has long been employed in the technical literature and until recently in the annual Season Summary of the Lepidopterists' Society. However, a majority of amateur butterfly counters have begun to employ a different nomenclature, as recently published by the North American Butterfly Association (1995). For the sake of continuity with other counting efforts, the latter is essentially the nomenclature employed in this report.

Checklist methodology.—Preliminary checklists were based on hypothetically complete lists of regularly breeding resident species for each site. They were developed as a composite of formal records for the county of the site and all adjacent counties. Occasional or infrequent immigrant species were excluded, but species were included when it seemed likely that a lack of records derived from incompleteness of information rather than actual absence. A separate reporting form was used for each episode of checklist surveying.

With these lists, each site was subjected to a comprehensive checklist search aimed at (1) identification and confirmation of all species occurring on the site and (2) determining the number of individuals of each species encountered per hour of search effort. In rare instances where identification was impossible without handling, an example was collected. Within the constraints of the above counting method, each butterfly encounter was tallied in a blank space provided next to the species name on the checklist.

Transect methodology.—On the ground, each transect was composed of flagged 10 m segments and, where possible, of permanently placed, fireproof 100-m reference posts. This scheme was in turn represented on the reporting form by a series of 100-m linear scales, each divided into 10 boxes corresponding to the flagged 10-m segments. Butterflies encountered along the transect were identified and tallied by location within each 10 m segment. This made it possible later to define a precise location for each butterfly counted, and to tally (1) number of species and (2) number of individuals of each species encountered per hour of search effort. A separate reporting form was used each time the transect was surveyed.

Data analysis.—To assess differences between the two survey methods in the number of individual butterflies and the number of butterfly species observed, we used analysis of covariance (ANCOVA) techniques. ANCOVA techniques were used because the number of individual butterflies observed and the number of species observed are expected to increase with increasing search time, in a way similar to that seen in species-area curves (Rosenzweig, 1995:8–22). Therefore, we used hours of searching effort as a covariate to adjust the number of individual butterflies and number of butterfly species before comparing the two survey methods. We first summarized the data by summing the number of butterflies, the number of species, and the total amount of survey effort (hours) across surveys within a survey date, for each method at each site. For the ANCOVAs, sites were considered to be random blocks in a completely randomized block design, with survey date the sampling unit (Milliken and Johnson, 1984:52). The number of butterflies and number of species were $\ln(Y + 1)$ transformed to linearize their relationship with hours of effort, which was also $\ln(Y + 1)$ transformed (Rosenzweig, 1995:8–22). ANCOVAs were done using the general linear models procedure (PROC GLM) of SAS (SAS Institute Inc., 1989), with 0.05 the significance level. We report means as least squares means (LSMEANS) (SAS Institute, Inc., 1989) where appropriate.

We also computed odds-ratios (Agresti, 1990:15) to address the question of whether a particular butterfly species was more likely to be observed using one survey method as opposed to the other. An odds-ratio, which is not a probability, is a ratio of the ratio of two odds. Computationally, the odds ratio of checklist (c) to transect (t) is:

$$\theta c{:}t = \Omega c/\Omega t = [\pi_c/(1 - \pi_c)]/[\pi_t/(1 - \pi_t)]$$

where

Ωc = odds in favor of detecting versus not detecting a particular butterfly species using the checklist,

Ωt = odds in favor of detecting versus not detecting a particular butterfly species using the transect,
π_c = probability of detecting a particular butterfly species using the checklist, and
π_t = probability of detecting a particular butterfly species using the transect.

Therefore, an odds-ratio of 1.0 implies an equal chance of observing a particular butterfly species using the checklist approach as compared to the transect approach. We estimated the odds-ratio of the checklist survey method vs. the transect survey method for each butterfly species observed at each site using each survey count within each survey date as an independent observation. For species with zero counts for one of the methods, we added 0.5 to all counts in estimating the above probabilities (Agresti, 1990:54). To test whether we were more likely to observe a particular butterfly species using the checklist method or the transect method, we computed and compared asymptotic 95% confidence intervals of each odds-ratio to the value 1.0. Here, a confidence interval with its lower limit greater than 1.0 implies that the probability is greater of observing a particular butterfly species using the checklist approach as opposed to the transect approach. A confidence interval with its upper limit less than 1.0 implies that the odds are greater of observing a particular butterfly species using the transect method as opposed to the checklist method.

RESULTS AND DISCUSSION

Effect of site and method on number of butterflies and number of species.—As expected, log number of butterflies ($F = 28.26$; df = 1,88; $p < 0.0001$) and log number of butterfly species ($F = 18.33$; df = 1,88; $p < 0.0001$) increased significantly with increasing log hours of search effort. Adjusting for increasing log hours of search effort, both site ($F = 11.29$; df = 6,6; $P = 0.0047$) and method ($F = 8.50$; df = 1,6; $P = 0.0268$) affected the number of butterflies counted. Significantly more butterflies were counted per hour effort using the checklist survey than the transect survey (back-transformed LSMEANS, adjusted for mean hours effort, are 41.1 and 25.8 for checklist and transect, respectively). Chase Lake National Wildlife Refuge had the most butterflies counted per hour effort and Burning Coal Vein Campground the least (Table 1). Because site and method did not indicate an interaction in the ANCOVA ($F = 0.39$; df = 6,88; $P = 0.8851$), the differences in number of butterflies counted between checklist and transect are fairly consistent across all sites. However, the number of butterfly species counted, adjusting for log hours of search effort, did not differ significantly among sites ($F = 0.46$; df = 6,6; $P = 0.8139$) or between methods ($F = 2.11$; df = 1,6; $P = 0.1962$), nor was there any indication of an interaction between sites and method ($F = 1.00$; df = 6,88; $P = 0.4275$) (Table 1).

These findings indicate that while the checklist count produced significantly higher rates of encounter with individual butterflies, it did not produce a significantly higher likelihood of encountering more species on a given date. With 146 species on record, North Dakota has one of the smallest butterfly faunas of any state or province in the Great Plains. The typical hypothetical list for a North Dakota county contains approximately 70 species, including invaders and seasonal immigrants. Species richness at any site on any particular date is bound to be low under such circumstances. Also, a number of localized or sedentary species were detected only during checklist counting (*see* Appendix 1), but the low frequency of such encounters rendered them statistically undetectable in this test.

Species encountered by only one method or the other.—When we segregated results by species found by both methods, by checklist method only, and by transect method only, there was clearly a dominance of sedentary, habitat-specialized taxa in the checklist-only category (*see* Table 2 and Appendix 1), particularly lycaenids [*e.g.,* hoary elfin (*Callophrys polia*) at J.

TABLE 1.—Number of butterflies and number of butterfly species counted per hour of effort, 1995, by survey method, expressed as LSMEANS ± standard error (SE)

		No. butterflies counted/h		No. species counted/h	
Site	Method	LSMEANS (SE)[A]	Count/hr[B]	LSMEANS (SE)[A]	Count/hr
Lostwood National Wildlife Refuge	Checklist	4.98 (0.47)	62.8	2.37 (0.22)	4.2
	Transect	4.44 (0.44)	36.4	1.84 (0.21)	2.3
J. Clark Salyer National Wildlife Refuge	Checklist	4.52 (0.41)	39.5	2.40 (0.19)	4.4
	Transect	3.74 (0.49)	18.3	2.22 (0.23)	3.6
Chase Lake National Wildlife Refuge	Checklist	5.36 (0.50)	92.1	2.17 (0.23)	3.4
	Transect	4.51 (0.48)	97.2	2.33 (0.22)	4.0
Sully's Hill National Game Preserve	Checklist	4.85 (0.47)	55.1	2.22 (0.22)	3.6
	Transect	4.20 (0.52)	28.6	2.25 (0.24)	3.7
Sheyenne National Grassland	Checklist	4.13 (0.39)	26.6	2.32 (0.18)	4.0
	Transect	3.79 (0.42)	18.8	1.94 (0.20)	2.6
Summit Campground	Checklist	4.26 (0.37)	30.4	2.17 (0.17)	3.4
	Transect	4.26 (0.41)	30.4	2.31 (0.19)	3.9
Burning Coal Vein Campground	Checklist	3.80 (0.40)	19.0	2.24 (0.19)	3.6
	Transect	2.88 (0.39)	7.3	1.83 (0.18)	2.3

[A] LSMEANS are in log-scale [ln(Y + 1) transformation], as used in ANCOVA

[B] Backtransformed LSMEANS, adjusted to per hour of effort by dividing by back-transformed mean hours of effort = 2.30

Clark Salyer National Wildlife Refuge] and hesperiids [*e.g.,* Afranius dusky wing (*Erynnis afranius*) at Lostwood National Wildlife Refuge]. We interpret this to be at least in part related to habitat diversity at the site. We reasoned that the mobility of a given species is necessarily related to its chances of being detected by only one method (more sessile species detected primarily by checklist) or by both methods (more vagile species being detectable by both checklist and transect). However, confidence in such distinctions with respect to any single species is clearly related to the number of counts in which it was detected by only one method. In a majority of cases, detections occurred in only one or two counts out of an average of 27 transect and 26 checklist counts per site.

Odds ratios.—When odds-ratio analysis was applied, on all but one site (Chase Lake National Wildlife Refuge Complex) the checklist method was again found more likely than the transect method to detect certain species. Not surprisingly, all species for which results were statistically significant (Table 3) showed greater odds of being detected by the checklist method than by the transect method; no species showed greater odds of being detected by the transect method than the checklist method. In most cases, detections appear to be related to habitats that were (1) not included in the transect or (2) specifically targeted by the observer during checklist counting. For example, at Burning Coal Vein Campground, the predominant habitat is dry, native, shortgrass prairie pasture, and the transect was broadly representative of that habitat. However, it also included substantial segments of brush and shaded woodland draws. The six species with significantly greater odds of detection by the checklist method at Burning Coal Vein Campground were all generalist denizens of open sunny environments, but most were also typical of disturbed habitats not represented in the transect—roadside ditches [containing alfalfa (*Medicago sativa*) and sweet clovers (*Melilotus* spp.), which attracted the orange sulphur (*Colias eurytheme*), clouded sulphur (*Colias philodice*), and Melissa blue (*Lycaeides melissa*)] and patches of thistle (*Cir-*

TABLE 2.—Summary of number of counts and number of butterfly species detected by checklist or transect method at seven federally managed sites in North Dakota, 1995

Site	Checklist			Transect				
	No. surveys	No. species detected	No. species unique to checklist	No. surveys	No. species detected	No. species unique to transect	No. species detected by both methods	Total no. species detected
Lostwood National Wildlife Refuge	25	37	18	29	19	0	19 (51%)	37
J. Clark Salyer National Wildlife Refuge	24	45	24	22	22	1	21 (46%)	46
Chase Lake National Wildlife Refuge	25	30	7	24	25	2	23 (72%)	32
Sully's Hill National Game Preserve	16	36	12	15	29	5	24 (58%)	41
Sheyenne National Grassland	31	43	25	31	19	1	18 (41%)	44
Summit Campground	30	42	13	26	34	5	30 (67%)	47
Burning Coal Vein Campground	34	49	16	43	35	2	33 (67%)	51

TABLE 3.—Species having significantly higher probability of detection using checklist method vs. transect method, as determined by odds-ratio test. N = Number of surveys conducted. D = Number of surveys where species was detected. Odds-ratio is the odds of detecting at least one butterfly of species *I* under Checklist vs. Transect method

Site	Species	Checklist		Transect		Odds-ratio	Lower and Upper 95% Conf. Interval	
		N	D	N	D			
Burning Coal Vein Campground	*Colias eurytheme*	34	6	43	0	19.842	1.075	366.069
	Colias philodice	34	19	43	13	2.842	1.127	7.167
	Euptoieta claudia	34	12	43	4	4.876	1.476	16.117
	Lycaeides melissa	34	8	43	1	9.088	1.499	55.107
	Papilio bairdii	34	8	43	1	9.088	1.499	55.107
	Speyeria callippe	34	8	43	2	5.234	1.198	23.673
Lostwood National Wildlife Refuge	*Pieris rapae*	25	10	29	1	12.870	2.087	79.376
	Colias philodice	25	20	29	15	3.487	1.069	11.377
	Erynnis afranius	25	6	29	0	19.667	1.047	369.351
J. Clark Salyer National Wildlife Refuge	*Pieris rapae*	24	11	22	3	4.746	1.190	18.925
Sheyenne National Grassland	*Limenitis archippus*	31	17	31	6	4.735	1.565	14.328
Sully's Hill National Game Preserve	*Speyeria aphrodite*	16	7	15	1	7.632	1.103	52.819
Summit Campground	*Euptoieta claudia*	30	8	26	1	6.422	1.034	39.877
Chase Lake National Wildlife Refuge	none							

sium spp.) (which attracted Baird's swallowtail (*Papilio bairdii*)). Variegated and callippe fritillaries (*Euptoieta claudia* and *Speyeria callippe,* respectively) are neither specialists nor otherwise localized in occurrence. Why these two species also showed greater odds of detection by the checklist method is not clear, although the fact that transect counts involved sizable nonprairie segments (woodland and brushy areas) may be a factor.

At Lostwood National Wildlife Refuge, two of the three species showing significantly higher odds of detection during checklist counting again were crop pests, the cabbage butterfly (*Pieris rapae*) and clouded sulphur, both of which are more commonly found along roadsides or in disturbed areas not included anywhere in the transect. The third, Afranius dusky wing, was specifically targeted during checklist surveys by searching areas with *Thermopsis rhombifolia,* its presumed larval host but a plant species absent from the transect area.

Although a large area of J. Clark Salyer National Wildlife Refuge includes widespread stands of exotic plant species in meadows and ditches, the transect path was established in the refuge's native and ecologically unique Sandhills area. The cabbage butterfly, characteristic of nonnative habitats, was the only species more likely to be detected by checklist than by transect counting at this site.

Similarly, at Sullys Hill National Game Preserve, the transect was established almost entirely in woodland habitat. More than half the checklist counts (nine of 16) were conducted in prairie hay meadow. The single species showing higher likelihood of detection using the checklist method was the Aphrodite fritillary (*Speyeria aphrodite*), a wide-ranging species more characteristic of prairie hay meadows than of woodlands. In the same way, the transect at Summit Campground was established in a rugged landscape which included sizable segments of wooded coulee. The variegated fritillary, characteristic of more open, disturbed landscapes, was thus more likely to be detected during checklist surveys, which commonly included such areas.

In contrast to these examples, habitat throughout Chase Lake National Wildlife Refuge Complex is relatively homogeneous, open, rolling native prairie with very few other habitats. No difference in odds of detection was found for any species at this site.

Some highly localized and sedentary species were counted only during checklist surveys, but such events occurred infrequently enough that the test was unable to demonstrate significant results because of small sample sizes. In the odds-ratio test, odds are not related to actual abundance, but only to the fact of detection in a single transect or checklist walk. Consequently, a single detection may not have shown statistical significance even when many individuals were counted.

Major differences in odds of detection appear to be related only to very broad ecological parameters—*e.g.*, species of woodland vs. prairie or of native vs. cultivated habitats. A larger database would no doubt provide for further refinement of such distinctions.

There was clearly a dominance of ''local'' or ''habitat specialist'' taxa, especially lycaenids and hesperiids, in the checklist-only category at most study sites. We interpreted the proportion of species detected only by checklist to be an indirect indicator of a site's habitat diversity, for unless specialized habitats were included in the transect path, one would not normally expect to detect the obligate species they host. Conversely, generalist species which do tend to range widely also tended to appear in both kinds of counting method rather than exclusively in one or the other. Confidence in these conclusions with respect to any single species is no doubt related to the number of counts in which it was detected by only one of the methods; in a majority of such cases, only one or two counts were involved. However, when up to 25 different species appear in only one kind of count and not the other, one may confidently conclude that that method offers the more reliable means of assessing species richness. Table 2 and Appendix 1 show that within each site the checklist method identified many species that were not detected during transect surveys.

We believe these results indicate that the checklist survey method is the more efficient means for initial determination of a site-specific butterfly species list, especially in the case of large sites such as one encounters in the Great Plains. For continued, long-term monitoring, however, less time-consuming Pollard Walk transect counts offer a more focused, practical alternative. As noted in our introduction, the carefully constrained transect approach also supports more precise statistical analysis than is possible with ''open-ended'' checklist data. Pollard Walk transects are thus recommended once the resident butterfly fauna has been defined for a site by means of checklist counting. In such situations, permanent Pollard Walk routes may be specifically designed to take specialized habitats into account, favoring prolonged monitoring of those butterfly species that may be of particular conservation concern or interest at a site.

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APPENDIX I

Butterfly species encountered by only one survey method (checklist or transect) at seven federally owned sites in North Dakota, 1995. Number of surveys species detected is given in parentheses

Site	Species
Lostwood National Wildlife Refuge	
Detected by Checklist method only	*Thorybes pylades* (1); *Erynnis afranius* (6); *E. icelus* (1); *Polites mystic* (3); *Papilio polyxenes* (2); *Euchloe olympia* (1); *Pontia protodice* (1); *Lycaena hyllus* (1); *Satyrium liparops* (1); *Glaucopsyche lygdamus* (3); *Agriades rusticus* (2); *Speyeria cybele* (4); *Boloria bellona* (3); *Boloria selene* (1); *Vanessa atalanta* (1); *Limenitis archippus* (2); *Oeneis uhleri* (3); *Danaus plexippus* (1)
Detected by Transect method only	none
J. Clark Salyer National Wildlife Refuge	
Detected by Checklist method only	*Polites themistocles* (1); *Poanes hobomok* (4); *Euphyes ruricola* (2); *Euchloe olympia* (1); *Pontia occidentalis* (1); *Colias eurytheme* (1); *Satyrium edwardsii* (1); *Satyrium liparops* (1); *Strymon melinus* (1); *Lycaena helloides* (1); *Callophrys polia* (3); *Everes amyntula* (1); *Celastrina ladon* (3); *Glaucopsyche lygdamus* (1); *Speyeria aphrodite* (2); *Boloria bellona* (1); *Chlosyne gorgone* (1); *Polygonia comma* (1); *Nymphalis milberti* (2); *Nymphalis antiopa* (1); *Vanessa atalanta* (2); *Asterocampa celtis* (1); *Enodia anthedon* (1); *Danaus plexippus* (1)
Detected by Transect method only	*Oarisma garita* (2)
Chase Lake National Wildlife Refuge	
Detected by Checklist method only	*Pyrgus communis* (2); *Lycaena hyllus* (1); *Lycaena helloides* (1); *Speyeria cybele* (3); *Boloria selene* (2); *Chlosyne gorgone* (4); *Danaus plexippus* (2)
Detected by Transect method only	*Euptoieta claudia* (1); *Nymphalis milberti* (1)
Sully's Hill National Game Preserve	
Detected by Checklist method only	*Ancyloxpha numitor* (1); *Oarisma garita* (2); *Hesperia comma* (2); *Polites peckius* (2); *Polites themistocles* (1); *Papilio polyxenes* (1); *Lycaena helloides* (1); *Lycaeides melissa* (3); *Pontia protodice* (2); *Speyeria idalia* (3); *Phyciodes tharos* (2); *Nymphalis antiopa* (1)
Detected by Transect method only	*Satyrium titus* (2); *Satyrium calanus* (2); *Satyrium edwardsii* (1); *Speyeria cybele* (4); *Polygonia progne* (1)

APPENDIX I——Continued.

Butterfly species encountered by only one survey method (checklist or transect) at seven federally owned sites in North Dakota, 1995. Number of surveys species detected is given in parentheses

Site	Species
Sheyenne National Grassland	
Detected by Checklist method only	*Pholisora catullus* (1); *Ancyloxypha numitor* (1); *Polites peckius* (3); *Hesperia dacotae* (2); *Poanes hobomok* (3); *Euphyes ruricola* (1); *Anatrytone logan* (1); *Pontia protodice* (1); *Lycaena helloides* (1); *Satyrium liparops* (1); *Celastrina ladon* (3); *Speyeria cybele* (2); *Boloria selene* (5); *Chlosyne nycteis* (1); *Phyciodes cocyta* (3); *Polygonia interrogationis* (1); *Polygonia comma* (2); *Nymphalis antiopa* (2); *Vanessa atalanta* (1); *Vanessa virginiensis* (1); *Limenitis arthemis* (1); *Asterocampa celtis* (1); *Enodia anthedon* (3); *Satyrodes eurydice* (1); *Megisto cymela* (3)
Detected by Transect method only	*Pyrgus communis* (1)
Summit Campground	
Detected by Checklist method only	*Pieris rapae* (3); *Pontia occidentalis* (3); *Colias eurytheme* (6); *Lycaena xanthoides* (2); *Satyrium calanus* (6); *Satyrium edwardsii* (1); *Strymon melinus* (2); *Everes amyntula* (1); *Plebejus saepiolus* (1); *Nymphalis antiopa* (2); *Vanessa atalanta* (1); *Danaus plexippus* (2)
Detected by Transect method only	*Polites rhesus* (1); *Anatrytone logan* (2); *Satyrium liparops* (2)
Burning Coal Vein Campground	
Detected by Checklist method only	*Pholisora catullus* (1); *Polites origenes* (1); *Amblyscirtes vialis* (1); *Colias eurytheme* (6); *Lycaena hyllus* (1); *Lycaena rubida* (2); *Lycaena helloides* (1); *Plebejus acmon* (3); *Speyeria cybele* (1); *Speyeria idalia* (1); *Chlosyne gorgone* (2); *Nymphalis antiopa* (2); *Vanessa atalanta* (1); *Limenitis arthemis* (1); *Limenitis archippus* (1)
Detected by Transect method only	*Atryonopsis hianna* (2); *Speyeria edwardsii* (1)