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# SITE-SPECIFIC OBSERVATION IN THE BREEDING SEASON IMPROVES THE ABILITY OF CHECKLIST DATA TO TRACK POPULATION TRENDS

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Abstract.—Checklist programs that compile birding observations are potentially useful for population monitoring. Previous analyses showed that trends in Quebec checklist data from migration seasons were significantly correlated with trends from the Breeding Bird Survey (BBS) in Quebec, although agreement of trend magnitudes for individual species was low. Here we analyze Quebec checklist data from the breeding season for comparison, using both the full data set and a subset of data collected at frequently visited (''standard'') sites. Checklist trends from the breeding season for standard sites corresponded much more closely to magnitudes of BBS trends than checklist trends based on all sites, although in both cases, checklists accurately reflected direction of BBS trend in >80% of species. Checklist trends from migration seasons for all sites and for standard sites were similar to each other, and did not correspond as well to BBS trends, probably because different populations were sampled in the two seasons. Checklist programs can be improved for population monitoring purposes by encouraging frequent reporting from standard sites, and by collecting recommended ancillary data that allow analysts to select data most appropriate to their research questions.

## OBSERVAR EN LUGARES ESPECÍFICOS DURANTE LA TEMPORADA REPRODUCTIVA AUMENTA LA HABILIDAD DE DATOS EN LISTAS DE COTEJO PARA MONITOREAR TENDENCIAS POBLACIONALES

Sinopsis.—Los programas de listas de cotejo que compilan las observaciones de aves son potencialmente útiles para monitorear poblaciones. Análisis previos mostraron que la tendencia de los datos de migración provenientes de listas de cotejo en el área de Quebec fueron correlacionadas significativamente con tendencias de Monitoreo de Aves en Reproducción (BBS) en Quebec, aunque el acuerdo concordancia de las magnitudes en las tendencias de especies individuales fue poco. Analizamos aquí los datos de listas de cotejo para Quebec para compararlos, usando tanto los datos totales como segmento de datos colectados en lugares frecuentemente visitados (control). Tendencias en las listas de cotejo para la temporada reproductiva en los lugares control corresponden mucho más cercamente a las magnitudes de tendencias medidas por BBS que las tendencias de listas de campo reflejaron dirección hacia las tendencias medidas por el BBS en >80% de las especies. Las tendencias notadas en listas de cotejo en períodos migratorios para todas las áreas y para áreas control fueron similares entre sí y no correspondieron tan bien a las tendencias del BBS, probablemente porque se muestrearon diferentes poblaciones en las dos temporadas. Programas de listas de cotejo pueden mejorarse con el propósito de monitorear poblaciones al estimular los reportes frecuentes de lugares contro y al colectar datos ancilares recomendados que permita a los analistas seleccionar los datos más apropiados para contestar sus preguntas de investigación.

Checklist programs that compile birders' observations into a common database can provide information on long-term population trends (Cyr and Larivée 1993; Dunn et al. 1996). While no one suggests that they replace standardized programs such as the Breeding Bird Survey (BBS), checklist programs might provide useful trend data for comparative purposes. Moreover, checklist data can be gathered for species, regions and habitats that are poorly sampled by BBS, such as secretive or sparsely distributed species, arctic and boreal regions, or wetland habitats.

One criticism of using checklist data for trend analysis is that there are no restrictions on where birders go, and observations are probably biased towards productive birding areas. When habitat at a favorite site is lost, birders move to a better site, which could mask declines in total population size of some species. A possible means of reducing this kind of bias is to restrict analysis of data to a standard set of sites that are visited regularly by birders. The aim of this paper is to conduct such an analysis, using data from Quebec's Étude des Populations d'Oiseaux du Québec (ÉPOQ), North America's oldest and largest checklist program. We compare the resulting trends to those derived from the entire data set and also to trends from the BBS.

In addition, we compare ÉPOQ trends for three seasons: spring and fall migration and the breeding season. Migration season trends were previously shown to be correlated with Quebec BBS trends across a large number of species, but there were many discrepancies for individual species (Dunn et al. 1996). If discrepant trends are a result of migrants coming from different areas than are sampled by BBS (southern Quebec), then breeding season ÉPOQ trends should correspond more closely to BBS trends because both are certain to be sampling birds from the same areas.

## METHODS

Each ÉPOQ checklist reports the number of each species detected on a single day at a single locality, an area less than one minute of latitude and longitude (about 3.2 $km^2$, Cyr and Larivée 1993, 1995). All lists are vetted by local bird clubs before submission to the data set, to ensure that unusual records are confirmed or corrected.

Data were analyzed for the 55 species listed in Table 1 for the period 1971–1992. For each season, analysis was restricted to species-specific time periods encompassing the appropriate range of dates for migration or breeding. For the breeding season, dates were chosen based on data in Cyr and Larivée (1995) and David (1996). Length of season varied among species, and mean daily sample size ranged from 22 checklists for the Yellow-bellied Flycatcher to 74 for the Song Sparrow, with an average of 42 per day for all species. For migration season date selection and sample sizes, see Dunn et al. (1996).

For each season, we identified localities that were regularly visited throughout the 22-yr study period and also had an annual average of at least 20 checklists. There were 32 such sites for the breeding season, 26 for spring migration and 16 for fall migration. Data from these sites were analyzed using the same methods used for analysis of data for all sites, as described below.

For all seasons, annual indices of abundance were derived from a multiple regression in which the dependent variable was the log(mean daily count + 1) where a single "daily count" was total birds reported on one checklist, and 1 was added to the mean of all checklist values for that day to allow transformation of zeros. (Tests with smaller additions showed that level of correspondence with BBS was not altered.) Each daily mean was weighted in the regression in proportion to the number of checklists used to calculate that mean.

Independent variables included date terms (see below) and dummy variables for each year. Day was set to 0 for a date near the center of the species-specific breeding or migration season. First- through third-order day terms were used in analysis of the breeding season (to model curvilinear relationships with date), while first- through sixth-order terms were used in analysis of migration seasons (to model the more complex pattern of abundance in those seasons). Dummy variables for each year were set to 0 or 1 (value = 1 if the observation was made in that year), and annual indices were calculated from the coefficients of the dummy variable for year that were estimated in the regression, as described in Dunn et al. (1996). Because day was set to 0 for a date near the center of the season, the index represents average abundance at that date.

Checklist trends were calculated from weighted regression of log annual indices on year, where weights were proportional to the number of checklists in the species-specific analysis period each year. Despite nonlinear trajectories in some species, all trends were calculated as linear regressions in order to compare them directly with the linear BBS trends (calculated for Quebec for 1971–1992 as per Erskine et al. 1992).

## RESULTS

Quebec checklist trends for spring and fall migrations and the breeding season were significantly correlated with BBS trends for the province, whether based on ÉPOQ data from all sites or from a standard set of sites ($r_s = 0.49$ to 0.54, $P < 0.001$ in all cases, $n = 55$ species except $n = 51$ for fall). For each season, trend values from standard sites were correlated with those based on the full data set (spring $r = 0.83$, fall $r = 0.75$, breeding season $r = 0.65$; $P < 0.001$ for all comparisons).

Correlation coefficients do not show whether the magnitude of trends correspond well or whether one set is biased relative to the other. Plots showed that breeding season trends based on all ÉPOQ sites differed markedly from BBS in the magnitude of trends for individual species. The checklist trends fell into a narrow range of values (both positive and negative) in comparison to the magnitude of BBS trends (Fig. 1, Table 2). By contrast, breeding season ÉPOQ trends from standard sites agreed much better in magnitude to BBS trends (Fig. 2, Table 2). However, the full and standard data sets agreed in direction of trend for 87% of the

TABLE 1. Species and codes for figures, ÉPOQ trends for the breeding season, and BBS trends for Quebec, 1971–1992.

| Species | Key to symbols in figures | ÉPOQ trend[a] | | BBS trend |
|---|---|---|---|---|
| | | All sites | Standard sites | |
| Chimney Swift (*Chaetura pelagica*) | A | −0.8* | −5.1* | −3.5 |
| Ruby-throated Hummingbird (*Archilochus colubris*) | a | 0.4* | 1.2 | 1.0 |
| Northern Flicker (*Colaptes auratus*) | B | −0.9* | −4.6* | −2.1+ |
| Yellow-bellied Sapsucker (*Sphyrapicus varius*) | C | 0.2* | 2.6* | −0.2 |
| Eastern Wood-Pewee (*Contopus virens*) | D | −0.4* | −2.3+ | −1.4 |
| Eastern Phoebe (*Sayornis phoebe*) | E | 0.0 | −4.7* | 0.9 |
| Yellow-bellied Flycatcher (*Empidonax flaviventris*) | F | 0.5* | 4.2* | 4.5 |
| Least Flycatcher (*E. minimus*) | G | −0.6* | −2.7* | −2.3 |
| Great Crested Flycatcher (*Myiarchus crinitus*) | H | −0.0 | −2.0+ | −2.5 |
| Blue-headed Vireo (*Vireo solitarius*) | I | 0.3* | 6.7* | 8.6+ |
| Warbling Vireo (*V. gilvus*) | b | 0.1 | 1.4 | 1.7 |
| Red-eyed Vireo (*V. olivaceus*) | c | 0.1 | 0.4 | 2.3* |
| House Wren (*Troglodytes aedon*) | J | −0.3* | −7.3* | −3.8+ |
| Winter Wren (*T. troglodytes*) | d | 0.2 | 0.8 | 3.5 |
| Golden-crowned Kinglet (*Regulus satrapa*) | K | 1.1* | 10.0* | −2.0 |
| Veery (*Catharus fuscescens*) | e | −0.3 | −0.7 | −0.1 |
| Swainson's Thrush (*C. ustulatus*) | L | −0.8+ | −4.2* | −2.3* |
| Hermit Thrush (*C. guttatus*) | f | 0.3* | 0.4 | −0.7 |
| Wood Thrush (*Hylocichla mustelina*) | M | −0.8* | −7.9* | −3.5 |
| American Robin (*Turdus migratorius*) | g | −0.3 | −0.7 | 1.0 |
| Gray Catbird (*Dumetella carolinensis*) | N | −1.0* | −5.1* | −5.5* |
| Brown Thrasher (*Toxostoma rufum*) | O | −0.6* | −5.7* | −4.6* |
| Tennessee Warbler (*Vermivora peregrina*) | h | −0.4 | −2.6 | −4.7 |
| Nashville Warbler (*V. ruficapilla*) | i | 0.1 | −1.5 | −4.2 |
| Northern Parula (*Parula americana*) | j | 0.0 | 1.4 | −0.3 |
| Yellow Warbler (*Dendroica petechia*) | P | −0.7* | −6.7* | 2.9+ |
| Chestnut-sided Warbler (*D. pensylvanica*) | Q | −0.6* | −4.2* | −6.5 |
| Magnolia Warbler (*D. magnolia*) | k | 0.3 | −0.6 | 5.8 |
| Cape May Warbler (*D. tigrina*) | l | −0.4 | −4.1 | −0.2 |
| Yellow-rumped Warbler (*D. coronata*) | m | 0.1 | 1.0 | 2.8+ |
| Black-throated Green Warbler (*D. virens*) | n | 0.1 | 1.2 | 0.0 |
| Blackburnian Warbler (*D. fusca*) | o | 0.2 | 2.2 | 3.7 |
| Black-and-white Warbler (*Mniotilta varia*) | R | 0.4* | 3.3* | 4.7+ |
| American Redstart (*Setophaga ruticilla*) | p | −0.2 | −0.4 | −2.0 |
| Ovenbird (*Seiurus aurocapillus*) | q | 0.1 | −0.9 | −0.4 |
| Northern Waterthrush (*S. noveboracensis*) | r | 0.1 | −0.2 | −0.5 |
| Mourning Warbler (*Oporornis philadelphia*) | S | −0.5* | −6.2* | 0.2 |
| Common Yellowthroat (*Geothlypis trichas*) | T | −0.3 | −1.2* | −2.2+ |
| Canada Warbler (*Wilsonia canadensis*) | s | −0.1 | −1.6 | −0.6 |
| Scarlet Tanager (*Piranga olivacea*) | t | −0.2 | 2.5 | −1.8 |
| Chipping Sparrow (*Spizella passerina*) | u | 0.1 | −0.6 | 1.4 |
| Vesper Sparrow (*Pooecetes gramineus*) | v | −0.0 | −1.6 | −6.8* |
| Savannah Sparrow (*Passerculus sandwichensis*) | U | −0.4+ | −1.2+ | −2.3* |
| Song Sparrow (*Melospiza melodia*) | V | −0.8* | −1.7* | −0.2 |
| Lincoln's Sparrow (*M. lincolnii*) | W | 0.1 | −3.9* | −4.0* |
| Swamp Sparrow (*M. georgiana*) | w | 0.2+ | 0.9 | −5.0 |

TABLE 1. Continued.

| Species | Key to symbols in figures | ÉPOQ trend[a] | | BBS trend |
|---|---|---|---|---|
| | | All sites | Standard sites | |
| White-throated Sparrow (*Zonotrichia albicollis*) | X | −1.1* | −1.6+ | −1.9* |
| Dark-eyed Junco (*Junco hyemalis*) | x | −0.3 | −1.6 | −3.7 |
| Rose-breasted Grosbeak (*Pheucticus ludovicianus*) | y | −0.5 | −1.3 | −4.8* |
| Bobolink (*Dolichonyx oryzivorus*) | Y | −1.8* | −5.4* | −6.2* |
| Red-winged Blackbird (*Agelaius phoeniceus*) | z | −0.9* | −1.1 | −3.5* |
| Eastern Meadowlark (*Sturnella magna*) | Z | −0.7* | −5.3* | −5.3* |
| Common Grackle (*Quiscalus quiscula*) | z′ | −0.6 | −1.3 | 0.0 |
| Brown-headed Cowbird (*Molothrus ater*) | % | −3.2* | −4.5* | −7.2* |
| Baltimore Oriole (*Icterus galbula*) | $ | −0.6* | −3.5* | −2.1 |

[a] Significance of trends: + = $0.05 < P < 0.10$, * = $P < 0.05$.

55 species. Moreover, significant ÉPOQ trends ($n = 16$) showed the same direction of trend as BBS (whether significant or not) in 81% and 85% of species for the full and standard data sets, respectively. In both analyses, ÉPOQ showed a significant decline for the Yellow Warbler while BBS showed a significant increase. There was no evidence of a positive bias in ÉPOQ trends from the breeding season relative to BBS trends (in either data set), as there was in the migration-season counts (Dunn et al. 1996).

ÉPOQ trends from migration seasons (all sites) also had a narrower range of trend magnitudes than BBS (Dunn et al. 1996), but analysis of data from standard sites did not improve correspondence to BBS (Table 2).

TABLE 2. Range of trend magnitudes from ÉPOQ and BBS.

| Data set | Min | Max | Interquartile range | Range |
|---|---|---|---|---|
| Breeding Bird Survey | −7.2 | 8.6 | 4.6 | 15.8 |
| ÉPOQ Summer | | | | |
| All sites | −3.2 | 1.1 | 0.8 | 4.3 |
| Standard sites | −7.9 | 10.0 | 5.0 | 17.9 |
| ÉPOQ Spring | | | | |
| All sites | −4.3 | 2.2 | 2.2 | 6.5 |
| Standard sites | −4.2 | 0.8 | 0.8 | 5.0 |
| ÉPOQ Fall | | | | |
| All sites | −4.9 | 4.5 | 2.8 | 9.4 |
| Standard sites | −2.4 | 3.1 | 2.0 | 5.4 |

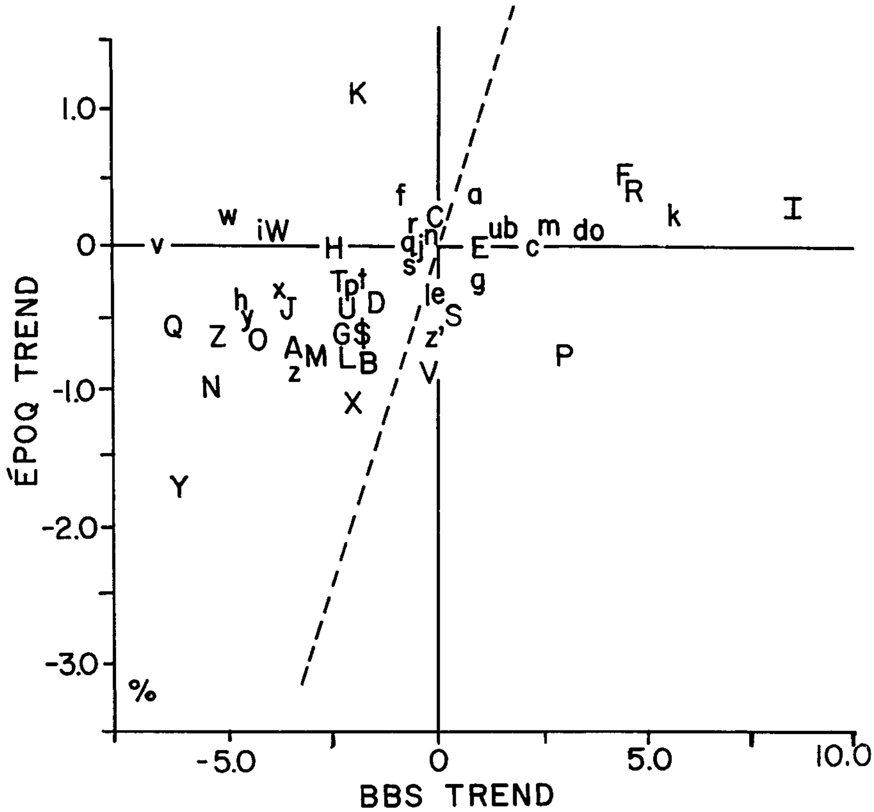


FIGURE 1. ÉPOQ trends for summer (full data set), plotted against BBS trends (1971–92). See Table 1 for key to symbols. Trends are expressed as annual percent change in abundance. Dashed line indicates one-to-one correspondence.

## DISCUSSION

The checklist program detected population change most similar to that of BBS when observation conditions were also the most similar to BBS, i.e., when checklist data were from the breeding season and from a set of standard sites that were visited annually. Breeding-season ÉPOQ trends based on all sites were quite different in magnitude than those from standard sites (compare Figs. 1 and 2), indicating that unrestricted inclusion of all birding sites did bias the data. However, the bias was in numbers of birds counted, and not in direction of trend. Birders evidently tend to favor sites where bird populations are relatively stable, but even unrestricted birding can detect the same directional trends as found in BBS.

For the migration seasons, checklist trends based on standard sites were similar in direction and magnitude to trends based on the complete data

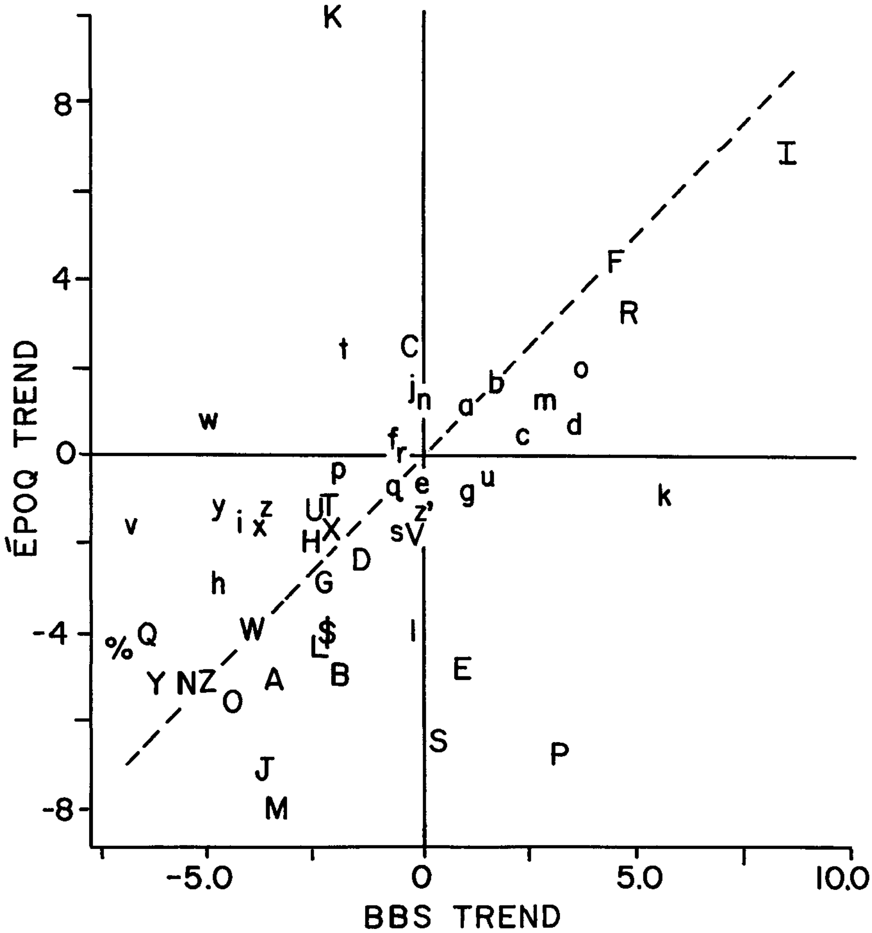


FIGURE 2. ÉPOQ trends for summer, from a standard set of 32 sites, plotted against BBS trends (1971–92). Symbols for species (Table 1) indicate whether ÉPOQ trend shown here was statistically significant (capital letter or symbol), or nonsignificant (lower case letter). Other details as for Figure 1.

set. Migrants are more evenly distributed across the landscape than are breeding birds (with less habitat selection), so migration season counts may vary less among birding locations than would numbers of locally breeding birds, making it less important to restrict analysis to standard sites. Neither the restricted nor the full data set, however, showed signs of one-to-one correspondence of trend magnitudes between migration-season ÉPOQ trends and BBS (Dunn et al. 1996, Table 2). This probably reflects the fact that many migrants counted in southern Quebec on migration breed in northern Quebec or in other provinces, where population trends could differ from those in southern Quebec. (BBS covers only the southern part of the province.) Trends in daily migration counts from a single site have been shown to agree more closely with BBS trends when birds originate from areas sampled by both surveys (Hussell 1997).

Even in the strongest comparison between checklist and BBS trends, that involving breeding season checklist trends from standard sites, there were discrepancies for individual species (Fig. 2). Differences could result from some of the known biases in checklist programs (Dunn et al. 1996) or in BBS (e.g., road-side bias; Sauer et al. 1994). In other cases, trends might genuinely differ among the sites sampled by the two programs. Although BBS provides a useful yardstick for determining whether checklist programs detect population change, it does not necessarily represent the more accurate of the two surveys for every species. For example, ÉPOQ shows large increases in Golden-crowned Kinglets in all seasons, while BBS shows a nonsignificant decline. However, slightly different analysis methods (Sauer et al. 2000) produce a large (nonsignificant) positive trend for kinglets in Quebec for the study period, with extremely high variance. The high variance and instability of trend estimates indicate that the species is poorly sampled by BBS in Quebec, and in this case ÉPOQ may more accurately reflect true population change. In other cases, such as the open-country species that show notably larger and more significant changes in BBS than in ÉPOQ (Vesper Sparrow, Red-winged Blackbird, Brown-headed Cowbird), the discrepancies may indicate that ÉPOQ participants undersample open agricultural habitats. The most important discrepancy between the surveys is the Yellow Warbler, shown to be significantly increasing in BBS, but significantly declining according to ÉPOQ. Further investigation is needed to explain this particular disagreement.

Results presented here indicate that the value of checklist programs for population monitoring purposes is increased when analysis is restricted to a standard set of regularly visited sites, for data collected during the breeding season. However, we do not advocate restricting checklist programs to standard sites alone, as programs with broad participation are valuable for a wide variety of additional purposes, not only scientific (as in documenting range changes or timing of migration) but also recreational and educational (Droege et al. 1998). Moreover, unrestricted birding appears able to detect direction of trend in most species, even if not the magnitude of change. Nonetheless, checklist program organizers might consider selecting a set of standard sites and promoting regular visits to them in order to increase the value of their program for population monitoring. Program organizers can also enhance the usefulness of their data by adhering to recommended data collection protocols (Droege et al. 1998; http:www.rsl.psw.fs.fed.us/pif/ext_prot.html). These include requiring separate lists for each day and birding locality ($< 2$–3 km$^2$), and routine recording of latitude and longitude of birding location, hours of active birding, numbers of birds seen (as opposed to presence/absence) and a simple rating of observer skill and quality of viewing conditions. Recording these data makes it possible for analysts to select portions of the database that are appropriate for their particular analyses, and widens the scope for checklist data to be used as a resource for answering research and conservation questions.

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