

EFFECT OF TIME OF DAY ON BIRD ACTIVITY

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ABSTRACT.—Breeding season activity, based on detections recorded on more than a million 3-minute Breeding Bird Survey stops, reaches a peak for most species during the hour centered at sunrise or in the following hour. Activity of most species then declines gradually as the morning progresses. When large samples are considered, activity patterns for a given species are quite constant from year to year; but each species has its own characteristic pattern and there is much similarity among members of the same genus.

Activity reaches a low point in midday, and may almost cease in some habitats (e.g. deserts); but in deciduous forests, activity of many species continues at a reduced rate. By reducing walking rate or lengthening listening periods, productive censusing of many species could be extended into midday. Winter activity is even more strongly oriented toward the early morning.

Bird activity through the day is predictable to a degree, and varies greatly from species to species. Knowledge of peak times of activity or conspicuousness can be helpful in planning the timing of field work and even in the selection of the most productive method. This paper summarizes data from literally millions of sight observations and tens of thousands of net-hours of breeding season banding activity.

METHODS

BREEDING BIRD SURVEY

All North American Breeding Bird Survey (BBS) data for 1965–1979 were summed annually by species for each 10-stop interval to determine what percentage of the birds were recorded in stops 1–10, 11–20, . . . 41–50. These periods are roughly equivalent to five hourly intervals with the first one centered at sunrise. If a species were equally conspicuous in all five intervals, 20% of the total recorded would be observed in each interval.

ALL DAY "IPA" POINT COUNTS

Twenty-minute point counts, recorded as four consecutive 5-minute counts, were taken periodically throughout several days at a single location on the wooded Patuxent River bluff at my home near Laurel, Maryland to plot singing activity and general conspicuousness through the day. Of interest were changes in activity as reflected in number of species and individuals detected and number of singing birds.

HOURLY BREEDING SEASON BANDING TOTALS

These totals are based on dawn-to-dusk operation of a grid of 44 mist nets, operated generally on 12 days per season for 12 summers. The nets, which sampled about 40 ha of lowland deciduous forest on the Patuxent Wildlife Research Center near Laurel, Maryland, were operated on alternate days and visited on a 2-hour schedule. Time of capture was considered to be one hour prior to removal from the net.

WINTER BIRD SURVEY

This experimental sampling technique consisted of a grid of 46 8-km transects, one located at the center

of each 7½' quadrangle (USGS topographic map) in central Maryland. The area sampled included all of Anne Arundel, Baltimore, and Howard Counties and Baltimore City as well as parts of adjacent Carroll, Frederick, Montgomery, and Prince Georges Counties. Transects were 8 km in length, with 2 km covered on foot in each hour. Coverage began at sunrise and lasted exactly 4 hours. Data from all five years of the Survey, 1970–74, were used in this study.

RESULTS

BREEDING SEASON

Early morning activity

Morning breeding season activity patterns for woodland species, which are detected primarily by voice, are shown in Figure 1. Breeding Bird Survey coverage begins at one-half hour before local sunrise and ends between 3½ and 4½ hours after sunrise, thereby bracketing the period of greatest activity. As shown by Figure 1, the number of individual birds recorded in a series of 3-minute stops decreases more rapidly as the morning progresses than does the number of species detected.

Each species has its own distinctive diurnal activity pattern, as illustrated for representative species in Figure 2 and Table 1, based on the percentage of individuals recorded during each ten-stop interval on the BBS. The percentages are remarkably constant from year to year as shown by the 95% confidence limits in Figure 2.

Hérons.—Although there tends to be consistency in activity patterns within a genus, there are some striking differences within families. The large and conspicuous Great Blue Heron (*Ardea herodias*) shows almost no change in conspicuousness as the morning progresses (Fig. 2). Several herons, including Green (*Butorides striatus*), Louisiana (*Hydranassa tricolor*), and Snowy Egret (*Leucophoyx thula*), reach a peak in the first hour after sunrise. Other herons are most conspicuous in the sunrise hour as they fly to or from their nests; these include the Little Blue Heron (*Florida caerulea*), Cattle Egret (*Bubulcus ibis*), Common Egret (*Casmerodius albus*), Black-crowned Night Heron (*Nyc-*

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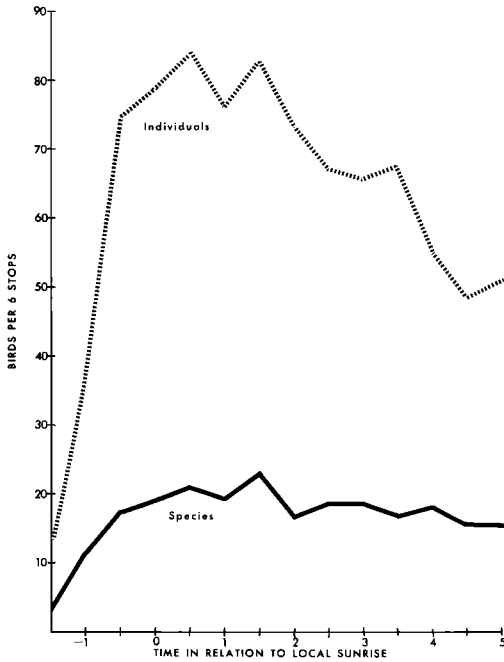


FIGURE 1. Numbers of species and individuals recorded by the author during 3-minute intervals at six points in floodplain forest habitat (mean of four days). Counts were repeated every half hour.

ticorax ncticorax), and especially the three ibises. The American Bittern (*Botaurus lentiginosus*) has its greatest vocal activity period during the sunrise hour, as shown in Figure 2.

Waterfowl, vultures, hawks.—Waterfowl activity patterns are varied and unpredictable, except that observations tend to decrease in the fifth hour. Turkey (*Cathartes aura*) and Black (*Coragyps atratus*) Vulture observations increase to a strong peak in the final hour (Fig. 3, Table 1). Hawks also increase in conspicuousness as the morning progresses, though not so dramatically.

Gallinaceous birds, limpkins, rails.—Some gallinaceous birds, including Turkey (*Meleagris gallopavo*), Ring-necked Pheasant (*Phasianus colchicus*, Fig. 2), and especially Greater Prairie Chicken (*Tympanuchus cupido*) decline sharply in activity after sunrise, while others, such as Ruffed Grouse (*Bonasa umbellus*), Gambel's Quail (*Lophortyx gambelii*), and Gray Partridge (*Perdix perdix*), follow the pattern of the Bob-

white (*Colinus virginianus*, Fig. 2). The Scaled (*Callipepla squamata*), California (*Lophortyx californica*), and Mountain (*Oreortyx picta*) Quail have a pattern between those of the Ring-necked Pheasant and the Bobwhite (Fig. 2). Limpkin (*Aramus guarauna*) and rail observations decrease gradually after passing a peak in the sunrise hour.

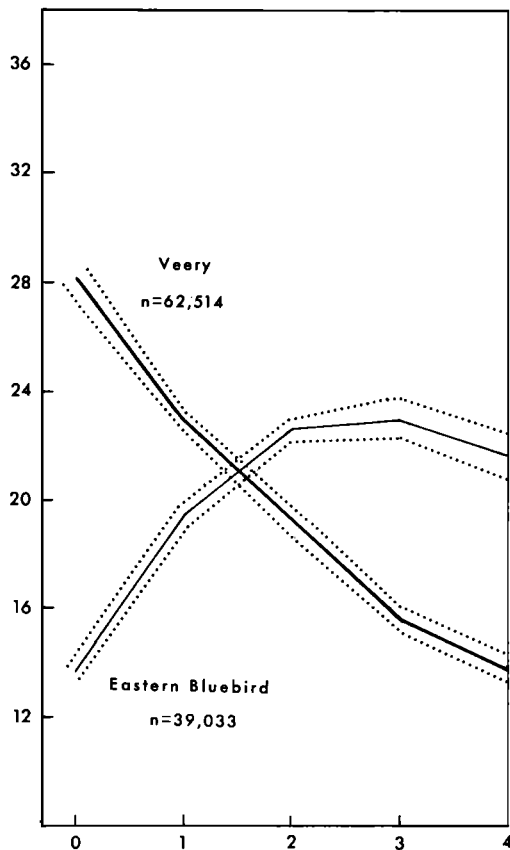
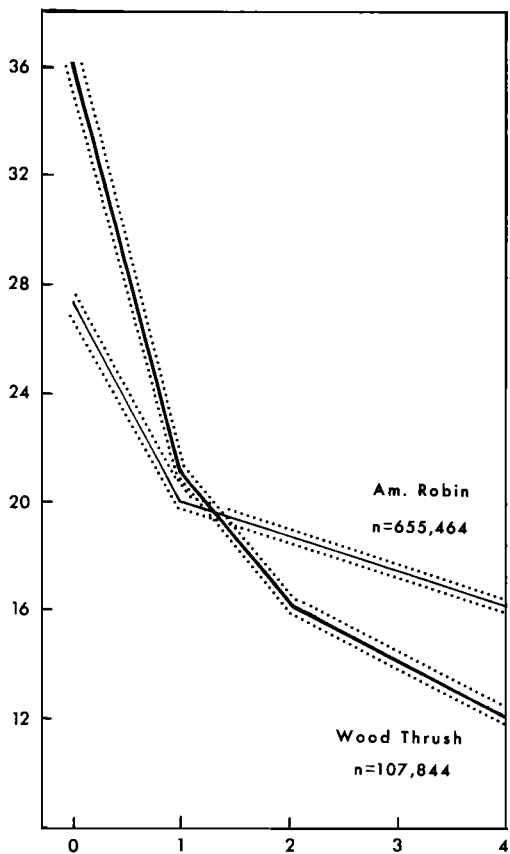
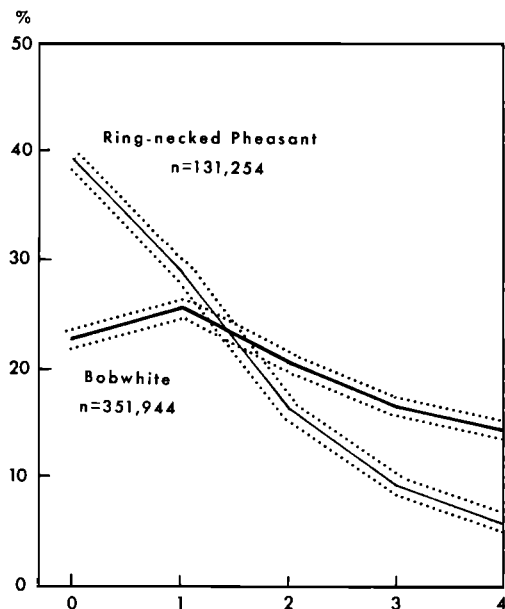
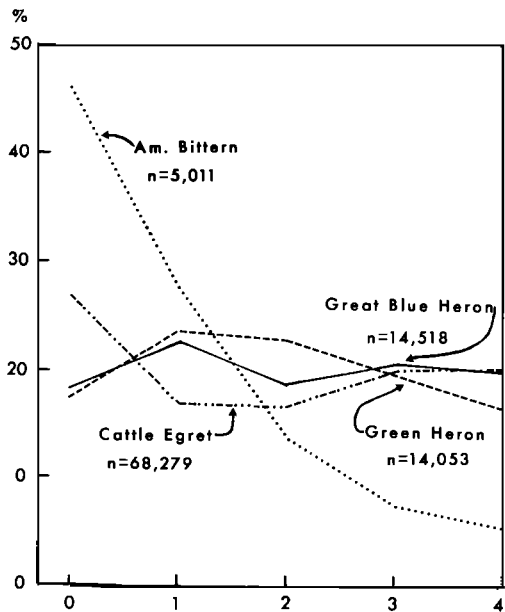
Shorebirds.—Killdeer (*Charadrius vociferus*, Table 1), Marbled Godwit (*Limosa fedoa*), Upland Sandpiper (*Bartramia longicauda*), Willet (*Catoptrophorus semipalmatus*), Spotted Sandpiper (*Actitis macularia*), and Common Snipe (*Capella gallinago*) exhibit low activity in the sunrise hour, and peak in the first three hours after sunrise. American Woodcock (*Philohela minor*), however, declined very sharply after a sunrise peak of 72%, and Wilson's Phalarope (*Steganopus tricolor*) showed an increase from 10% at sunrise to 24% in the final period.

Doves, cuckoos.—Pigeons and doves reached a peak in the first hour after sunrise, except for the White-crowned Pigeon (*Columba leucocephala*) and Mourning Dove (*Zenaida macroura*, Table 1), which were equally conspicuous in the sunrise period. The Yellow-billed (*Coccyzus americanus*, Table 1) and Black-billed (*C. erythrophthalmus*) Cuckoos also reached a peak in the hour after sunrise, then declined 37% and 48% respectively, by the final period.

Owls, goatsuckers.—Screech (*Otus asio*), Great Horned (*Bubo virginianus*), and Barred (*Strix varia*) Owls were equally clustered in the sunrise hour, with 77 to 79% of observations recorded then. Not so restricted to the dawn period were the following owls, listed by decreasing percentage detected in the sunrise hour: Pygmy (*Glaucidium gnoma*, 43%), Short-eared (*Asio flammeus*, 30%), and Burrowing (*Athene cunicularia*, 22%). Except for the night-hawks, the goatsuckers were almost entirely restricted to the sunrise hour; see Chuck-will's-widow (*Caprimulgus carolinensis*), Table 1. The Lesser Nighthawk (*Chordeiles acutipennis*) was more restricted to the sunrise period (71% of observations) than was the Common Nighthawk (*C. minor*, 58%, Table 1).

Swifts, hummingbirds.—Counts of all species of swifts were depressed in the sunrise hour. The pattern shown for the Chimney Swift (*Chaetura pelagica*, Table 1) is typical. Hummingbirds, except for the Broad-tailed (*Selas-*

FIGURE 2. Activity patterns from BBS, shown as the percentage of the total birds (with 95% confidence limits) detected that were recorded in each of the five 10-stop intervals, corresponding approximately to hourly periods beginning one-half hour before sunrise.



Hours from sunrise

TABLE 1
PERCENT OF TOTAL OBSERVATIONS THAT FELL IN EACH 10-STOP BBS INTERVAL, 1965-1979

Species	Total recorded	% each hour after sunrise				
		0	1	2	3	4
Mallard	58,055	20.7	24.1	19.9	19.2	16.1
Black Vulture	6350	4.1	10.7	11.9	21.4	52.0
Red-tailed Hawk	12,806	10.3	16.1	19.3	24.0	30.3
American Kestrel	17,374	14.7	19.9	20.8	22.3	22.3
Killdeer	112,701	16.1	22.9	22.1	20.3	18.6
Rock Dove	161,004	7.4	30.2	26.3	21.1	15.0
Mourning Dove	600,763	25.0	24.6	19.5	16.3	14.6
Yellow-billed Cuckoo	71,506	21.5	24.6	20.4	18.0	15.5
Chuck-will's-widow	9577	98.3	1.1	0.3	0.2	0.1
Common Nighthawk	32,039	58.2	13.9	9.0	9.3	9.5
Chimney Swift	138,701	13.5	21.0	21.8	20.9	22.8
Ruby-throated Hummingbird	1195	11.1	19.4	21.6	24.1	23.9
Eastern Kingbird	90,303	19.5	21.9	20.6	19.0	18.9
Eastern Phoebe	36,478	29.6	18.2	18.2	17.5	16.2
Barn Swallow	367,013	11.9	19.4	21.8	23.7	23.1
Bank Swallow	68,515	7.0	17.4	23.3	23.5	28.7
Black-capped Chickadee	43,603	22.1	19.9	21.8	19.5	16.8
Gray Catbird	102,092	25.5	21.4	20.1	17.3	15.7
Swainson's Thrush	52,379	29.6	21.8	17.6	15.4	15.8
Blue-gray Gnatcatcher	18,426	25.3	21.3	20.0	18.0	15.5
Cedar Waxwing	45,939	10.3	20.0	22.4	23.5	23.8
Red-eyed Vireo	180,795	18.3	22.4	20.5	19.9	18.8
Yellow Warbler	80,874	19.0	21.6	21.1	19.8	18.4
Ovenbird	76,168	22.2	23.0	19.3	18.0	17.5
Common Yellowthroat	212,523	22.0	22.4	19.8	18.2	17.6
Western Meadowlark	438,513	22.4	23.6	20.7	17.7	15.6
Northern Oriole	80,333	14.1	20.6	22.3	21.6	21.5
Scarlet Tanager	28,341	19.5	22.2	20.8	19.4	18.1
Indigo Bunting	223,071	26.7	19.8	18.6	17.6	17.3
Chipping Sparrow	164,677	25.3	19.6	19.2	18.4	17.5

phorus platycercus), are late risers, with counts for the sunrise hour only about half as great as in the next hour; see Ruby-throated Hummingbird (*Archilochus colubris*) in Table 1.

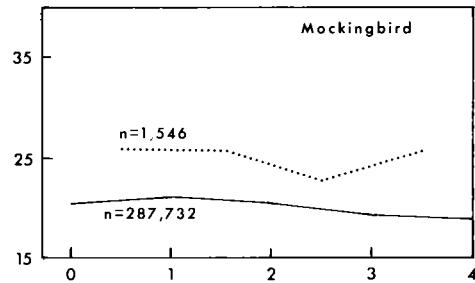
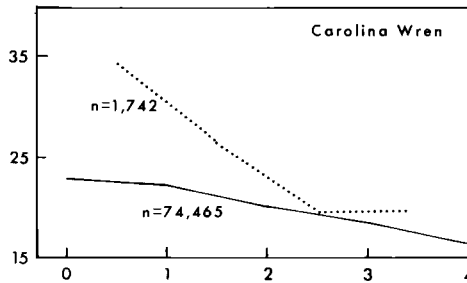
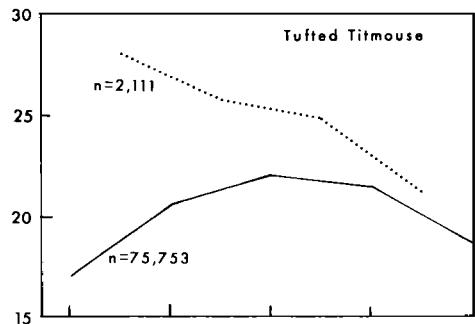
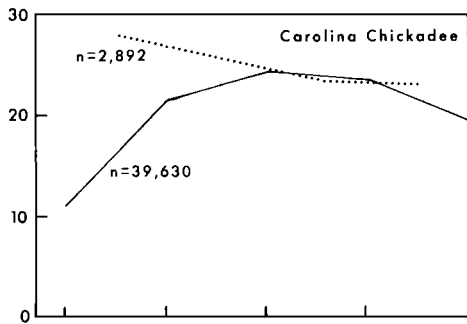
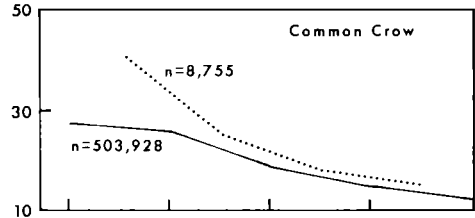
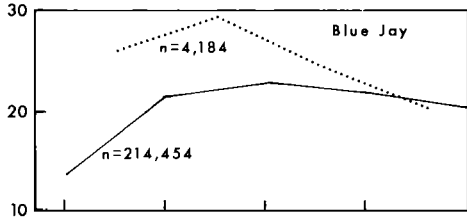
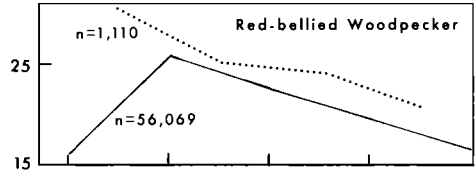
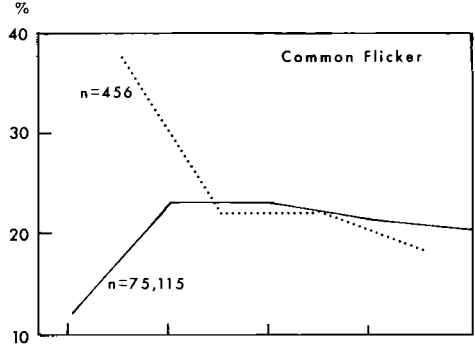
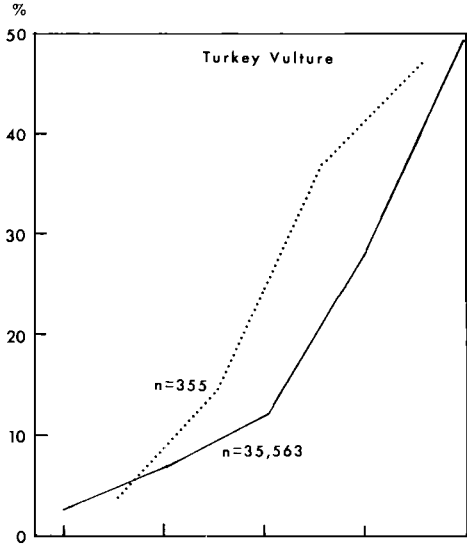
Woodpeckers.—The desert-inhabiting Gila Woodpecker (*Melanerpes uropygialis*) was the only member of this family with significantly more birds ($P < 0.05$) recorded in the sunrise hour than later in the morning. The Lewis' Woodpecker (*M. lewis*) was unique in this family in becoming more conspicuous as the morning progressed. The other woodpeckers had activity patterns similar to that shown for the Red-bellied Woodpecker (*M. carolinus*) in Figure 3.

Flycatchers.—The Eastern (*Tyrannus tyrannus*, Table 1) and Western (*T. verticalis*) King-

birds, which are conspicuous by both voice and sight, were among the most constant species throughout the morning. The Scissor-tailed Flycatcher (*Muscivora forficata*), however, was more conspicuous (25%) in the sunrise hour and then declined by about 30% by the last two hours. The genus *Myiarchus* showed a peak in the first hour after sunrise, then declined sharply as the morning progressed. The three species of phoebes, however, peaked in the sunrise hour and continued to decline thereafter; see Eastern Phoebe (*Sayornis phoebe*) in Table 1. Most members of the genus *Empidonax* peaked in the first period and decreased thereafter, but the Yellow-bellied (*E. flaviventris*) and Acadian (*E. vireescens*) Flycatchers had significantly higher ($P < 0.05$) totals in the hour after sunrise than

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FIGURE 3. Comparison of summer (solid lines) and winter (dotted lines) patterns from BBS and Winter Bird Survey. See text for explanation. Scientific names not in the text are: Blue Jay (*Cyanocitta cristata*), Common Crow (*Corvus brachyrhynchos*), Carolina Chickadee (*Parus carolinensis*), Tufted Titmouse (*P. bicolor*), and Carolina Wren (*Thryothorus ludovicianus*).



Hours from sunrise

in any other period. The Eastern Wood Pewee (*Contopus virens*) varied little with time, whereas the Western Wood Pewee (*C. sordidulus*) decreased slightly from a sunrise peak, as did the Olive-sided Flycatcher (*Nuttallornis borealis*).

Larks, swallows.—Horned Larks (*Eremophila alpestris*), with a sample of a quarter of a million observations, decreased smoothly from 22.2% in the first period to 17.6% in the last. Except for the Purple Martin (*Progne subis*), which maintained a constant detectability, the swallows were consistently low in the sunrise hour, then gradually increased to peaks in the third or fourth hour after sunrise; see Barn Swallow (*Hirundo rustica*) and Bank Swallow (*Riparia riparia*) in Table 1.

Jays, crows, titmice.—Jays were low in the sunrise hour, but steady thereafter, while crows steadily declined in observations after a sunrise peak that was twice as high as their final hour (Fig. 3). Chickadees and titmice tended to peak in one of the middle periods (Fig. 3).

Nuthatches, creepers, wrens.—Nuthatch observations were especially low in the sunrise period, then nearly doubled in the next hour and maintained their high totals through the last hour. One quarter of the entire Brown Creeper (*Certhia familiaris*) count, however, was tallied in the sunrise period. Wrens declined gradually from a dawn peak, except for the Long-billed Marsh (*Cistothorus palustris*), Short-billed Marsh (*C. platensis*), and Canyon (*Catherpes mexicanus*) Wrens, which peaked strongly at sunrise (34%, 30%, and 29% of total observations), then declined to between 11% and 14% by the final period.

Mockers, thrushes.—The Mockingbird (*Mimus polyglottos*), which is a loud and persistent singer as well as a conspicuous roadside bird easily identified in flight, had one of the most consistent records throughout the morning (Fig. 3). The Gray Catbird (*Dumetella carolinensis*), on the other hand, frequently sings from within dense cover and is less often seen; catbird observations dropped steadily (Table 1), as did those of thrashers. Graphs for representatives of four thrush genera are depicted in Figure 2. The American Robin (*Turdus migratorius*), after a dawn song peak, maintained a high detectability because it feeds in the open and is easily detected visually. The more secretive Varied Thrush (*Ixoreus naevius*) has a pattern much like that of the Wood Thrush (*Hylocichla ustulata*, Fig. 2). The Hermit (*Catharus guttatus*) and Swainson's (*C. ustulatus*) Thrush patterns are similar to that shown for the Veery (*C. fuscescens*, Fig. 2). The Mountain Bluebird (*Sialis currucoides*) pattern is similar to that depicted

for the Eastern Bluebird (*S. sialis*, Fig. 2), but flatter, while the Western Bluebird (*S. mexicana*) has a sunrise peak followed by a lull the next hour.

Gnatcatchers, waxwings, shrikes, starlings.—The Blue-gray Gnatcatcher (*Polioptila caerulea*, Table 1), which is detected at close range, primarily by its calls, continued to decline in activity after its sunrise peak. Cedar Waxwings (*Bombycilla cedrorum*, Table 1), on the other hand, were low in the sunrise hour, doubled in the next hour, then gradually rose to peak activity in the last two hours. Loggerhead Shrikes (*Lanius ludovicianus*) and Starlings (*Sturnus vulgaris*), which are visually conspicuous, followed a pattern similar to that of the Yellow-shafted Flicker (*Colaptes auratus*) in Figure 3.

Vireos.—Vireos are detected almost entirely by voice, but they are loud and persistent songsters and vary little in detectability during early and mid-morning. The Red-eyed Vireo (*Vireo olivaceus*) pattern shown in Table 1 is also typical of the White-eyed (*V. griseus*), Yellow-throated (*V. flavifrons*), and Solitary (*V. solitarius*) Vireos. The Warbling Vireo (*V. gilvus*), however, differed by reaching its highest total in the sunrise hour, from which it declined only 10.7% by the last period; this was one of the smallest changes noted in any species.

Wood warblers.—The great majority of the warblers followed the pattern shown for the Yellow Warbler (*Dendroica petechia*) in Table 1, with the peak in the first hour after sunrise, followed by a gradual decline in detections. Notable exceptions were those species that were most conspicuous in the sunrise hour and steadily decreased in vocal activity thereafter; these were the Tennessee (*Vermivora peregrina*), Orange-crowned (*V. celata*), Nashville (*V. ruficapilla*), Louisiana Waterthrush (*Seiurus motacilla*), Mourning (*Oporornis philadelphia*), MacGillivray's (*O. tolmiei*), Yellow-breasted Chat (*Icteria virens*), and Canada Warbler (*Wilsonia canadensis*).

House Sparrow, icterids, tanagers.—The House Sparrow (*Passer domesticus*), Eastern Meadowlark (*Sturnella magna*), and the various blackbird species had activity patterns similar to that shown in Table 1 for the Western Meadowlark (*S. neglecta*), with the highest count in the first hour after sunrise. The orioles, however, started low and built up to an activity peak in the middle period that was maintained through the final hour, as shown for the Northern Oriole (*Icterus galbula*) in Table 1. Except for the Scarlet Tanager (*Piranga olivacea*) shown in Table 1, the native tanagers showed a strong activity peak in the sunrise hour, followed by a gradual decline.

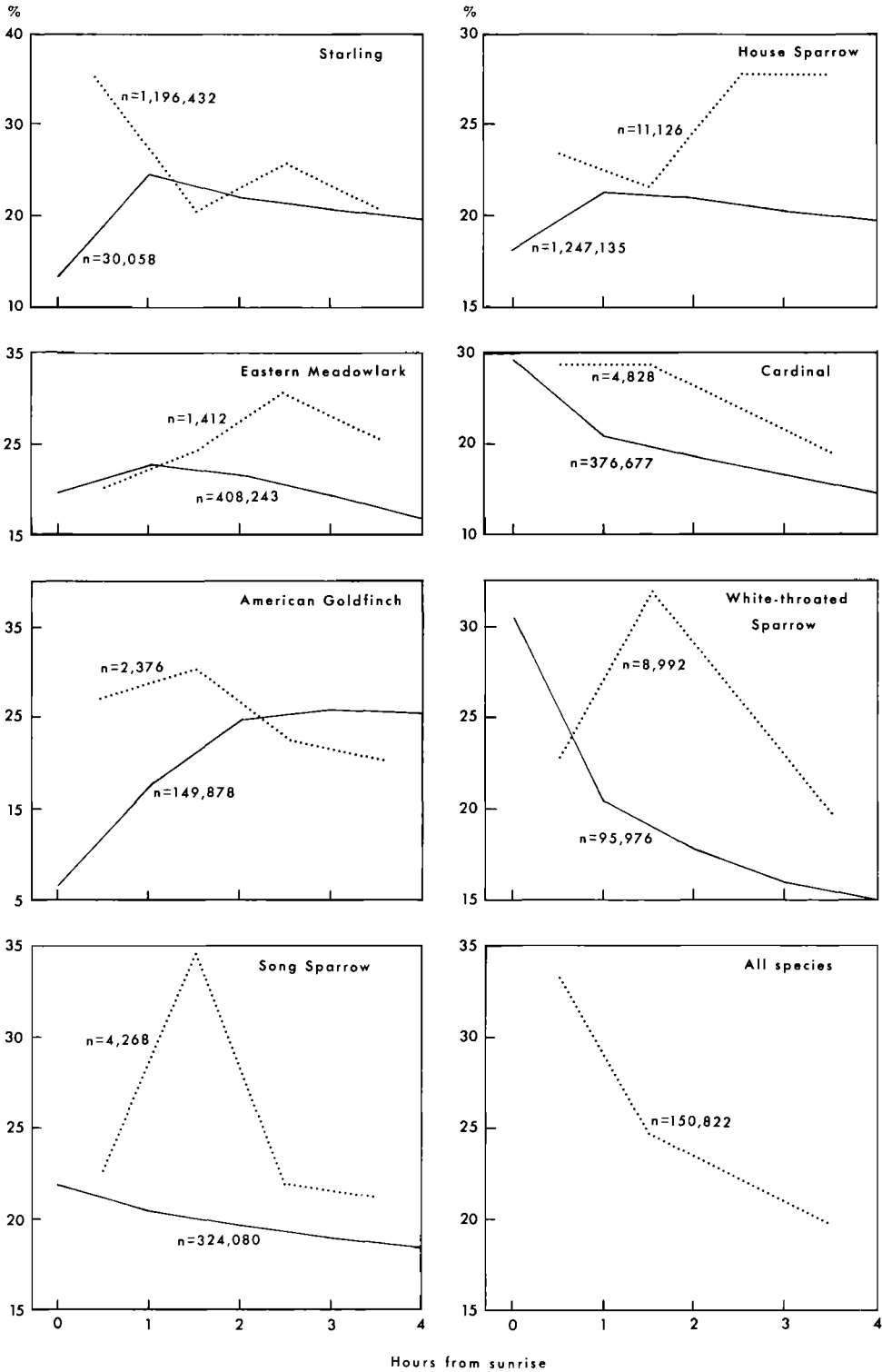


FIGURE 4. Comparison of summer (solid lines) and winter (dotted lines) patterns from BBS and Winter Bird Survey. See text for explanation.

Grosbeaks, finches.—The Cardinal (*Cardinalis cardinalis*, Fig. 4) was the only grosbeak with a sharp activity peak in the sunrise hour; twice as many birds were recorded in this first hour as in the final hour. The pattern for the Pyrrhuloxia (*C. sinuatus*) was similar to that for the Painted Bunting (*Passerina ciris*) and for the Indigo Bunting (*P. cyanea*) shown in Table 1. Blue (*Guiraca caerulea*) and Black-headed (*Pheucticus melanocephalus*) Grosbeaks gradually declined from sunrise peaks, while the Rose-breasted Grosbeak (*P. ludovicianus*) and Lazuli Bunting (*Passerina amoena*) maintained equal activity throughout the five hours. The Lazuli Bunting varied less than any other species, with a difference of only 8.5% between the highest and lowest hourly counts. The Dickcissel (*Spiza americana*) reached a slight but significant ($P < 0.05$) peak in the hour after sunrise, then declined gradually. The cardueline finches, represented in Figure 4 by the American Goldfinch (*Carduelis tristis*), typically had very low counts in the sunrise hour, reached a peak in the second or third hour after sunrise and maintained an above-average count into the final hour.

Towhees, sparrows.—A strong sunrise peak involving more than half of the observations was characteristic of the Olive Sparrow (*Arremonops rufivirgata*). Similar but weaker early peaks were recorded for the towhees. Sparrows were typically most conspicuous in the sunrise hour. Species with a peak of 30% or more in the sunrise hour, as illustrated by the breeding season graph for the White-throated Sparrow (*Zonotrichia albicollis*) in Figure 4, were Henslow's (*Ammodramus henslowii*), Le Conte's (*Ammodramus leconteii*), Sharp-tailed (*A. caudacuta*), Seaside (*A. maritima*), and Bachman's (*Aimophila aestivalis*) Sparrows, and members of the genus *Junco*. Lower sunrise peaks followed by more gradual decreases were recorded for the Savannah (*Passerculus sandwichensis*), Grasshopper (*Ammodramus savannarum*), Baird's (*A. bairdii*), Vesper (*Pooecetes gramineus*), Rufous-crowned (*Aimophila ruficeps*), Cassin's (*A. cassinii*), Black-throated (*Amphispiza bilineata*), Clay-colored (*Spizella pallida*), Brewer's (*S. breweri*), Black-chinned (*S. atrogularis*), White-crowned (*Zonotrichia leucophrys*), Lincoln's (*Melospiza lincolni*), and Swamp (*M. georgiana*) Sparrows and are represented by the Chipping Sparrow (*S. passerina*) in Table 1. A few species were lowest in the sunrise hour: Lark Bunting (*Calamospiza melanocorys*), Lark Sparrow (*Chondestes grammacus*), Sage Sparrow (*Amphispiza belli*), Fox Sparrow (*Passerella iliaca*), and Chestnut-collared Longspur (*Calcarius ornatus*). Only the Field Sparrow (*Spizella pusilla*) and Song Sparrow (*Melospiza*

melodia, Fig. 4) varied little as the morning progressed.

All-day activity

Activity measured by point counts.—The results of five all-day series of 20-minute point counts are summarized in Figure 5. The counts were conducted on 12, 13, 15, 19, and 20 July 1980 from a single point on the Patuxent River bluff near Laurel, Maryland. Local sunrise during this period ranged from 04:53 to 04:59, E.S.T., sunset from 19:30 to 19:34. Minimum temperatures at the observation point in the woods ranged from 16° to 21°C on these five days and maxima ranged from 26° to 33° (3.5°C above normal). Figure 5A shows the mean number of singing males (and 95% confidence limits) recorded per 20-minute period. Figure 5B shows (with 95% confidence limits) the number of species recorded per 20-minute period (light line, above) and per 5-minute period (heavy line, below). Figure 5C indicates the mean number of individuals observed per 5-minute period.

Singing activity was at a morning peak from 05:00 to 07:00, declined 37 percent by noon, then rose gradually to a brief evening peak. The number of species recorded per 20 minutes peaked at 06:00, declined to a low five hours later and maintained about the same level for the rest of the day; there was no evening peak in number of species observed. Each 20-minute observation period was broken into four 5-minute segments. The 5-minute counts, although lower than the 20-minute counts, were more consistent throughout the morning, but dropped more rapidly in the afternoon. The number of species recorded was lowest at 13:00, E.S.T. The mean number of individuals per 5-minute period had a broad morning peak, 06:00–09:00, then decreased gradually to a low at 17:00 before recovering for the evening peak. Broadness of the morning peak results from the greater likelihood of detecting more individuals in 5 minutes versus the 3-minute interval used in the BBS.

Because the number of individuals detected at a single point is too small to show all-day activity levels for most species, only a few representative species are considered. Singing patterns (5-day means of 20-minute totals) are shown in Figure 6 for the Wood Thrush, Scarlet Tanager, and Cardinal. Note the prominent evening peak for Wood Thrush, the early morning peak for the Cardinal (see also Fig. 4), the brief pre-dawn peak for the Scarlet Tanager followed by the sunrise low (see Table 1), and the evening peak for this same species. Note also that the lowest counts in mid-day did not coincide.

Activity detected by banding.—Systematic use of Japanese mist nets (within 2 m of the ground) reveals a very different diurnal activity

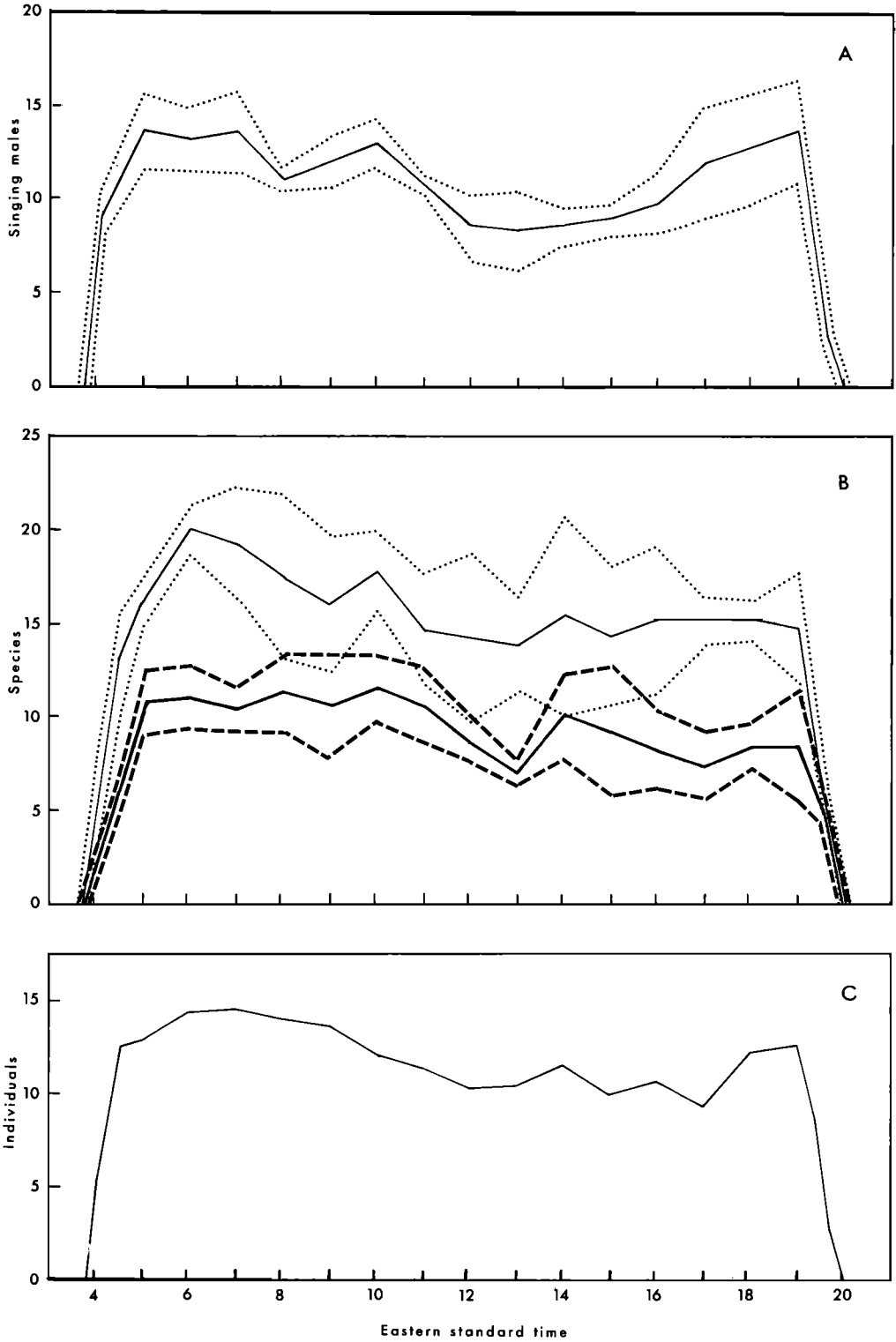


FIGURE 5. All-day activity patterns from point counts on five mid-July days. A. Singing males per 20 minutes. B. Total species per 20 minutes (above) and per 5 minutes (below) with 95% confidence limits. C. Total individuals per 5 minutes.

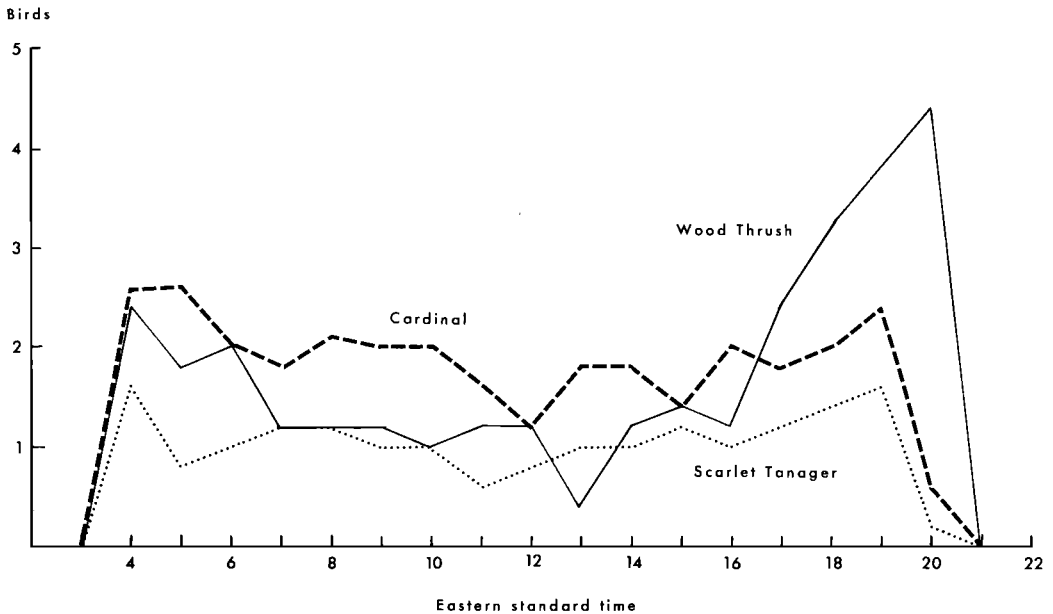


FIGURE 6. Singing patterns of three species from 20-minute point counts on hot days in mid-July (5-day means).

period than that observed by the census taker. Capture totals for 14 species are shown by one-hour intervals in Figure 7. Note the high early peaks for the thrushes, waterthrushes, and most of the other warblers, and the rapid decline that follows. Note also that even for the Wood Thrush there is only a very minor recurrence of activity in the evening, and the pattern for the day is almost the reverse of the singing activity shown in Figure 4. Woodpeckers, titmice, and flycatching birds, on the other hand, remained active through most of the day. Patterns for summer resident species were very similar to those for close relatives that occurred only as transients (see thrushes and waterthrushes, Fig. 7).

WINTER SEASON

A comparison of breeding season and winter activity is presented in Figures 3 and 4. The breeding season figures are the percentages of total birds recorded in each of the five 10-stop BBS intervals. The winter figures are percentages recorded in each of the four one-hour Winter Bird Survey intervals starting at sunrise. Be-

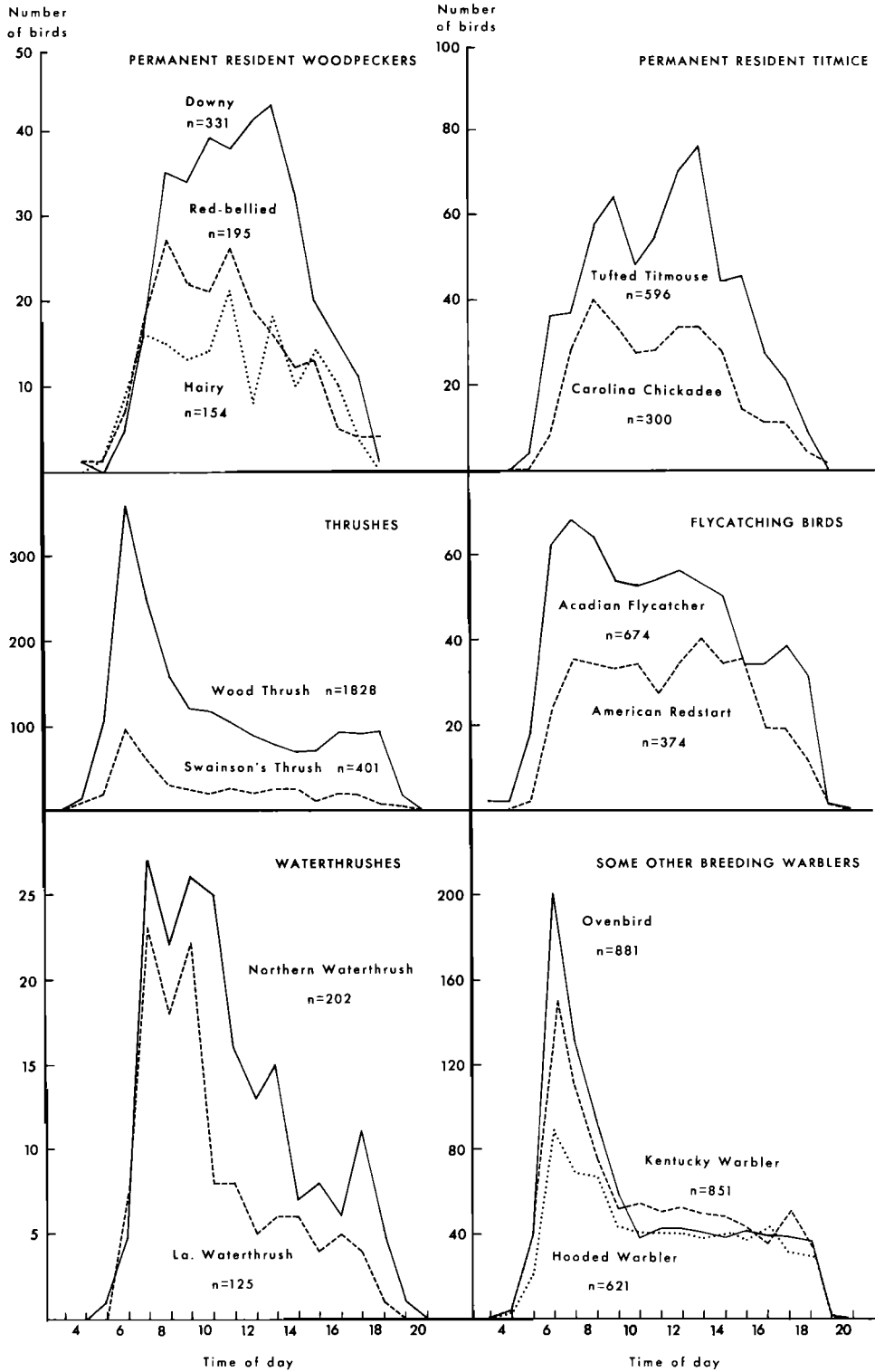
cause of the difference in number of intervals, the breeding season data (solid lines) are centered about a mean of 20%, while the winter data are centered about a mean of 25%. Thus it is the shape, not the position of the line that is important. As in the breeding season, the Mockingbird demonstrates fairly constant activity through the morning. The Turkey Vulture in both winter and summer becomes progressively more active as the morning progresses. Most other species in Figure 3 are more frequently recorded in the first hour in winter than in summer, indicating the greater importance of early censusing in winter. The high early morning count of Starlings in winter is probably related to dispersal from their roosts. Fringillids, unlike most other families, show a low count in the first hour in winter; but when all species are considered (Fig. 4), the first hour after sunrise is by far the most productive.

DISCUSSION

There are remarkably few literature references to effect of time of day on conspicuousness or on singing activity of North American birds other than the beginning of dawn song.

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FIGURE 7. Activity patterns from all-day mist netting during the breeding season. Scientific names not in the text are: Hairy Woodpecker (*Picoides villosus*), Downy Woodpecker (*P. pubescens*), Ovenbird (*Seiurus aurocapillus*), Northern Waterthrush (*S. noveboracensis*), Kentucky Warbler (*Oporornis formosus*), Hooded Warbler (*Wilsonia citrina*), and American Redstart (*Setophaga ruticilla*).



Nice (1964) made an all-day count on 11 May 1935 of 2305 songs from one Song Sparrow that had lost its mate four days before; these showed a peak of 278 and 277 songs in the first two hours beginning at 04:45, the time of the first song. After seven hours with totals of 200 or more songs each, the subsequent hourly totals were 150, 182, 121, 60, 52, 16, 12, and 20. This early morning breeding season activity is similar to that shown in Figure 4. Fortunately, point counts, especially those that last as much as 20 minutes, do not register nearly as sharp a decline as do the number of songs given.

Mayfield (1960) gave 5-minute song counts for a Kirtland's Warbler (*Dendroica kirtlandii*) on 21 June 1956, one day before its first egg hatched. When converted to 05:00 sunrise for comparison with the BBS data, there were 80 (7%) songs in the hour centered at sunrise, and 156 (14%), 291 (27%), 271 (25%), and 287 (26%) in the next four hours. Unfortunately, there are no BBS data for this species; but other *Dendroica* warblers do not have such low detectability in the first one or two hours. Again, the point counts are less sensitive to changes in singing intensity than are counts with shorter exposure to each individual bird. Note also that total individuals decline much more slowly on 20-minute point counts (Fig. 5C) than on 3-minute BBS stops (Fig. 1) as the morning progresses. Saunders' (1929:67) statement that "song in the middle of a hot day in June or July is a rarity" should not be taken literally in view of the results of 20-minute point counts made on five abnormally hot days in mid-July (Fig. 5A). It must be kept in mind, however, that even though some birds, such as vireos, orioles, tanagers and finches, continue to sing at least occasionally through the middle of the day, others

such as pheasants, doves, thrashers, gnatcatchers, and many of the warblers may sing very little after mid-morning, especially in the latter part of the breeding season (late June and July).

CONCLUSIONS

When large amounts of data are examined, diurnal activity patterns are consistent from year to year. These patterns vary with species, but birds in the same genus tend to have similar patterns.

Most of the species that are detected primarily by voice are recorded in largest numbers in the hour centered at sunrise or the next hour following; after that they are less frequently detected as the morning progresses. Birds frequently detected by sight show less decline later in the morning than do species detected by ear.

Activity patterns can be used in planning field work so as to concentrate censusing during periods of maximum activity or of most consistent activity. When, because of weather delays or insufficient field personnel, it is necessary to conduct some censusing during other than the most productive early morning hours, slower walking or longer listening periods can compensate in part for decreasing bird activity. In some instances, knowledge of activity patterns may be helpful in adjusting census data to account for time of day, especially when very large samples are involved.

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