Geographic Distributions and Patterns of Relative Abundance of Wisconsin Birds: A WSO Research Project

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Since 1982 the Wisconsin Society for Ornithology (WSO) has sponsored a research project that involves the analysis of weekly checklist-records from cooperating birdwatchers around the state (Temple 1982). In the first phase of our analysis of these checklist-records, we showed that they were sensitive indicators of changes in the seasonal abundance of birds (Temple and Temple 1984). In this, the second, phase of our analysis, we shall demonstrate that the checklist-records can also be used: (1) to construct range maps for Wisconsin birds and (2) to reveal geographic patterns of relative abundance within each species' range. We shall also show that the geographic patterns of relative abundance revealed by the checklist data can be correlated with general geographic patterns of habitat types of Wisconsin.

METHODS

Beginning in 1982, cooperating members of WSO have voluntarily kept weekly checklist-records of the bird species they have detected in the regions where they watched birds. These weekly records, which are entered on special machine-readable forms, are automatically scanned and then stored on magnetic tape for subsequent computer analysis.

To construct range maps and reveal geographic patterns of relative abundance, we analyzed all of the accumulated records from January 1982 through April 1985. We defined 43 regions of the state (Figure 1), delimited so that we had at least 200 weekly checklist-records to analyze from each region. Most regions corresponded to a single county, but some were combinations of two to four counties. For each species of bird during a specific season of the year, we plotted the presence or absence of reports in each of the 43 regions. The resulting range maps show the regions of the state in which a particular bird had been reported during the specified months of the year.

For each of the regions in which the bird had been reported, we then calculated the regional reporting frequency (the percentage of checklists from the region on which the species had been reported). We also calculated the overall statewide reporting frequency for the species in all of the regions in which the species had been reported. If the regional reporting frequency for a particular region was greater than the overall statewide reporting frequency, we assumed that the species was relatively more abundant there than in regions for which the regional reporting frequency was less than the statewide reporting frequency. For each bird we indicated, on the already prepared range map, the regions in which the bird was either more abundant or less abundant than the statewide average. The final result was a range map that also showed the regions of the state in which the particular species of bird was relatively common or uncommon.

We performed the above analysis on the checklist-records for 23 combinstions of bird species and seasons of the year that were, *a priori,* thought to show interesting patterns.

Finally, in each of these 23 particular cases, we tried to interpret the patterns of relative abundance in terms of general geographic and ecological

Figure 1. The 43 regions of the state used to analyze patterns of geographic distribution and relative abundance of Wisconsin birds.

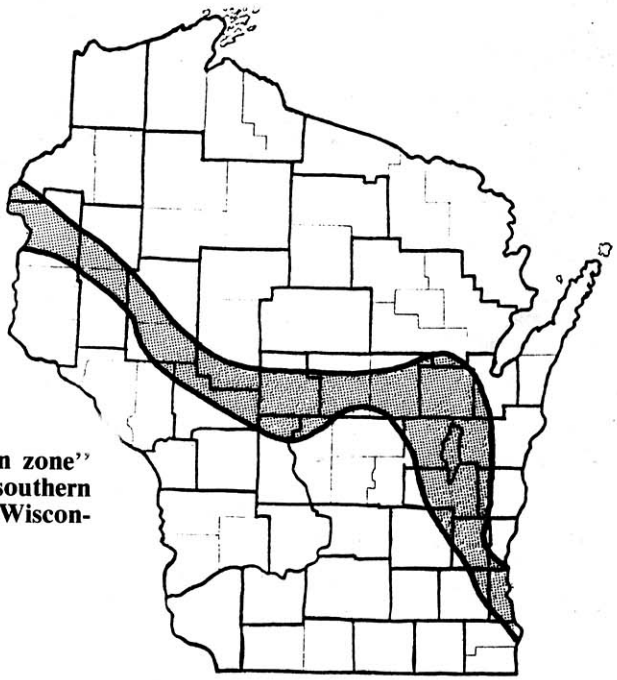


Figure 2. The "tension zone" between northern and southern forest communities in Wisconsin (after Curtis 1959).

characteristics that should play a role in determining the distribution and relative abundance of birds. For each of the 43 regions of the state, we determined the percentage of the region's total surface area that was covered by four major habitat types: (1) lakes and ponds, (2) fields, pastures, and prairies, (3) northern forest types (see Curtis 1958), or (4) southern forest types (see Curtis 1959). These statistics were taken from a variety of sources (e.g., State of Wisconsin 1984, U.S. Bureau of Census 1984, Spencer and Thorne 1972).

We looked for significant correlations — by calculating Spearman's rank correlation coefficients, r_s (Zar 1985) — between the reporting frequencies for a species in the regions and the percent area of each of the four major habitat types in the regions. Reporting frequencies for a bird that is typical of field habitat might, for example, be expected to show a positive correlation with the percent area of field in the regions and perhaps a significant negative correlation with the percent area of northern or southern forest. In this example, a significant positive correlation between reporting frequencies and the percent area of field habitat in the regions would indicate that reporting frequencies become progressively higher when there is more percent area of field in a region; a significant negative correlation between reporting frequency and percent area of forest in the regions indicates that reporting frequencies become progressively lower when there is more percent area of forest in a region.

We were particularly interested in geographic patterns of distribution and relative abundance that corresponded to the major change in plant communities that takes place across the "tension zone" of transition between northern type forests and southern type forests (Figure 2). Because many birds are closely associated with either northern or southern forests, we expected to find some species with geographic distributions and patterns of relative abundance that were truncated by the "tension zone."

RESULTS

Common Loon *(Gavia immer).*— The range map in Figure 3 shows the geographic distribution and relative abundance of loons in Wisconsin during the summer breeding season (July through September.) In general, it can be seen that loons were most abundant in the northern regions of the state. More specifically, the reporting frequency for loons was positively correlated with both percent area of water ($r_s = +0.370$, $P < 0.01$) and percent area of northern forest ($r_s = +0.549$, $P<0.001$) in the regions.

Red-tailed Hawk *(Buteo jamaicensis).*—The range map in Figure 3 shows the geographic distribution and relative abundance of Red-tailed Hawks in Wisconsin during the winter season (November through March). Red-tailed Hawks are most abundant in the southern regions of the state south of the "tension zone." The reporting frequency is positively correlated with percent area of field ($r_s = +0.406$, $P<0.005$) and percent area of southern forest ($r_s = +0.414$, $P<0.001$) but negatively correlated with the percent area of northern forest ($r_s = -0.480$, $P <0.001$) in the regions.

Broad-winged Hawk *(Buteo platypterus).*—The range map in Figure 3 shows the geographic distribution and relative abundance of Broad-winged Hawks in Wisconsin during the summer (June through August). Broad-winged Hawks are generally most abundant in the northern regions of the state. The reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.645$, $P<0.001$) and negatively correlated with the percent area of southern forest ($r_s = -0.381$, $P<0.01$) in the regions.

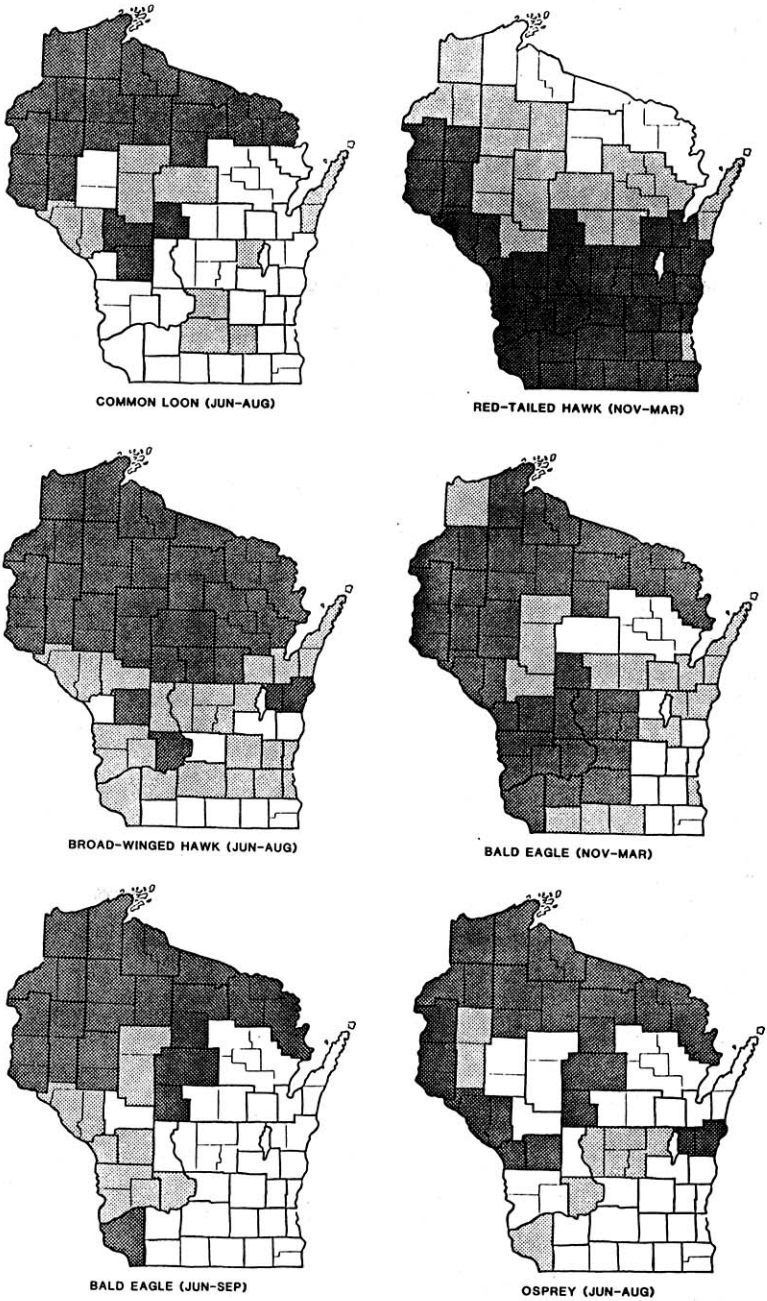


Figure 3. Range maps showing geographic distributions and patterns of relative abundance of birds in Wisconsin. In areas with dark stippling, the bird was reported more often than the statewide average within its range, in areas with light strippling, less often.

Bald Eagle *(Haliaeetus leucocephalus).*—The two range maps in Figure 3 show the geographic distribution and relative abundance of Bald Eagles in Wisconsin either during the summer (June through September) or during the winter (November through March). Bald Eagles are more widely distributed throughout the state in winter than in summer, but they are always more abundant in the northern regions of the state than in the south, with the exception of the winter concentrations in regions along the Wisconsin and Mississippi Rivers. During the summer the reporting frequency of eagles is positively correlated with the percent area of water ($r_s = +0.384$, $P<0.01$) and the percent area of northern forest ($r_s = +0.522$, $P<0.0005$) in the regions, but in winter there were no significant correlations between reporting frequencies and the geographical variables we analyzed. Almost certainly the distribution of eagles during the winter would be correlated with the percent area of open water in a region, but we have no statistics available on this variable.

Osprey *(Pandion haliaeetus).*—The range map in Figure 3 shows the geographic distribution and relative abundance of Ospreys in Wisconsin during the summer (June through August). Ospreys are restricted mainly to the northern regions of the state. The reporting frequency is positively correlated with the percent area of water ($r_s = +0.397$, $P<0.005$) and the percent area of northern forest ($r_s = +0.368$, $P<0.01$) in the regions.

Sandhill Crane *(Grus canadensis).*—The range map in Figure 4 shows the geographic distribution and relative abundance of Sandhill Cranes during the summer breeding season (May through August). Although widely distributed around the state, Sandhill Cranes are most abundant in the central regions where extensive, shallow-water wetlands provide nesting sites. Reporting frequencies are not correlated significantly with any of the four geographic variables we examined; other variables, such as percent area of wetland, are probably correlated, but we did not analyze these statistics.

Barred Owl *(Strix varia).*—The range map in Figure 4 shows the geographic distribution and relative abundance of Barred Owls in Wisconsin throughout the year. They are widely distributed throughout the state wherever forest cover is available. The reporting frequency is negatively correlated ($r_s = -0.308$, $P<0.05$) with the percent area of field in the regions, reflecting the owl's avoidance of regions with little forest cover.

Ruby-throated Hummingbird *(Archilochus colubris).*—The range map in Figure 4 shows the geographic distribution and relative abundance of hummingbirds in Wisconsin during the summer breeding season (June through August). Although widely distributed around the state, the hummingbird is most abundant in northern regions. The reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.608$, $P<0.0005$) in the regions.

Pileated Woodpecker *(Dryocopus pileatus).*—The range map in Figure 4 shows the geographic distribution of Pileated Woodpeckers in Wisconsin throughout the year. Although widely distributed around the state this woodpecker tends to be increasingly common as one moves northwestward through the state. The reporting frequency is positively correlated with the percent area in northern forest ($r_s = +0.453$, $P<0.0025$) in the regions.

Red-bellied Woodpecker *(Melanerpes carolinus).*—The range map in Figure 4 shows the geographic distribution and relative abundance of Red-bellied Woodpeckers in Wisconsin throughout the year. Although widely distributed around the state, it is most common south of the "tension

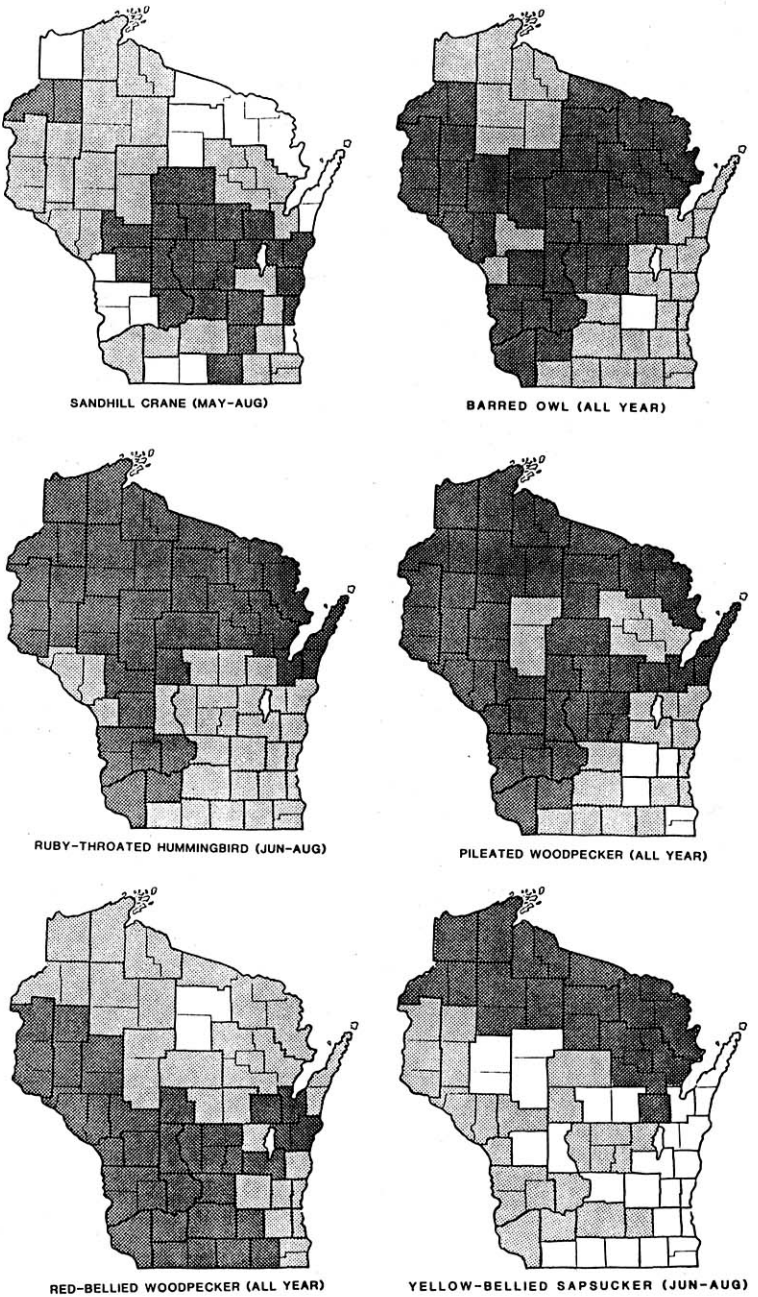


Figure 4. Range maps showing geographic distributions and patterns of relative abundance of birds in Wisconsin. In areas with dark stippling, the bird was reported more often than the statewide average within its range, in areas with light stippling, less often.

zone." The reporting frequency is positively correlated with the percent area of southern forest ($r_s = +0.467$, $P<0.001$) and percent area of field ($r_s = +0.616$, $P<0.005$) in the regions, suggesting an affinity to areas of broken fields and forest stands.

Yellow-bellied Sapsucker *(Sphyrapicus varius).*—The range map in Figure 4 shows the geographic distribution and relative abundance of Yellow-bellied Sapsuckers in Wisconsin during the breeding season (June through August). The sapsucker is most abundant north of the "tension zone." Its reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.551$, $P<0.005$) and negatively correlated with the percent area of southern forest ($r_s = -0.331$, $P< 0.05$) in the regions.

Cliff Swallow *(Hirundo pyrrhonota).*—The range map in Figure 5 shows the geographic distribution and relative abundance of Cliff Swallows in Wisconsin during the summer breeding season (June through August). Although widely distributed around the state Cliff Swallows are most abundant north of the "tension zone." The reporting frequency was positively correlated with the percent area of northern forest ($r_s = +0.466$, $P<0.001$) in the regions.

Tufted Titmous *(Parus bicolor).*—The range map in Figure 5 shows the geographic distribution and relative abundance of the Tufted Titmouse in Wisconsin throughout the year. The titmouse is restricted to areas south of the "tension zone" between northern and southern forest regions. The reporting frequency is positively correlated with the percent area of southern forest ($r_s = +0.481$, $P<0.001$) and negatively correlated with the percent area of northern forest ($r_s = -0.459$, $P<0.0025$) in the regions.

Brown Creeper *(Certhia familiaris).*—The range map in Figure 5 shows the geographic distribution and relative abundance of Brown Creepers during the summer breeding season (June through September). The creeper is most abundant in regions north of the "tension zone." Its reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.562$, $P<0.0005$) and negatively correlated with the percent area of southern forest ($r_s = -0.582$, $P<0.0005$) in the regions.

House Wren *(Troglodytes aedon).*—The range map in Figure 5 shows the geographic distribution and relative abundance of House Wrens in Wisconsin during the summer breeding season (May through August). This wren is widely distributed throughout the state but is most abundant south of the "tension zone." Its reporting frequency is positively correlated with the percent of southern forest ($r_s = +0.345$, $P<0.05$) and the percent area of fields ($r_s = +0.497$, $P<0.0005$) but negatively correlated with the percent area of northern forest ($r_s = -0.443$, $P<.0025$). This pattern is in keeping with the wren's habitat preference for southern forest edges adjacent to fields.

Ovenbird *(Seiurus aurocapillus).*—The range map in Figure 5 shows the geographic distribution and relative abundance of Ovenbirds in Wisconsin during the summer breeding season (June through August). Ovenbirds are widely distributed throughout the state but most abundant north of the "tension zone." Its reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.604$, $P<0.0005$) in the regions.

Northern Cardinal *(Cardinalis cardinalis).*—The range map in Figure 5 shows the geographic distribution and relative abundance of Northern Cardinals in Wisconsin throughout the year. Although widely distributed

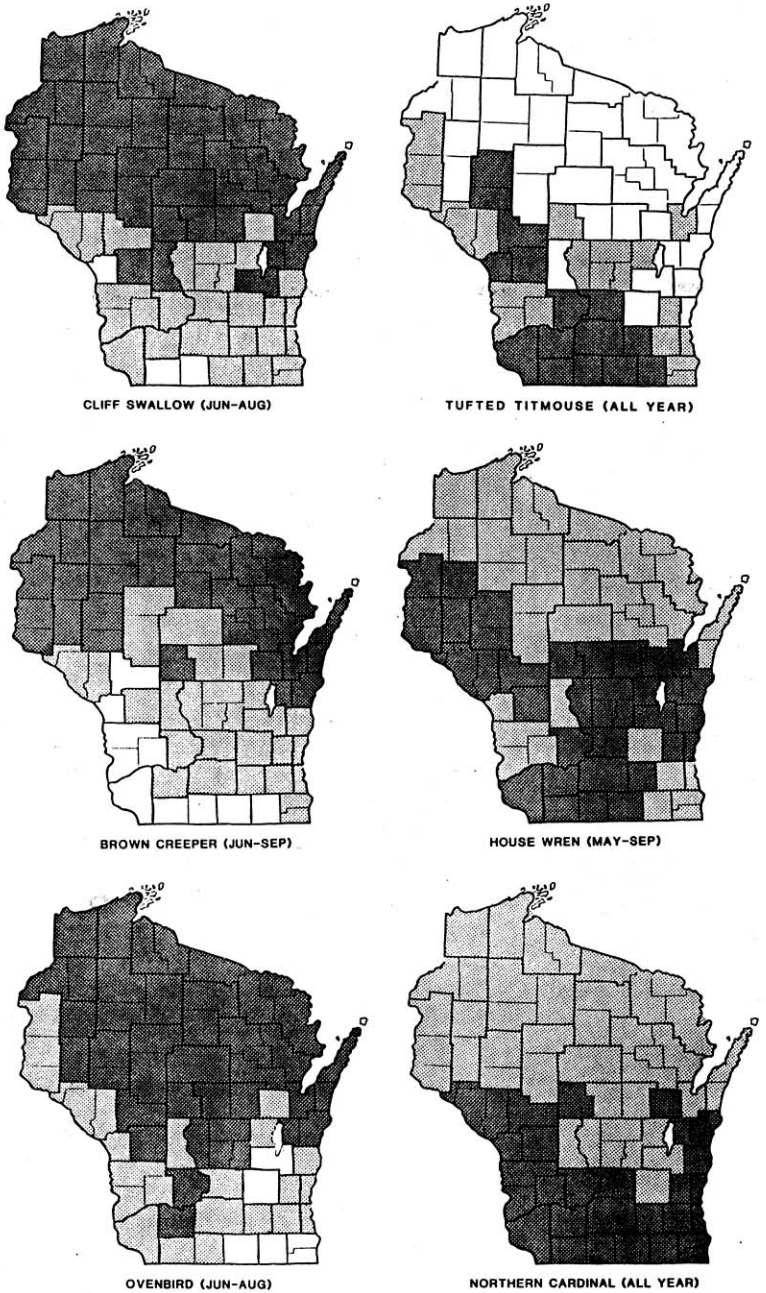


Figure 5. Range maps showing geographic distributions and patterns of relative abundance of birds in Wisconsin. In areas with dark stippling, the bird was reported more often than the statewide average within its range, in areas with light stippling, less often.

throughout the state, the cardinal is most abundant south of the "tension zone." Its reporting frequency is positively correlated with the percent area of southern forest ($r_s = +0.374$, $P < 0.01$) and negatively correlated with the percent area of northern forest ($r_s = -0.655$, $P < 0.0005$) in the regions.

Purple Finch *(Carpodacus purpureus).*—The range map in Figure 6 shows the geographic distribution and relative abundance of Purple Finches in Wisconsin during the summer breeding season (June through August). The Purple Finch is found primarily north of the "tension zone." Its reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.706$, $P < 0.0005$) and negatively correlated with the percent area of southern forest ($r_s = -0.427$, $P < 0.0025$) in the regions.

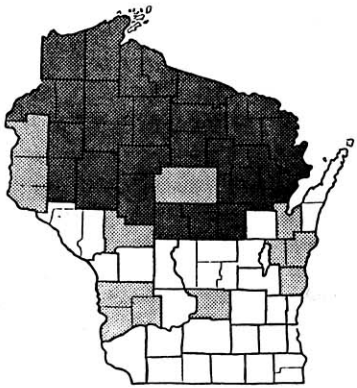
Field Sparrow *(Spizella pusilla).*—The range map in Figure 6 show the geographic distribution and relative abundance of Field Sparrows in Wisconsin during the summer breeding season (June through August). Although Field Sparrows are widely distributed throughout the state, they are far more abundant south of the "tension zone." The reporting frequency is positively correlated with the percent area of fields ($r_s = +0.367$. $P < 0.01$) and percent area of southern forests ($r_s = +0.427$, $P < 0.0025$) but negatively correlated with the percent area of northern forest ($r_s = -0.385$, $P < 0.01$) in the regions.

Dark-eyed Junco *(Junco hyemalis).*—The range map in Figure 6 shows the geographic distribution and relative abundance of Dark-eyed Juncos in Wisconsin during either the summer breeding season (June through August) or the winter season (October through March). An interesting seasonal reversal of geographic distributions occurs as a result of migration movements. During the summer, juncos are found only north of the "tension zone," but during the winter they are found throughout the state and most commonly south of the "tension zone." During the summer the reporting frequency is positively correlated with the percent area of northern forest ($r_s = +0.567$, $P < 0.005$) and negatively correlated with the percent area of southern forest ($r_s = -0.560$, $P < 0.0005$) in the regions. During winter the reporting frequency is negatively correlated with the percent area of northern forest ($r_s = -0.391$, $P < 0.005$) in the regions.

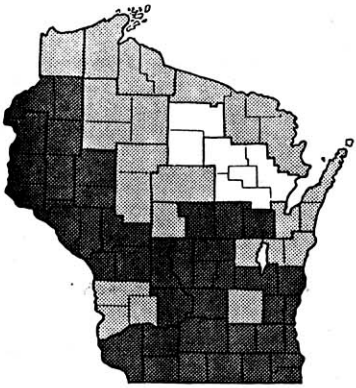
White-throated Sparrow *(Zonotrichia albicollis).*—The range map in Figure 6 shows the geographic distribution and relative abundance of White-throated Sparrows in Wisconsin during the summer breeding season (June through August). This sparrow is restricted to regions north of the "tension zone." Its reporting frequency is positively correlated with percent area of northern forest ($r_s = +0.494$, $P < 0.0005$) and negatively correlated with the percent area of southern forest ($r_s = -0.424$, $P < 0.0025$) in the regions.

DISCUSSION

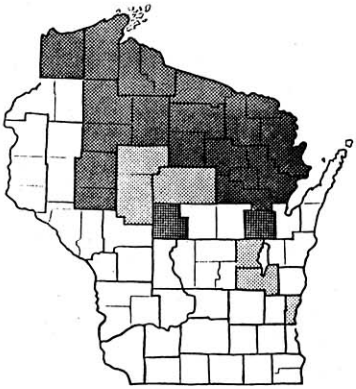
The range maps and patterns of relative abundance derived from analyses of weekly checklist-records are apparently good indicators of the geographic distribution and relative abundance of birds in Wisconsin. In some cases, we can compare the results of the analysis of checklist-records with other indications of the geographic distribution and relative abundance of birds. We can, for example, compare the geographic patterns of relative abundance of selected winter birds derived from the checklist-records with the geographic patterns of relative abundance suggested by the number of individuals of the same species reported on the 1984 Christmas Bird Counts (Hilsenhoff 1985). By segregating Christmas Bird Counts into the 43 regions used in the checklist analysis, we could calculate Spearman rank



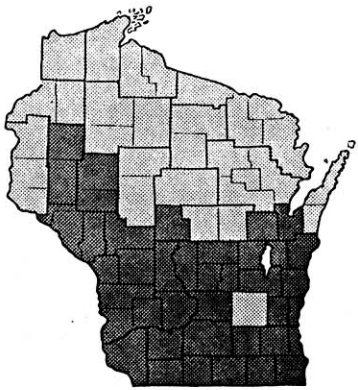
PURPLE FINCH (JUN-AUG)



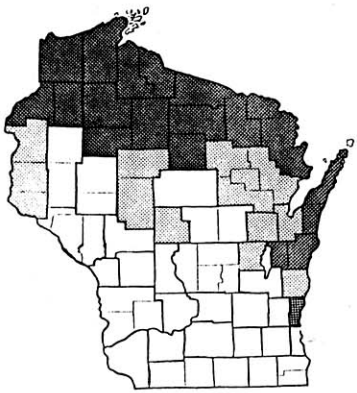
FIELD SPARROW (JUN-AUG)



DARK-EYED JUNCO (JUN-AUG)



DARK-EYED JUNCO (OCT-MAR)



WHITE-THROATED SPARROW (JUN-AUG)

Figure 6. Range maps showing geographic distributions and patterns of relative abundance of birds in Wisconsin. In areas with dark stippling, the bird was reported more often than the statewide average within its range, in areas with light stippling, less often.

correlation coefficients between the two indicators of regional abundance. We analyzed winter checklist data for 5 species: Red-tailed Hawk, Bald Eagle, Kestrel, Brown Creeper, and Dark-eyed Junco. The correlation between the percentage of all birds seen on 1984 Christmas Bird Counts in the 43 regions that were Red-tailed Hawks and the checklist reporting frequencies for those regions was very high and positive ($r_S = +0.613$, $P < 0.0005$), indicating a close agreement between the two indices of geographic patterns of relative abundance. Similarly, high positive correlations existed between Christmas Bird Count records and checklist-records for Bald Eagles ($r_S = +0.540$, $P < 0.0005$), Kestrels ($r_S = +0.706$, $P < 0.0001$), Brown Creepers ($r_S = +0.313$, $P < 0.05$), and Dark-eyed Juncos ($r_S = +0.431$), $P < 0.0025$). These close agreements between the two indices of geographic patterns of relative abundance of winter birds is an encouraging indication that the patterns are real and not artifacts of the ways in which the respective data are recorded.

The Sandhill Crane provides another case in which the results of our analysis of checklist data can be compared with other independent indicators of geographic distribution and relative abundance. The 1984 Sandhill Crane count, sponsored by the International Crane Foundation (see **Passenger Pigeon** 47:41), provides information on the number of cranes in each of 59 counties. We found a significant positive correlation ($r_S = +0.698$, $P < 0.0005$) between the numbers of cranes counted in a region and the regional reporting frequencies from checklist records. Again, this strong positive correlation suggests that the counts and the checklists are measuring the same characteristics of the crane population.

ACKNOWLEDGMENTS

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