Local Changes in a Breeding Bird Community following Forest Disturbance (Cambios Locales en Una Comunidad de Aves en Reproduccion Tras un Disturbio Forestal)

Author(s): Grant E. Canterbury and David E. Blockstein

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LOCAL CHANGES IN A BREEDING BIRD COMMUNITY FOLLOWING FOREST DISTURBANCE

GRANT E. CANTERBURY[1] AND DAVID E. BLOCKSTEIN[2]

Department of Ecology, Evolution, and Behavior
University of Minnesota
Saint Paul, Minnesota 55108 USA

Abstract.—Species composition and population sizes of breeding birds changed substantially in less than 10 yr following local disturbances in a mixed deciduous forest plot in Itasca State Park, northern Minnesota. Dutch elm disease, drought, and windstorms changed a closed-canopy elm-birch-ash forest to a more open habitat dominated by basswood, ash, and standing snags with large areas of dense fern cover. Breeding bird censuses conducted in 1979–1981 and 1990–1992 showed substantial changes in local populations of several species including Ovenbirds (*Seiurus aurocapillus*) (20.0 territories/10 ha in 1979–1981 to 1.6 in 1990–1992), Veeries (*Catharus fuscescens*) (4.1 to 0.9), Mourning Warblers (*Oporornis philadelphia*) (0.7 to 5.5), Song Sparrows (*Melospiza melodia*) (0.0 to 6.4), and White-throated Sparrows (*Zonotrichia albicollis*) (0.0 to 7.1). These changes were related to increased density of ground vegetation and increased light levels. Spatial distribution of species showing major increases was strongly associated with the locations of patches of dense undergrowth. Arboreal species showed less population change between census periods than did ground foragers. These local population changes were unrelated to trends over the same period on a 15-km roadside survey in the park. Changes in species abundance on the plot appear to be caused by local habitat change rather than broader-scale processes.

CAMBIOS LOCALES EN UNA COMUNIDAD DE AVES EN REPRODUCCION TRAS UN DISTURBIO FORESTAL

Sinopsis.—La composición de especies y los tamaños poblacionales cambiaron sustancialmente en menos de 10 años tras disturbios locales en una parcela de bosque deciduo mixto en el Bosque Estatal de Itasca, en el norte de Minnesota. La plaga del Olmo Holandés, la sequía, y las tormentas de viento tornaron el dosel cerrado del bosque de *Ulmus, Betula* y *Fraxinus* en un habitat más ablerto dominado por *Tilia, Fraxinus* y tocones, con grandes areas densamente cubiertas de helechos. Censos de aves en reproducción conducidos entre 1979 y 1981 y entre 1990 y 1992 muestran cambios sustanciales en las poblaciones locales de varias especies incluyendo *Seiurus aurocapillus* (de 20.0 territorios/10 ha entre 1979 y 1981 a 1.6 entre 1990 y 1992), *Catharus fuscescens* (4.1 a 0.9), *Oporornis philadelphia* (0.7 a 5.5), *Melospiza melodia* (0.0 a 6.4) y *Zonotrichia albicollis* (0.0 a 7.1). Estos cambios se relacionan con un incremendo en la densidad de vegetación de suelo y aumento en los niveles de luz. La distribución espacial de las especies mostrando incrementos mayores fué asociada fuertemente con la localización de parchos de sotobosque denso. Las especies arbóreas mostraron menos cambios poblacionales entre los períodos de censo que las especies que se alimentan en el suelo. Estos cambios poblacionales locales no fueron relacionados a tendencias en muestreos llevados a cabo en el mismo parque en una vereda a 15 km a través del mismo período de tiempo. Los cambios en la abundancia de especies en la parcela parecen ser causados por cambios en el hábitat local más que por procesos de escala más amplia.

It is often unclear whether local population changes in migrant songbirds are primarily the result of habitat alterations within a site, broader-

[1] Current address: *U.S. Fish and Wildlife Service, 3310 El Camino Ave., Sacramento, California 95821 USA.*
[2] Current address: *Committee for the National Institute for the Environment, 1725 K Street NW, Suite 212, Washington, D.C. 20006-1401 USA.*

scale effects on the breeding grounds, changes in wintering habitat, or other factors. Long-term monitoring of bird populations and habitat structure is useful for detecting local population trends and suggesting the degree to which changes can be attributed to local factors. This study was conducted in a large forested park where an area that had previously been sampled quantitatively for birds and vegetation suffered a dramatic but localized forest disturbance. Subsequent sampling allowed us to determine how different bird species responded to the disturbance. By comparing results from this study site with population data from elsewhere in the park we assessed the effects of local habitat disturbance and larger-scale population changes on local bird population trends.

METHODS

We conducted this study on Bear Paw Point, 0.5 km south of the University of Minnesota Forestry and Biological Station in Itasca State Park. Clearwater County, Minnesota (47°10′N, 95°W). Itasca State Park is composed of 128 km^2 of largely unfragmented forest, with a diversity of forest types ranging from mature red pine (*Pinus resinosa*) and white pine (*P. strobus*) forests to stands of aspen (*Populus tremuloides*) and maple (*Acer saccharum*). The park contains over 40 lakes including Lake Itasca, the source of the Mississippi River. Bear Paw Point extends into Lake Itasca and is bordered in part by a floating bog. The peninsula was covered with a closed-canopy deciduous forest in 1979 when the study began (Ponto and Loeffler 1980).

In 1979 Frances James and her students established a number of Breeding Bird Census (BBC) plots in the park, including an 8.75-ha plot on Bear Paw Point. The plot boundaries were shifted slightly in 1980. This plot was censused in June and July 1979–1981 (Bell and Candee 1981, Nagel and Madsen 1982, Ponto and Loeffler 1980). In 1990 Blockstein and his students reestablished a plot on this site and expanded it to 11.5 ha, covering nearly the entire peninsula. The plot was censused in June and July 1990–1992 (Canterbury 1991, Iverson and Storbakken 1992, Schulte et al. 1993). An area of 7.25 ha, where all 1979–1981 and 1990–1992 plots overlapped, was surveyed during all six years. All data presented for Bear Paw Point in this paper are based on this 7.25-ha area of overlap, and population densities have been recalculated from original territory maps. An additional BBC plot (10 ha) was also established in mature aspen-maple forest in the park, approximately 7 km from Bear Paw Point (Lambert and Skiba 1992, Nyberg et al. 1993, Peterson 1991). This plot allows comparisons between bird communities on Bear Paw Point and a representative area of mature forest.

The census plots consisted of a rectangular grid with stations 50 m apart. Teams of two to three students conducted the census following standard BBC procedures (Van Velzen 1972). Eight visits were made each summer, in which the teams walked the grid lines and recorded all birds seen and heard. Territory boundaries were determined based on repeated occurrences and simultaneous singing. The number of bird territories

per plot gives a measure of population density. The standardized methodology of the BBC allows density estimates to be compared between different sites and between different years at the same site. However, variation among observers may have caused some biases in census results. To minimize these effects as much as possible, from 1990–1992 one or both authors worked closely with all students while censusing plots and determining territory boundaries. However, observer effects may be larger in comparisons between the 1979–1981 and 1990–1992 periods.

Species included here are limited to those with small (<2 ha), well-defined territories that can be easily delineated. Birds that were excluded include species with large poorly defined territories (e.g., hawks and woodpeckers), non-territorial species (e.g., swallows, cowbirds, finches), and early breeders, which often finished nesting before June (e.g., chickadees, nuthatches). Species for which fewer than four territories were found on Bear Paw Point over the six years of the study were also excluded from this analysis. Differences in population densities between 1979–1981 and 1990–1992 were expressed as percentage change. Statistical tests were not used to test significance of changes because densities estimate complete censuses of the plot and are not estimates of population levels within a larger spatial area.

We classified the bird species in the analysis by general habitat preference, using three categories: early successional species (characteristic of shrub thickets and open clearings), intermediate/generalist species (forest birds not strongly associated with closed-canopy forest-interior sites), and mature forest species (characteristic of continuous, closed-canopy forest). Classifications were based on studies at other locations in Itasca State Park (Canterbury 1993, Collins et al. 1982) and other studies of habitat associations (Bertin 1977, Collins 1983, Noon et al. 1980, Robbins et al. 1989).

Vegetation was surveyed quantitatively using the methods of James and Shugart (1970) and James (1980) in 1979, 1980, 1990 and 1992. Ten randomly placed 0.04-ha circular plots were evaluated for ground cover and canopy cover using an ocular tube. Shrub density was estimated from two transects across each plot. All trees with a dbh of at least 7.6 cm were recorded by species and diameter size class within each plot. Standard formulas were used to calculate tree density and dominance (James and Shugart 1970).

During five field seasons (1979–1981, 1990, and 1992), roadside surveys were conducted along the Wilderness Drive between Squaw Lake and Elk Lake in Itasca State Park (James, unpubl. data; Blockstein, unpubl. data). These surveys give additional information about forest bird communities on a broader geographic scale within the park. The habitat along the survey route is predominantly mature, unfragmented forest. Three-minute unlimited-radius point counts were done at 0.8 km intervals along the roadside, for a total of 15–19 points per survey. All counts were done between 0500–0900 h on dates ranging from 17 June to 8 July. For each species, the mean number of individuals detected per point count was

TABLE 1. Vegetation changes on Bear Paw Point from 1979–1992. Data from vegetation surveys are averaged from 1979 and 1980 to represent the first period of the study and from 1990 and 1992 for the second period. Data from each period represent 20 vegetation plots.

Vegetation parameters	Summer 1979 & 1980	Summer 1990 & 1992
Ground Cover	71%	87%
Shrub Stem Density (per ha)	2220	1460
Trees/ha (All Trees)	792	863
Trees/ha (Size A: 7.6–15.2 cm dbh)	234	499
Trees/ha (Size B: 15.2–22.9 cm dbh)	189	151
Trees/ha (Size C: 22.9–30.5 cm dbh)	271	95
Trees/ha (Size D: 30.5–38.1 cm dbh)	32	66
Trees/ha (Size E: 38.1–53.3 cm dbh)	65	47
Trees/ha (Size F: 53.3–66.6 cm dbh)	0	4
Trees/ha (Size G: 66.6–83.8 cm dbh)	0	3
Total Tree Basal Area (m^2/ha)	51.8	30.1
Snag Basal Area (m^2/ha)	3.5	10.8
Elm Basal Area (m^2/ha)	10.0	0.5
Black Ash Basal Area (m^2/ha)	8.5	5.3
Birch Basal Area (m^2/ha)	23.1	1.2

calculated for the 1979–1981 surveys (49 points) and 1990–1992 surveys (34 points). These roadside surveys do not allow estimates of population density and are thus not directly comparable to territory mapping data, but do give a rough index of population changes between the two survey periods along a large cross-section of the park. Local population trends on Bear Paw Point can be compared to these data.

RESULTS

Vegetation structure.—In 1979–1981, Bear Paw Point was covered by a closed-canopy forest dominated by American elm (*Ulmus americana*), black ash (*Fraxinus nigra*), and paper birch (*Betula papyrifera*). Elm, ash, and basswood (*Tilia americana*) were dominant in the understory. The ground cover was typical of mature forests—moderately open and dominated by blue cohosh (*Caulophyllum thalictroides*), horsetail (*Equisetum arvense*), and ostrich fern (*Matteucia struthiopteris*).

In the mid-1980s (between the census periods) the study area was subject to severe drought and strong wind storms. Dutch elm blight invaded the park, including the study area. These disturbances killed and felled many of the elms and birches. Basal area of living elms and birches declined dramatically (from 10.0 m^2/ha and 23.1 m^2/ha respectively to 0.5 m^2/ha and 1.2 m^2/ha) while standing dead trees increased from 3.5 m^2/ha to 10.8 m^2/ha.

The forest during the 1990–1992 censuses was thus quantitatively different from the previous period (Table 1). The disturbances left an open forest dominated by black ash and basswood. Elm and birch had declined to insignificance. The center of the plot was particularly open, with stand-

ing dead elms and some broken birch snags. Isolated trees remained, scattered through the canopy openings. The increased light availability caused dramatic changes in the ground flora as well. A dense growth of ostrich fern, reaching 1.5 m in height, covered most of the plot except for the remnant forest-interior areas. Nettles (*Urtica* spp.) and thistles (*Cirsium* spp.) also grew in following the disturbance. Because canopy gaps dominated the center of the plot, most of the plot now consisted of forest-edge habitat. This habitat was quite different from the continuous, mature forests of deciduous and pine trees that dominate the rest of the park.

Bird communities.—From 1979–1981 the most common birds in the Bear Paw Point plot were Red-eyed Vireos (averaging 23.4 territories/10 ha; scientific names of birds given in Table 3) and Ovenbirds (20.0/10 ha). Other common birds were Least Flycatchers (8.3/10 ha), Blackburnian Warbler (7.2/10 ha), Black-throated Green Warbler (5.5/10 ha), Great Crested Flycatcher (4.1/10 ha), and Veery (4.1/10 ha).

In 1990–1992, Red-eyed Vireos remained the dominant species on Bear Paw Point (averaging 33.5 territories/10 ha) followed by Common Yellowthroats (8.7/10 ha), White-throated Sparrows (7.2/10 ha), Song Sparrows (6.5/10 ha), and Black-throated Green Warblers (6.5/10 ha). The Ovenbird population in the study area had declined to 1.7 territories/10 ha (Table 2). Substantial declines were also observed in Veeries and Blackburnian Warblers. Mourning Warblers, Song Sparrows, and White-throated Sparrows had major increases. Of these three species, only Mourning Warblers were present in even one year (1981) during the first period. Less dramatic increases occurred in Red-eyed Vireos, Chestnut-sided Warblers, Common Yellowthroats, and Yellow-rumped Warblers. Population densities and trends calculated for the entire Bear Paw Point census plot (8.75 or 11.5 ha, depending on year) rather than the 7.25 ha area of overlap closely resembled the results above.

Bird populations on the 10-ha Mature Forest plot (Table 2) were dominated by Ovenbirds, Red-eyed Vireos, Veeries, and Black-throated Green Warblers. These species also dominated the roadside surveys during 1979–1981 and 1990–1992 (Table 3). Early successional species, with the exception of Common Yellowthroats, were relatively uncommon or absent in both the roadside surveys and the Mature Forest plot.

DISCUSSION

Although the species that showed declines on Bear Paw Point were all typical forest birds, there is no evidence of an overall decline of forest birds in the park (Blockstein 1991). Ovenbirds and Veeries, two species with dramatic local declines, continue to be abundant in the park. Along with Red-eyed Vireos, they were among the most common species in roadside breeding bird surveys in 1979–1981 and in 1990–1992 (Table 3). In fact, the roadside surveys suggest an increase in Veeries and Ovenbirds between 1979–81 and 1990–1992. Thus, their virtual disappearance from

TABLE 2. Population densities of major bird species on Bear Paw Point plot (7.25 ha) and Mature Forest plot (10.0 ha). Species are grouped by habitat preference. Species with <4 territories found during six seasons on Bear Paw Point are excluded.

Species	Territories/10 ha on Bear Paw Point						Percent change in population density (1979–1981 to 1990–1992)	Territories/10 ha Mature Forest plot (mean 1990–1992)
	1979	1980	1981	1990	1991	1992		
EARLY SUCCESSIONAL SPECIES								
Chestnut-sided Warbler	1.4	1.4	0	1.4	0	5.5	+150%	1.5
Mourning Warbler	0	0	2.1	5.5	6.9	4.1	+700%	0
Common Yellowthroat	4.8	2.8	0	4.8	11.7	5.5	+190%	3.5
Song Sparrow	0	0	0	3.4	7.6	8.3	—[a]	0.3
White-throated Sparrow	0	0	0	9.0	8.3	4.1	—[a]	0
INTERMEDIATE/GENERALIST FOREST SPECIES								
Great Crested Flycatcher	4.1	5.5	2.8	3.4	2.8	5.5	−5%	2.7
Least Flycatcher	5.5	6.9	12.4	0	2.8	6.2	−64%	0.3
Red-eyed Vireo	29.7	22.8	17.9	24.1	38.6	37.9	+43%	25.3
Yellow-rumped Warbler	0.7	0	0	0	2.1	2.8	+600%	0
Blackburnian Warbler	7.6	5.5	8.3	1.4	1.4	4.8	−42%	0
Black-throated Green Warbler	9.7	5.5	1.4	7.6	4.8	6.2	+12%	8.5
American Redstart	4.1	4.8	1.4	2.8	0	4.8	−27%	2.3
Northern Oriole	0.7	2.1	0	0	1.4	1.4	+0%	0
MATURE FOREST SPECIES								
Winter Wren	4.1	3.4	0	1.4	0	0	−82%	0
Veery	4.8	2.1	5.5	1.4	0	1.4	−78%	7.2
Black-and-white Warbler	2.1	1.4	2.1	0	2.8	1.4	−25%	0
Northern Parula	5.5	0	4.1	2.1	2.1	4.1	−14%	0
Ovenbird	24.8	13.8	21.4	1.4	1.4	2.1	−92%	19.8

[a] Occurred on plot during 1990–1992 but not during 1979–1981: percentage change undefined.

TABLE 3. Roadside survey results from Itasca State Park Wilderness Drive.

Species	Mean number of individuals per survey point	
	1979–1981 (n = 49 points)	1990 & 1992 (n = 34 points)
Least Flycatcher, *Empidonax minimus*	0.31	0.44
Great Crested Flycatcher, *Myiarchus crinitus*	0.12	0.35
Winter Wren, *Troglodytes troglodytes*	0.06	0.06
Veery, *Catharus fuscescens*	0.49	1.15
Red-eyed Vireo, *Vireo olivaceus*	1.49	1.85
Northern Parula, *Parula americana*	0.12	0.18
Chestnut-sided Warbler, *Dendroica pensylvanica*	0.14	0.24
Yellow-rumped Warbler, *Dendroica coronata*	0.04	0.03
Black-throated Green Warbler, *Dendroica virens*	0.39	0.38
Blackburnian Warbler, *Dendroica fusca*	0.10	0.09
Black-and-White Warbler, *Mniotilta varia*	0.02	0.00
American Redstart, *Setophaga rutacilla*	0.08	0.32
Ovenbird, *Seirus aurocapillus*	1.14	1.68
Mourning Warbler, *Oporornis philadelphia*	0.04	0.00
Common Yellowthroat, *Geothlypis trichas*	0.57	0.44
Song Sparrow, *Melospiza melodia*	0.14	0.18
White-throated Sparrow, *Zonotrichia albicollis*	0.04	0.06
Northern Oriole, *Icterus galbula*	0.04	0.03

Bear Paw Point was a local phenomenon, almost certainly related to habitat change within the plot.

Ovenbirds are forest interior specialists that typically forage and nest on the ground in open leaf litter (Smith and Shugart 1987). These birds declined when the opening of the canopy and increased density of ground cover made that foraging substrate unavailable. Ovenbirds are known to be sensitive to forest fragmentation and are vulnerable to brood parasitism by Brown-headed Cowbirds (Brittingham and Temple 1983), which were observed intermittently on Bear Paw Point. The few remaining Ovenbirds in 1990–1992 were located in the remnants of interior forest (50–100 m from edges) and did not settle in closed-canopy forest that was near an edge. Veeries are also ground-foragers that prefer closed-canopy forest (Bertin 1977) and probably declined on the plot for similar reasons.

The cause of the local decline of Least Flycatchers is less clear. Habitat changes might have contributed to the decline by reducing availability of foraging perches. However, BBC data for this species may not accurately reflect changes in habitat quality or background population levels. Least Flycatchers have a semi-colonial territorial system (Sherry and Holmes 1985); territories tend to be clumped rather than being randomly or regularly distributed. Populations within the restricted area of a census plot may vary from year to year because of the presence or absence of a single colony, although regional population levels and the suitability of local habitat may not have changed. The absence of Least Flycatchers

from the plot in 1990 led Blockstein (1991) to speculate about a larger decline as has been indicated from national Breeding Bird Survey data (Droege and Sauer 1990). However, Least Flycatchers returned to the plot in 1991 and 1992. The data from local roadside surveys (Table 3) do not suggest a general decline within the park during the 1980s.

The other species that showed substantial declines on Bear Paw Point during the 1980s were generally forest species (Winter Wren, Blackburnian Warbler, Black-and-white Warbler, American Redstart). None showed notable declines in the roadside surveys; thus local habitat disturbance remains a plausible explanation for the population changes on Bear Paw Point.

In contrast, the species that increased most dramatically on Bear Paw Point during the 1980s (Mourning Warbler, White-throated Sparrow, Song Sparrow) are early-successional species that typically forage and nest in shrubby clearings and dense ground cover. The territories of all three were concentrated in this habitat type through the open central area of the plot, and showed dramatic increases in density compared to the 1979–1981 censuses. However, the roadside surveys did not indicate a clear population increase in any of these species within the park (Table 3). The changes in population density within the plot can thus be reasonably attributed to local habitat changes.

Common Yellowthroats and Chestnut-sided Warblers, which had less dramatic local population increases, are also typical of early-successional habitats and may have responded to forest disturbance in the plot. Red-eyed Vireos and Yellow-rumped Warblers are both generalist forest species in Itasca State Park. The local increases in their populations might be linked to local habitat changes or could simply be random fluctuations. Red-eyed Vireos showed a moderate increase in the roadside surveys. It is possible but not certain that their local population increase was linked to a broader-scale increase in the park.

The bird community within the 10-ha mature forest plot (Table 2) was generally similar to the pre-disturbance avifauna on Bear Paw Point (dominated by Ovenbirds, Red-eyed Vireos, Black-throated Green Warblers, Veeries, etc.), although a few species such as Blackburnian Warblers and Winter Wrens were absent. The dominant species were similar to those identified in the roadside surveys, and such mature-forest bird communities are typical of the unfragmented forest landscape within the park.

The forest bird community in the park as a whole does not appear to be altered from the late 1970s. The dominant bird species in the park (Red-eyed Vireo and Ovenbird) have remained the same during that time. There is no evidence of a general parkwide decline in bird populations in general or Neotropical migrants in particular. Songbird population densities in the park are unusually high compared to figures from other BBCs in deciduous forests. The abundance of forest-interior birds within the park contrasts sharply with censuses in more fragmented habitats (see Askins et al. 1990). One would expect the park to retain stable populations for some time if general declines occurred in forest birds,

because a smaller population would abandon marginal fragmented habitat before disappearing from high-quality habitat. Significant declines in forest species within the park itself would indicate a serious problem, and continuation of the BBC plots within the park would be useful for monitoring population levels to detect such declines.

In general, it is reasonable to attribute the changes in the bird community of Bear Paw Point over the last decade mostly to local habitat changes rather than to population fluctuations on a broad geographic scale. Local changes in community composition were usually not reflected in parkwide trends. In addition, the direction of most population responses could be explained by considering local habitat changes with the foraging and nesting requirements of each species. Although ground-foraging species responded strongly to the habitat changes, canopy species showed a mixture of moderate increases and decreases without a predictable pattern, perhaps because scattered canopy trees and snags remained in the open areas. This effect may be typical of population responses to patchy natural disturbances where trees are not cut and removed.

The dramatic local habitat changes in this study were caused by weather and disease rather than direct anthropogenic effects such as logging and agriculture. The forests of Itasca State Park are nearly unaffected by human activities other than fire suppression. The Bear Paw Point plot is thus representative of a bird community's response to a natural dynamic pattern of patchy local disturbance in a forested landscape. Before European settlement, the populations of many early-successional bird species were probably maintained by continuous colonization of similar temporary open patches in a forested matrix.

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