WORKING PAPER 2000-2

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John S. Gunn, André Desrochers, Marc-André Villard, Julie Bourque and Jacques Ibarzabal

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Sustainable Forest Management Network
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Author and address for page proofs:

John S. Gunn

Hancock Land Company

P.O. Box 299

Casco, ME 04015

Playbacks of mobbing calls of Black-capped Chickadees as a method to estimate reproductive activity of forest birds

John S. Gunn

Atlantic Cooperative Wildlife Ecology Research Network, Department of Biology, University of New Brunswick, Box 45111, Fredericton, NB E3B 6E1 Canada

André Desrochers

Centre de Recherche en biologie forestière, Faculté de Foresterie et de Géomatique, Université Laval, Sainte-Foy, QC G1K 7P4 Canada

Marc-André Villard and Julie Bourque

Département de biologie, Université de Moncton, Moncton, NB E1A 3E9 Canada

Jacques Ibarzabal

Centre de Recherche en biologie forestière, Faculté de Foresterie et de Géomatique, Université Laval, Sainte-Foy, QC G1K 7P4 Canada

Abstract. —Community-level indices of reproductive success are useful for measuring or monitoring demographic effects of habitat alteration on birds. We present a time-efficient method to estimate the relative reproductive activity of the forest songbird community. A recording of mobbing calls of Black-capped Chickadees (Poecile atricapillus) was broadcast at pre-selected stations during the breeding season. These calls attracted individuals of many bird species present in the vicinity, allowing visual detection of reproductive activity (e.g., adults carrying food or presumed pairs). In mature deciduous forests of northern New Brunswick, 50 bird species responded to the playbacks. Playbacks significantly increased the probability of visual observations of birds compared to silent observations conducted before broadcasting mobbing calls. In coniferous forests of central Québec, playbacks attracted 24 species and also provided a significantly greater opportunity to make visual observations of individual birds. In New Brunswick, mobbing playbacks facilitated more observations of reproductive evidence relative to point counts. Observation periods were brief and a 306-ha plot (1.75 x 1.75 km, 64 points spaced 250 m apart) could be surveyed by foot in less than 32 observer-hours. The proportion of individuals of a given species showing evidence of reproductive activity was used as an index of reproductive success. Black-throated Blue Warblers (Dendroica caerulescens) and Ovenbirds (Seiurus aurocapillus) had a reproductive index consistent with their true nesting success as derived from intensive nest monitoring on the same plots.

Presence-absence and abundance data are insufficient to assess the status and probability of persistence of birds at local, landscape, or regional scales (Van Horne 1983). The proportion of territorial males that are actually unpaired can be high (Gibbs and Faaborg 1990, Robinson 1992, Villard et al. 1993, Sabine et al. 1996), and the detectability of unpaired males may be substantially higher than that of paired males because unpaired males tend to sing more frequently (Best 1981, Gibbs and Wenny 1993). Furthermore, the frequently assumed correlation between population density and reproductive success is often weak or absent (e.g., Vickery et al. 1992). Thus, when the objective of a study is to characterize the effects of landscape alterations on the probability of persistence of avian populations, it is critical to obtain information on pairing success and reproductive success in addition to abundance data. However, the time required to obtain data on reproductive success may be prohibitive, especially when one is interested in community-wide patterns.

Various indirect approaches have been proposed to quantify avian reproductive activity: (1) ratio of hatch-year to after-hatch-year individuals in captures obtained using constant-effort mist netting (du Feu and McMeeking 1991, Robinson 1992,

Nur and Geupel 1993); (2) distance sampling of fledged broods (Buford et al. 1996); (3) reproductive index based on behavioral observations (Vickery et al. 1992). These methods vary in their time efficiency and thus, in the possibility of applying them to several species over large spatial scales. Expanding the spatial extent of investigations in conservation-oriented studies has been advocated by several authors (e.g., Noss 1983, Merriam 1988, and Villard et al. 1995).

Here, we present a semi-quantitative method for assessing assemblage-wide reproductive activity in forest birds. This method combines the use of breeding behavior observations (as in Vickery et al. 1992) and the tendency of birds to mob potential predators (Curio 1978). It provides an assessment of reproductive performance from pairing to fledging stages. Our method requires minimal equipment, only 10-15 min of observation per sampling point, and can be applied over large areas.

STUDY AREA AND METHODS

This study was conducted in northwestern New Brunswick to measure the response of birds to mobbing call playbacks and assess the reproductive status of the attracted birds. In central Québec, data on the response of birds to mobbing call playbacks were collected for comparison with New Brunswick. The reproductive status of the birds attracted in Québec was not assessed. The New Brunswick study site was located near Plaster Rock, west of the Tobique River (47°17' N; 67°20' W), within the Acadian forest region (Rowe 1972). The vegetation was dominated by mature stands of sugar maple (Acer saccharum), American beech (Fagus grandifolia), and yellow birch (Betula alleghaniensis), along with balsam fir (Abies balsamea) and red spruce (Picea rubens) stands, interspersed with black spruce (P. mariana) plantations. The Québec study site was located in the Forêt Montmorency and surrounding areas (47°20' N; 71°07' W). Stands were dominated by balsam fir and white spruce (P. glauca; see Darveau et al. 1997 for details). Stands of white birch (Betula papyrifera) and American mountain-ash (Sorbus americana) were present on 2-20% of land**.**

We recorded Black-capped Chickadees (Poecile atricapillus) mobbing a stuffed Northern Saw-Whet Owl (Aegolius acadicus) on the New Brunswick study area. A similar recording was made in near Forêt Montmorency for use in the Québec study area. The recording included the "high-zee" and "chick-a-dee" calls typically made while chickadees approach a predator closely and perform stereotyped wing and tail movements (Curio 1978, Hurd 1996). The mobbing calls of Black-capped Chickadees, a regionally common resident species, communicate the presence of a predator to conspecifics and other species (Hurd 1996).

In New Brunswick, the study was conducted on two 1.75 x 1.75-km grids comprised of 64 points, 250 m apart. Each point was visited for 15 min (three successive 5-min intervals) on five separate occasions between 1 Jun. and 26 Jul. 1997 (0630 - 1500 h). At each point, all birds detected visually or aurally within 50 m were recorded during the first 5-min interval, providing data on the birds present before the mobbing call recording was played. During the second 5-min interval, we played the mobbing calls with two, 2.5-W amplifiers attached to a Radio Shack Realistic (CTR-76 Model) single speaker cassette player placed at or near the center of the station approximately 1 m above the ground and played at a volume that approximated the sound intensity produced by live birds. All new birds detected, and the responses of birds already present, were noted. Individuals were considered to be attracted to the playback if they approached within 5 m of the speaker and/or exhibited the

behaviors typical of mobbing. Individuals were also considered to be attracted to the playback if they investigated the mobbing calls (as denoted by posture and head movements). The final 5-min interval was monitored in silence for the response of any new individuals, providing an opportunity to make further observations while birds remained close to the station and to detect singing birds that could not be heard during the mobbing playback.

To determine if the mobbing playback method provided an adequate sampling of the birds present in the area, we compared the number of individuals of each species detected before, during, and after mobbing playbacks. To simplify the comparison, we determined if the number of individuals of each species detected at a station during the mobbing playback was greater, equal, or lower than the number detected during the pre-playback point count. We then calculated the proportion of detection comparisons with each result (more, equal, or less). The same calculation was made for a combination of the mobbing playback period and the post-playback period.

We compared the number of visual detections made before and during mobbing playbacks in New Brunswick and Québec. We used the Wilcoxon Signed-Ranks Test to compare the number of visual observations per station in each of five visits, and to compare the number per unit time in Québec.

We recorded all evidence of reproductive activity during the entire 15 min. Behavior was categorized as: male and female present in close proximity (suspected pair), adults carrying food, and adults feeding fledglings. If the observer suspected the presence of fledglings or a nest in the area, an additional 5 min was allowed to make a quick search. Comparisons of the number of reproductive observations made before and during mobbing playbacks were made using the Pearson Chi-square test.

In Québec, data were collected at 165 sampling points, at least 200 m apart in a 100-km^2 study area. We made two visits to each point, between 21 Jun. and 6 Jul. 1995 (0425-1045 h). On the first visit, we performed a 10-min point count and recorded all birds detected within a 50-m radius from the observer. On the second visit, we placed the cassette player at the center of the sampling point (approx. 1 m above ground) and played the Black-capped Chickadee mobbing recording for 10 min. Bird observations were limited to the 10-min playback period. In the Québec study area, we used single 2.5-W speakers connected to portable cassette players. We did not record whether or not birds were detected visually during the point counts. However, to make the data comparable to New Brunswick, we estimated that 10% of all birds detected at point counts were visually observed; this estimate is generous, as birds were seldom seen because they tended to sing and forage high in the coniferous canopy. During playbacks, visual detections of birds were recorded as in New Brunswick. We did not document reproductive activity in Québec, but we included those data to show the applicability of the mobbing playback tool to other regions and forest types.

We compared data obtained from mobbing playbacks to direct measures of reproductive success on corresponding plots to determine if the mobbing playback method estimates avian productivity accurately. We collected Ovenbird and Black-throated Blue Warbler productivity data on two 25-ha grids in 1997 and on four 25-ha grids (3 x 3 stations spaced 250 m apart) in 1998. We conducted mobbing playbacks at each station five times between 1 Jun. and 26 Jul. 1997 and four times between 28 May and 23 Jul. 1998. For the intensive productivity data, all songbird territories were mapped in each study grid using a standard spot-mapping technique (Bibby et al. 1992) between late May and early July 1997 and 1998. The territory maps were used to determine the approximate location of every territory of focal species males, which then helped us concentrate our nest-

searching efforts. We tried to locate all Black-throated Blue Warbler and Ovenbird nests present in, and within 50 m of the 25-ha grids. These species were selected for calibration because their nests could be found and monitored relatively easily.

For both species, we compared the proportion of territorial males with associated family groups (i.e., intensive data) to the proportion of stations (where at least one male was detected) with evidence of reproductive activity based on mobbing playbacks for both species on each grid. We used the Wilcoxon Signed-Ranks Test to compare reproductive activity as determined by both methods.

The mobbing playback method can be used to calculate a reproductive score (sensu Vickery et al. 1992) that represents the highest degree of reproductive success observed during any of the sampling periods at each station. We used an ordinal scoring scheme with: 0 = species not detected as being present at the sample point; 1 = detected only once at sample point; 2 = territorial male present at sample point (detected singing during more than one visit); 3 = pair observed together, or an observation of an individual carrying nesting material detected at sample point; 4 = food carrying or other evidence of successful hatching or fledging detected at sample point.

We present a sample comparison of the reproductive evidence of one of the most frequently responding species, the Northern Parula (Parula americana) in two sites (A and B; n=64 in both cases). Using the reproductive score as the dependent variable, we compared Sites A and B using the Kruskal-Wallis One-Way Analysis of Variance and Likelihood ratio Chi-square analysis.

RESULTS

Response to playbacks. — In New Brunswick, 50 species responded to the playback at least once in 1997 or 1998 (Appendix I). These species represent 74% of all species detected during point counts (Villard, unpublished data) at the same stations in 1996. Observations of ten species represented 75% of the responding birds (Appendix I). The group of species responding most frequently to the playbacks includes representatives of several families (e.g., Vireonidae, Sittidae, Turdidae, and Parulidae,).

In Québec, 24 species responded to playbacks, which represents 80% of the 30 species recorded in point counts at the same stations. Five of those species were not recorded in New Brunswick (Appendix I).

Comparison of mobbing playback vs. point count detections. — For New Brunswick, in 48.6% of the comparisons between visual contact rates, the number of mobbing individuals of each species was either greater or equal to the number detected at a station during the corresponding point count (31.6% equal + 17% greater, n=3790 comparisons). When pre-playback data were combined with birds detected during mobbing and post-mobbing (both mobbers and non-participants), an equal or greater number of birds were detected 75% (29.6% equal + 45.4% greater) of the time. This indicates that mobbing playbacks combined with a standard point-count technique will census an area more thoroughly than a point count about 75% of the time. When each round was considered separately, we obtained similar results (i.e., approximately 75%).

Visual observations. — In New Brunswick, the mobbing playback method provided more visual observations per station than pre-playback observations during all five rounds (Wilcoxon Signed-Ranks Test, $P < 0.001$). As in New Brunswick, playbacks

in Québec generally allowed more visual contacts per unit time (20 of the 24 species, see Figure 1) than passive (without playback) observations (Wilcoxon Signed-Ranks Test, P <0.001).

Reproductive activity. —In New Brunswick, evidence of reproductive activity (adults carrying food, suspected pairs, and family groups) was observed 5.5 times more often during the playback period than during the pre-playback period during every round of visits, as a result of the more frequent visual contacts (Table 1). Several additional observations of reproductive activity were made during the 5 min following the playback period.

Calibration. —In 1997, there was no significant difference between the degree of reproductive activity as indicated by intensive nest searching vs. mobbing playbacks (Wilcoxon Signed-Ranks Test, P = 0.068, Fig. 2). In 1998, the same degree of reproductive success was also indicated by both methods, albeit more strongly than 1997, probably due to fewer grids being sampled in that year (Wilcoxon Signed-Ranks Test, P = 0.398, Fig. 2).

Mobbing playback reproductive index. —In our sample comparison of Northern Parula reproductive success, Site A had significantly higher reproductive scores than Site B (P = 0.002). The same pattern was also observed when analyzing the data two different ways. First, the proportion of stations with a score greater than 0 (or, non-zero stations) that had reproductive scores of 3 or 4 was compared. Site A again showed a higher proportion of stations with reproductive evidence (Likelihood ratio Chi-square (Williams Correction), P = 0.019). Second, we compared the proportion of non-zero stations with transient males (reproductive score = 1). Site A had significantly fewer stations with transients than Site B (Likelihood ratio Chi-square (Williams Correction), P = 0.001), indicating again that Site A may indeed be more favorable to Northern Parula reproduction than Site B.

DISCUSSION

The advantage of the mobbing playback method is that it provides a greater opportunity than passive observation to make visual contact with individual birds of many different species, thus increasing not only the number of visual detections, but also the probability of witnessing evidence of reproductive activity. Visual observations at close range may also reduce the risk of species identification errors associated with typical acoustic point counts.

Our method allows observers to sample a large area in a relatively short amount of time. For example, in our study, we surveyed a 306-ha plot (1.75 x 1.75 km, 64 points spaced 250 m apart) by foot in less than 32 observer-hours. Roadside surveys analogous to a Breeding Bird Survey (Robbins et al. 1986) would allow covering substantially larger areas per unit time. Conversely, stations could be sampled at closer distances to allow more effort on replicate plots, thus increasing the ability to detect treatment effects. Playbacks could be detected by human ear at a modal distance of 125 m in closed-canopy forest (n=14), and at a modal distance of 100 m in open-canopy forest (n=16). This suggests that the minimum distance between stations should be no closer than 200 m. In addition, since playbacks stimulate bird response, data can be collected beyond the morning hours.

Our method represents an alternative to current large-scale assessments of reproductive success. Constant effort mist-netting (e.g., DeSante et al. 1993) has also been used to infer annual reproductive success of many species over large study areas. This method consists of comparing the ratio of hatch-year versus older birds in mist nets. Distance sampling of fledgling groups (Buford et al. 1996) is another approach that has been proposed to infer reproductive success in an area. Observers walk transects and measure the distance to all groups of fledglings detected. Neither distance sampling nor constant effort mist netting is designed to provide information on reproductive activity at fine levels of resolution. Distance sampling would be expected to be most effective when fledglings are older and beg more loudly for food, while constant effort mist netting will yield more information when hatch-year birds are highly mobile and may have moved several hundred meters from their natal location. Our method provides the opportunity to obtain reproductive data at relatively fine levels of resolution, thus suitable for heterogeneous forest habitats, since birds seem to be attracted to playbacks from distances of less than 100 m (Gunn, personal observation). In addition, another advantage of our method over constant-effort mist netting is that it can be applied throughout the breeding season, not just at the time when fledglings are still within family groups.

Reproductive indices based on behavioral observations (e.g., Gibbs and Faaborg 1990, Vickery et al. 1992) also provide information on the reproductive status of territorial males, but the measurement of these indices requires a large time investment to ascertain the reproductive status of territorial males with reasonable confidence [e.g., 30 - 60 min of contact time per individual (Gale et al. 1997), and up to 90 min elapsed time (Probst and Hayes 1987)]. Our method requires a maximum of 60-75 min per station (4 or 5 visits of 15 min each throughout breeding season) to assess the status of multiple individuals representing several species.

The method we present above can be refined to provide a reproductive index from pairing to fledging which more closely resembles that of Vickery et al. (1992). We pooled some behaviors into categories that are obviously not equivalent (e.g., successful hatching and fledging), but do maintain the proper chronology of reproductive behaviors. Data were pooled primarily because sample sizes of observations of food carries and fledglings for individual species were low. An increase in the intensity of the surveys during the period when the nests of most species were fledging could increase the efficiency of this method. The last 5-min period is thus particularly important to confirm these observations. Even without additional surveys late in the breeding season, our method provides an estimate of the degree of reproductive activity being achieved by different species at each sample location.

Our data suggest that the mobbing playback method is applicable to a wide range of stand types independently of the density of Black-capped Chickadees (which were uncommon in Québec's boreal study area). In regions where Black-capped Chickadees are absent, mobbing calls from another ubiquitous species could perhaps be substituted (e.g., Blue Jay [Cyanocitta cristata], Carolina Chickadee [Poecile carolinensis], Boreal Chickadee [Poecile hudsonicus]). Hurd (1996) reviews cases of interspecific response to alarm calls of several species in addition to those of Black-capped Chickadees. The relative simplicity of the procedure required to conduct the mobbing playback method makes it easily applicable to other geographic areas, provided that the method is used during the period when most species are at the nestling stage, or throughout the breeding season (i.e., repeated visits), before families start to wander outside territory limits.

The proportion of individuals attracted to mobbing playback may vary with several factors. For example, a small

experiment during the 1998 breeding season indicated that females incubating eggs or brooding young nestlings are less likely to respond than females feeding nestlings or fledglings. Mobbing tapes were played for 3 min at a distance of 10 m from active Black-throated Blue Warbler nests. Females incubating eggs left the nest and responded to the playbacks 11% of the time (n=9), whereas females with nestlings responded 43% of the time (n=7). Because reproductive success data are often used in the context of conservation, we encourage researchers to calibrate the mobbing playback index in their study area using an intensive study plot where actual nests are monitored for a few species. In addition to calibration, this extra effort permits the nesting phenology of target species to be monitored so that the timing of mobbing playback visits can be adjusted, if need be.

ACKNOWLEDGMENTS

The New Brunswick study was funded by grants from the Sustainable Forest Management Network and Natural Sciences and Engineering Research Council of Canada (NSERC) to MAV, and by grants from FCAR and NSERC to A. Desrochers. Gilles Couturier and Steve Young from Fraser Papers, Inc. provided logistical support throughout the project. We would also like to thank Matt Betts, Serge Rhéaume, and Heather Sisk for field assistance in NB. We are indebted to Steve Brisson, Bruno Drolet, and Carl Savignac for assistance in the field in QC. Staff at the Forêt Montmorency and at Daishowa provided much appreciated information on study sites. Tony Diamond, Colleen Cassady St. Clair, John Faaborg, and an anonymous reviewer provided useful comments on a previous version of the manuscript.

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Table 1. Comparison of the number of reproductive activity observations made before the mobbing call playback and during mobbing call playback, New Brunswick, 1997.

Visit Number	Number of Reproductive Activity Observations[a] (at 143 stations each round of visits)		χ^2 P
	Before Playback	During Playback	
1	4	141	< 0.001
2	3	58	< 0.001
3	3	41	< 0.001
4	17	75	< 0.001
5	43	73	0.022
Total	70	388	< 0.001

[a] all reproductive-related behaviors combined (pair observed, carrying nesting material, carrying food, feeding fledglings)

List of Figures

FIGURE 1

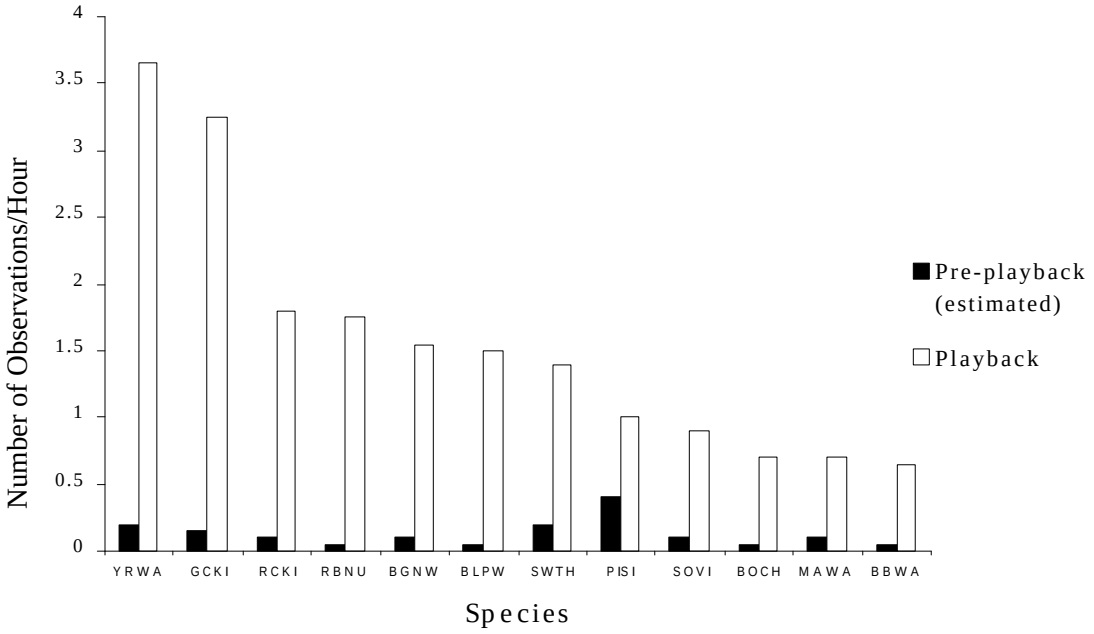
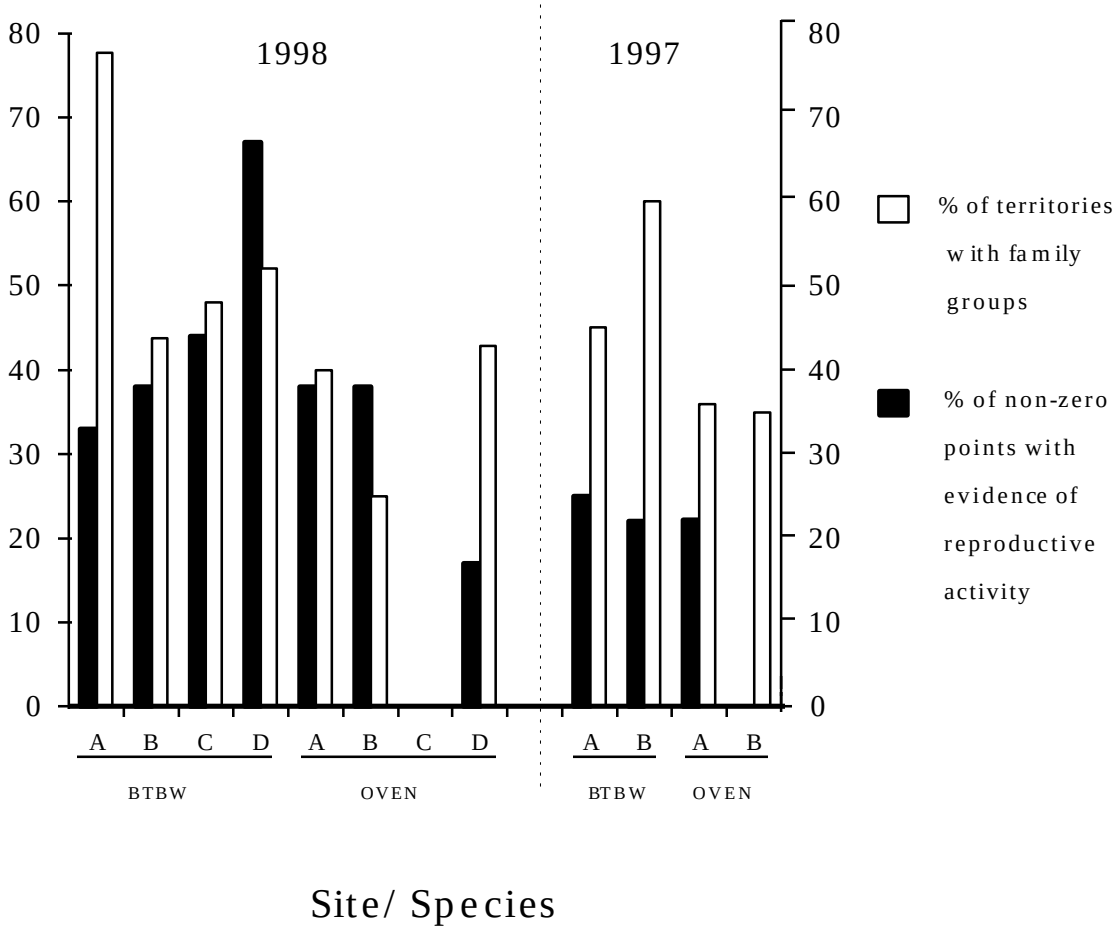

Number of Observations/Hour
4
3.5
3
2.5
2
1.5
1
0.5
0
YRWA
GCKI
RCKI
RBNU
BGNW
BLPW
SWTH
PISI
SOVI
BOCH
MAWA
BBWA
Species
Pre-playback (estimated)
Playback

FIGURE 2


1998
1997
80
70
60
50
40
30
20
10
0
A B C D A B C D
A B A B
BTBW
OVEN
BTBW
OVEN
% of territories with family groups
% of non-zero points with evidence of reproductive activity
Site/ Species

Appendix I. List of species attracted to mobbing playbacks at least once in New Brunswick or Québec study areas.

	Province[a]	
Species	NB	QC
Ruby-throated Hummingbird (Archilochus colubris)	2	0
Yellow-bellied Sapsucker (Sphyrapicus varius)	2	0
Downy Woodpecker (Picoides pubescens)	2	0
Hairy Woodpecker (Picoides villosus)	2	1
Northern Flicker (Colaptes auratus)	2	0
Pileated Woodpecker (Dryocopus pileatus)	2	0
Olive-sided Flycatcher (Contopus borealis)	2	1
Eastern Wood-Pewee (Contopus virens)	2	0
Yellow-bellied Flycatcher (Empidonax flaviventris)	2	2
Alder Flycatcher (Empidonax alnorum)	2	0
Least Flycatcher (Empidonax minimus)	2	0
Blue-headed Vireo (Vireo solitarius)	2	3
Philadelphia Vireo (Vireo philadelphicus)	3	0
Red-eyed Vireo (Vireo olivaceus)	3	0
Gray Jay (Perisoreus canadensis)	1	2
Blue Jay (Cyanocitta cristata)	2	0
Black-capped Chickadee (Parus atricapillus)	3	1
Boreal Chickadee (Parus hudsonicus)	2	3
Red-breasted Nuthatch (Sitta canadensis)	2	3
White-breasted Nuthatch (Sitta carolinensis)	2	0
Brown Creeper (Certhia americana)	2	2

Winter Wren (Troglodytes troglodytes)	2	2
Golden-crowned Kinglet (Regulus satrapa)	2	3
Ruby-crowned Kinglet (Regulus calendula)	2	3
Veery (Catharus fuscescens)	2	0
Swainson's Thrush (Catharus ustulatus)	3	3
Hermit Thrush (Catharus guttatus)	2	0
American Robin (Turdus migratorius)	2	2
Cedar Waxwing (Bombycilla cedrorum)	1	1
Nashville Warbler (Vermivora ruficapilla)	2	2
Northern Parula (Parula americana)	3	0
Chestnut-sided Warbler (Dendroica pensylvanica)	2	0
Magnolia Warbler (Dendroica magnolia)	3	2
Black-throated Blue Warbler (Dendroica caerulescens)	3	0
Yellow-rumped Warbler (Dendroica coronata)	2	3
Black-throated Green Warbler (Dendroica virens)	3	3
Blackburnian Warbler (Dendroica fusca)	2	1
Bay-breasted Warbler (Dendroica castanea)	2	2
Blackpoll Warbler (Dendroica striata)	0	3
Black-and-white Warbler (Mniotilta varia)	2	0
American Redstart (Setophaga ruticilla)	3	0
Ovenbird (Seiurus aurocapillus)	3	0
Mourning Warbler (Oporornis philadelphia)	2	1
Common Yellowthroat (Geothlypis trichas)	2	0
Canada Warbler (Wilsonia candensis)	2	0
Scarlet Tanager (Piranga olivacea)	2	0
Song Sparrow (Melospiza melodia)	2	0
Lincoln's Sparrow (Melospiza lincolnii)	2	1

White-throated Sparrow (Zonotrichia albicollis)	2	2
Dark-eyed Junco (Junco hyemalis)	2	2
Rose-breasted Grosbeak (Pheucticus ludovicianus)	2	0
Purple Finch (Carpodacus purpureus)	1	2
White-winged Crossbill (Loxia leucoptera)	2	2
Pine Siskin (Carduelis pinus)	2	3
American Goldfinch (Carduelis tristis)	2	0
Evening Grosbeak (Coccothraustes vespertinus)	1	2

[a] Mobbing response by Province (NB = New Brunswick, QC = Québec): 0 = Not present in study area; 1 = No mobbing response, but present in study area; 2 = Mobbing response; 3 = Mobbing response, top ten most frequent.