Monitoring Boreal Forest Owls in Ontario Using Tape Playback Surveys with Volunteers

Charles M. Francis and Michael S. W. Bradstreet[1]

Abstract.—Long Point Bird Observatory ran pilot surveys in 1995 and 1996 to monitor boreal forest owls in Ontario using roadside surveys with tape playback of calls. A minimum of 791 owls on 84 routes in 1995, and 392 owls on 88 routes in 1996; nine different species were detected. Playback improved the response rate for Barred (*Strix varia*), Boreal (*Aegolius funereus*), Northern Saw-whet (*Aegolius acadicus*) and possibly Great Gray (*Strix nebulosa*) Owls, and reduced variance among surveys for Barred Owls. Relatively few, long stops produced the most efficient survey for Barred Owls, while more numerous, shorter stops were optimal for Boreal and Northern Saw-whet Owls. Power estimates suggest that about 50 routes per species should be adequate to detect a uniform 20 percent decline over 10 years (2.2 percent per year) for Boreal and Northern Saw-whet Owls, and a 50 percent decline for Barred and Great Gray Owls (6.7 percent per year). However, some species were detected on many fewer than 50 routes, and models of uniform population changes may not be relevant for owls. For example, 60-80 percent fewer Northern Saw-whet and Boreal Owls ($P < 0.001$) were detected in 1996 than 1995 on routes that were run in both years, possibly related to emigration of many of these owls out of the study areas the preceding winter.

The Ontario Ministry of Natural Resources (OMNR) is responsible for the management of timber and natural resources, including wildlife, in much of central and northern Ontario. Under the terms of the Class Environmental Assessment of Timber Management on Crown Land in Ontario, the OMNR is required to monitor population trends of representative vertebrate species that are dependent upon forest habitats. There are several reasons why owls may be appropriate indicator species. First, some owls (such as the Spotted Owl, *Strix occidentalis,* in western North America) are known to be sensitive to logging and forest fragmentation. Second, some Ontario species are relatively rare. The Great Gray Owl (*Strix nebulosa*) was designated as Vulnerable in Canada until recently, while the Boreal Owl (*Aegolius funereus*) was considered too poorly known to be assigned a status in Ontario (Austen *et al*. 1994). Finally, as top predators, owls may also be sensitive to accumulations of toxins or other contaminants in the environment and thus may be useful as overall environmental indicators.

Most owl species, particularly species breeding in the boreal forests of Ontario, are not well monitored by other continental monitoring programs. Breeding Bird Surveys are conducted in the early morning and detect relatively few nocturnal species. Christmas Bird Counts detect some owls, but few such counts are conducted in northern Ontario, and the time spent "owling" on those counts is not standardized, so the results may be hard to interpret. Some owls, such as the Northern Saw-whet Owl (*Aegolius acadicus*), can potentially be monitored at migration monitoring stations, but the adequacy of those programs for monitoring this species has not been evaluated. Furthermore, because the

[1] Senior Scientist and Executive Director, respectively, Long Point Bird Observatory, P.O. Box 160, Port Rowan, Ontario, N0E 1M0, Canada.

breeding grounds of birds caught on migration are not known, it is difficult to tie population changes of migrants to specific land management practices.

A review of various monitoring methods suggested that a roadside playback survey would likely be the most effective monitoring technique for boreal forest species of owls in Ontario (Shepherd 1992). Similar surveys have been carried out in Manitoba and adjacent Minnesota since 1991 (Duncan and Duncan 1991, 1993) and in the Red Lake district of Ontario since 1993 (Gilmore and MacDonald 1996). As a result, Long Point Bird Observatory was contracted by the OMNR to coordinate a pilot study in March-April of 1995 and 1996 to test the feasibility of a volunteer-based roadside survey to monitor owl populations in Ontario. In this paper we evaluate various aspects of the design of the survey and consider its power and adequacy for detecting population trends of Ontario owls.

METHODS

Survey Design

The basic survey design asked volunteers to select routes along plowed secondary roads through forested areas, and drive these routes starting one-half hour after sunset, stopping at regular intervals to survey owls. Volunteers were asked to choose a night with little wind (0-3 on the Beaufort Scale), with no precipitation, and when the temperature was not too cold (above -15°C). Within the range of conditions surveyed, after correcting for date, we detected no correlations between weather conditions and numbers of owls reported, so we feel this component of the standardization was probably adequate.

At each stop, silent listening periods alternated with playback of selected target species of owls. Different survey protocols were established for northern Ontario (north of 47°N) and central Ontario, based on differences in the expected species in each region and their anticipated response rates. In both regions, calls of Boreal Owls were broadcast to elicit responses from Boreal Owls as well as from Northern Saw-whet Owls. The latter may respond to Boreal Owl calls, whereas the converse is believed not to be true (Shepherd 1992). In the northern region this was followed by a broadcast of Great Gray Owl calls. The Great Gray Owl was targeted because at the time it was designated as Vulnerable, and so that our surveys across northern Ontario could be compared to surveys already conducted in northwestern Ontario and southeastern Manitoba. Moreover, the Great Gray Owl call may elicit responses from Long-eared (*Asio otus*), Barred (*Strix varia*), or Great Horned (*Bubo virginianus*) Owls, in addition to Great Gray Owls. In the north, the playback protocol consisted of: 60 seconds silent listening to detect spontaneously calling owls, then 20 seconds of Boreal Owl call, then 60 seconds listening, then 20 seconds of Great Gray Owl, then a final 60 seconds of listening.

In the central region, where few Great Gray Owls were to be expected, the second species broadcast was the Barred Owl. Previous studies have indicated that Barred Owls may respond only very slowly to broadcasts (McGarigal and Fraser 1985), so the protocol was designed to include a very long listening period after the broadcast: 60 seconds listening, 20 seconds of Boreal Owl, 60 seconds listening, 20 seconds of Barred Owl, 120 seconds listening, 20 seconds of Barred Owl, and 480 seconds listening. The central region broadcast tape was modified in 1996 to test whether changes in two aspects of the playback protocols would improve response rates. One side of the tape used the same protocol as 1995, but with the final listening period divided into four intervals of 120 seconds each, separated by soft beeps. For the other side of the tape, Northern Saw-whet Owl calls were substituted for Boreal Owls, to test whether Northern Saw-whet Owls would respond better to conspecific broadcasts (because virtually no Boreal Owls had been detected in central Ontario in 1995 anyway). In addition, the number of broadcasts of Barred Owls was increased: the final 6 minutes was broken into three 120 second periods of 20 seconds of Barred Owl calls and then 100 seconds listening. Each protocol was usually played at alternate stops.

In northern Ontario, routes consisted of 25 stops spaced at 0.8 km intervals in 1995, but this was changed to 20 stops at 1.6 km intervals in 1996, to reduce the number of owls counted at more than one stop. Some routes in 1996 had slightly fewer stops because some of the available plowed roads could not accommodate the full length. In central Ontario, routes consisted of 10 stops at 2.0 km intervals in both years.

Surveyors were asked to survey each route twice, with the first survey window in early- to mid-March, and the second in early- to mid-April. In 1996, many routes in northern Ontario were surveyed again during a third window in late-April to early May. This survey was added in response to low numbers on the earlier surveys to determine whether owls might have been slow returning north because of the relatively cold, snowy winter, or because there had been an exceptional southwards movement the preceding winter (Ridout 1997).

Analysis Methods

Surveyors recorded the number of owls of each species detected during each time interval of the tape playback, as well as the total at each stop. In 1996, the form was designed to record the precise intervals when each individual owl was detected. In 1995, the information was slightly less complete and the time when a new owl started calling sometimes needed to be estimated.

To evaluate the effects of playback for Boreal, Northern Saw-whet and Great Gray Owls, we compared the total number of calls in the minute preceding any playback with the total number in the minute following playback of each species' call (or for Northern Saw-whet Owl, either its own or Boreal Owl calls). For Barred Owls, we used a similar procedure, but we used the combined total from the first 2 minutes (before and after Boreal/Saw-whet Owl playback) for comparison with the 2-minute interval after the first Barred Owl playback. For statistical testing, we excluded owls heard in both time periods (which would not be independent), and used a chi-square test to compare whether the number of owls calling only before playback was the same as the number calling only after playback. Because we had a one-tailed alternative hypothesis (that there would be more calling after playback), we created an approximate one-tailed test by halving the *P*-values if the difference was in the expected direction. To evaluate stop duration, we compared the proportions of owls that were first detected during each time interval.

To determine population changes, and estimate the power of the survey for detecting trends, two approaches were used. For comparing population indices between any 2 years, a combined ratio estimator was used, which consisted of the ratio of the total number of owls detected in each year on routes that were run in both years. The confidence limits and variance were estimated by boot-strapping, using routes as the sampling unit. A similar approach was used to compare numbers between survey windows within a year. For detecting long-term population trends, we assumed the data would be analyzed using log-linear route regression. This involves taking the log of all numbers (after adding a constant to avoid problems with log 0—we used 0.23 following Collins 1990), then using linear regression for data from each route, and finally calculating the mean slope across all routes. We used Monte Carlo simulations, as well as analytical techniques (John R. Sauer, pers. comm.) to estimate the relationships between variance after a 1-year interval (2 years of surveys) and variance after 5- or 10-year intervals, assuming a uniform, consistent population change across all routes and years. We then used the formulas in Snedecor and Cochrane (1967:113) to estimate the magnitude of change that could be detected based on these variance estimates with 80 percent power ($\beta = 0.8$) and a significance level of $\alpha = 0.05$. For analyzing annual changes, we used the maximum count for each species recorded in any of the survey windows for a particular year and route. This approach is not ideal, because not all routes were surveyed in all survey windows, but it did allow us to use as many routes as possible for power analyses.

The method of log-linear route regression has been shown to be flawed for various reasons, including sensitivity to the choice of constant added (Link and Sauer 1994). Link and Sauer (1994) proposed an alternative analysis technique using estimating equations, but this method requires enough data so that most routes have at least two non-zero years. We found we could not reliably use data from only two years of surveys to estimate the variance for longer periods with this method. Based on long-term data from the Breeding Bird Survey, precision of trend estimates derived from estimating equations tended to be slightly lower than that derived from log-linear route regression (Link and Sauer 1994), so the power of our surveys may be slightly less than we indicate here.

RESULTS

Effectiveness of Volunteer Surveys

The survey involved 73 volunteer surveyors in 1995 and 74 in 1996, usually accompanied by assistants. Many of the volunteers surveyed in both years, and indicated an interest in continuing with the survey into the future. In 1995, 84 routes were surveyed, 78 percent of them in both of the first two survey windows, while in 1996, 88 routes were surveyed, 76 percent of which were covered in both of the first two survey windows. However, only 44 routes were covered in both years. This high turnover in routes was due partly to replacement of routes that proved to be unsuitable in 1995, so we can hope for a lower turnover as the survey becomes more firmly established.

Owls were detected on most routes, with a total of at least 791 individuals of eight species in 1995 and 392 individuals of nine species in 1996. The most commonly encountered owls were Northern Saw-whet, Boreal and Barred Owls, though moderate numbers of Great Gray and Great Horned Owls were also detected (table 1). Only 5 routes in 1995 and 12 routes in 1996 failed to find owls on any survey (although on some of the others no owls were detected during one or more survey windows).

Table 1.—*Minimum number of different owls detected on the Ontario nocturnal owl survey along 84 routes in 1995 and 88 routes in 1996. The numbers given are the sums of the highest count for each species on each route during any of the survey windows in each year. The actual number of owls detected was probably higher, because owls detected during one survey window on a route were not necessarily the same birds as were detected on later survey windows. Note that these numbers are not reliable for estimating trends, because only 44 of these routes were surveyed in both years, and routes were not randomly selected.*

Owl species	Minimum number detected each year	
	1995	1996
Northern Saw-whet Owl	321	97
Boreal Owl	202	62
Great Gray Owl	28	15
Barred Owl	149	153
Great Horned Owl	74	39
Long-eared Owl	8	19
Short-eared Owl	7	2
Northern Hawk Owl	0	3
Eastern Screech-owl	2	2

Survey Design

Effects of Playback

For Boreal, Northern Saw-whet and Barred Owls, significantly more birds were detected after playback than before playback in both years (table 2). For Great Gray Owls, there was no evidence of any effect of playback in 1995, but in 1996 playback did seem to increase response, although the sample size was small. Additional data from Doug Gilmore (pers. comm.), who used a similar protocol to survey owls around the Red Lake district in northern Ontario in 1993 and 1994, indicated a substantial increase from before to after playback in the number of Great Gray Owls detected, from 5 to 13 in 1993, and from 26 to 46 in 1994.

For Boreal and Northern Saw-whet Owls, the estimated proportion of additional owls detected as a result of playback was only 16-19 percent, reflecting the large number of spontaneously calling owls. However, for Barred Owls, playback led to an increase of 50 percent in the number of owls detected during the first 2 minutes after playback. In addition, many owls that were detected in later listening intervals may also have been stimulated by playback, although the magnitude of the effect cannot be measured except by comparison with surveys not using playback.

With the 1996 data, we attempted to test whether Northern Saw-whet Owls would respond better to their own call or to that of Boreal Owls, in the Central Ontario region. However, during 1996 in that region we had so few Northern Saw-whet Owls that we could not even demonstrate an effect of playback of either species. Considering only the minute before and after playback, the numbers detected during the 1 minute before and after playback of each species were almost identical: 18 before and 17 after the Boreal Owl playback, and 17 before and 17 after the Northern Saw-whet Owl playback. If we consider the total numbers of owls first detected before and after playback (including the several minute listening period for Barred Owls), the numbers become 18 versus 16 and 17 versus 21,

Table 2.—*Numbers of responses of owls during the listening interval before and after playback of their own calls for Boreal, Great Gray and Barred Owls, and either their own or Boreal Owl calls for Northern Saw-whet Owls on the Ontario Nocturnal Owl Survey, 1995-1996.*

		Total owls detected in each interval		Number detected only in one interval		
Species	**Year**	**Before**	**After**	**Before**	**After**	**P**[1]
Boreal Owl	1995	206	234	49	77	0.006
	1996	52	66	11	25	0.01
Northern Saw-whet Owl	1995	262	305	61	104	0.004
	1996	56	73	9	26	0.002
Barred Owl	1995	43	60	17	34	0.009
	1996	49	77	10	38	0.001
Great Gray Owl	1995	19	19	9	9	n.s.
	1996	5	11	2	8	0.03

[1] Probability (one-tailed chi-square test) that the number detected only before playback was the same or higher than the number detected after playback, relative to the alternative hypothesis that more owls called after playback.

respectively, but while this is in the direction of a stronger effect of Saw-whet Owl playback, it is not significant.

We also tested whether additional playback increased response rates of slow responding Barred Owls. The numbers of Barred Owls detected before and after the third Barred Owl call (when the tapes began to differ) was 55 and 26 for the side with no additional calls, and 52 and 32 for the side with additional calls. While this is in the direction of suggesting better response rates with additional playback, it is not significant.

Stop Duration

All else being equal, the survey should be designed so that each surveyor will detect the maximum number of independent owls during a survey of a reasonable duration (3-4 hours). This involves selecting the optimal combination of waiting time at each stop, spacing between stops, and number of stops. For owls that respond quickly, more shorter stops may be preferred, while for slow responding owls, fewer longer stops may be preferred. For longer stops, the number of owls detected late in the listening period must be sufficiently high to justify the concomitant reduction in number of stops.

For Boreal Owls in northern Ontario, 65 percent of birds in 1995, and 56 percent in 1996 were first detected in the first minute before playback, and only 11 percent and 17 percent were first detected in the third minute (the final listening period). This suggests that prolonging stops would be unlikely to produce enough additional owls to justify any reduction in the number of stops. The results from Northern Saw-whet Owls from northern Ontario are similar, with 65 percent in 1995 and 48 percent in 1996 detected in the first minute, and only 11 percent and 12 percent first detected in the third minute. The data from central Ontario provided confirmation that a prolonged final listening period is not efficient for this species. In both years, listening for the final 8 minutes only increased the number of owls detected by about 30 percent over the number in the first 4 minutes. In contrast, listening for only 4 minutes and doubling the number of stops (which after allowing for travel time could be done in the same or less total survey time), would be expected to double the number detected (a 100 percent increase).

Response speed of Great Gray Owls could not be tested, because the listening period only extended for 1 minute after playback. However, for Barred Owls, a prolonged listening and playback period did appear to be worthwhile, based on data from central Ontario. In 1995, 80 owls were first detected in the final 8 minutes, as opposed to only 77 in the first 4 minutes. In 1996, the numbers were 91 in the final 8 minutes and 87 in the first 4 minutes. Breakdown of the last 8 minutes from 1996 indicates that 19 of these owls were not detected until the final 2 minutes. Based on

these figures, the total number of Barred Owls detected would have been expected to have been fairly similar if there were twice as many stops of only 4 minutes duration. However, comparison of results from the first and second survey windows indicates that the prolonged listening period may reduce variation due to seasonal changes in calling propensity. In the first survey window in 1995, 45 owls were first detected in the first 4 minutes, and 28 in the final 8 minutes, while in the second survey window the proportions were strongly reversed: 32 and 52 respectively. The relative difference in the totals (73 versus 84) was less than the difference between the numbers detected only in the first 4 minutes (45 and 32). In 1996, the number of responses during the first 4-minutes and final 8-minutes was much more similar between survey windows (38 and 41 for the first window and 49 and 50 for the second window).

Stop Spacing

Increasing the stop spacing from 0.8 km to 1.6 km in northern Ontario led to fewer owls being detected at multiple stops. This decrease was most dramatic for Boreal Owls (57 out of 318 records of owls in 1995 were believed to have been birds that were detected at previous stops, compared with only 1 out of 97 in 1996) and for Northern Saw-whet Owls (30 out of 260 in 1995 compared with 0 out of 121 in 1996). For Great Gray Owls, 7 out of 33 records were believed to be duplicates in 1995, compared with 0 out of 16 in 1996. However, for Barred Owls there was no change in the number being heard from multiple stops (4 out of 40 in 1995 compared with 6 out of 39 in 1996). Apart from reducing the amount of duplication in the area being surveyed at each stop, increasing the spacing may also help to reduce variance associated with differences in judgment among observers as to which owls are duplicates. However, this came at the cost of reducing the number of stops (to 20 from 25), and some routes were unable to accommodate the overall increased length (due to insufficient plowed roads) and were run with fewer than 20 stops.

Survey Timing

The seasonal peak in calling appeared to differ between 1995 and 1996 for some owl species (table 3). For Boreal and Northern Saw-whet Owls, peak numbers were detected in the first window in 1995, but during the second or third survey window in 1996. For Barred Owls, the peak was higher on the later surveys in both years, while for Great Gray Owls no strong seasonal effects were evident, although the sample size was small.

To test the significance of these changes between any two survey windows, we restricted analysis to routes sampled during both

Table 3.—*Mean number of target species of owls per route for the first (early to mid-March), second (early to mid-April) and third (late April to early May) survey windows in central and northern Ontario, 1995-1996.*

		Survey window				
		1995		1996[1]		
Species	Region	1	2	1	2	3
Boreal Owl	North	4.34	1.98	0.46	0.9	1.79
Northern Saw-whet Owl	North	2.76	2.79	0.4	0.3	0.75
	Central	3.55	3.09	0.77	1.24	-
Barred Owl	North	0.44	0.43	0.23	0.33	0.5
	Central	2.18	2.47	1.87	2.61	-
Great Gray Owl	North	0.34	0.29	0.06	0.2	0.17
	Central	0.06	0.06	0.03	0.03	-
Number of routes	North	41	42	35	40	24
	Central	33	39	39	38	-

[1] The third survey window was added in 1996 for northern Ontario only, to determine whether owls that had moved southwards might have returned later in the season to breed.

windows. In 1995, the number of Boreal Owls detected declined by about half between the first and second window ($P < 0.01$ based on boot-strapped confidence limits from a combined ratio estimator). In 1996, an increase of a similar magnitude from the first to the second window in 1996 was not significant, but there was a highly significant ninefold increase (from 2 to 18 owls) between the second and third window on the 19 routes surveyed during both those windows ($P < 0.01$). For these same routes in 1996, there appeared to be a substantial decline in Great Gray Owls from the second to the third window from 6 to only 1 ($P < 0.01$). However, a similar decline was not apparent if all routes were considered (table 3) suggesting this result must be treated cautiously, and may be a small sample artifact. None of the seasonal changes in other species were significant based on this test.

Population Changes and Survey Power

Based on the highest count recorded during any survey window for routes run in both years, the numbers of Northern Saw-whet Owls detected in 1996 were only 19 percent of those in 1995 for northern Ontario, and 41 percent of those in 1995 for central Ontario ($P < 0.001$ based on boot-strapped confidence limits from a combined ratio estimator). Boreal Owl counts in northern Ontario in 1996 were 27 percent of their level in 1995 ($P < 0.001$). Note that these ratios do not exactly match counts in table 1, because many routes were not run in both years. Numbers of owls of other species detected did not differ significantly between years.

Using variance estimates derived from these between-year changes, we estimated the percentage population change that the survey could detect over a 10-year interval, assuming a uniform population change across the range (table 4). With 50 routes per region, the survey should be able to detect a population change of 20 percent or less for Boreal and Northern Saw-whet Owls (representing a 1-2 percent change per year), while for Barred and Great Gray Owls the survey should be able to detect a 40-50 percent change. However, these sample sizes assume that routes are run in every year, and only include routes for which the species was recorded at least once (i.e., constant zero routes do not contribute to the analysis). For Great Gray Owls, the actual number of relevant routes for the first 2 years was only 8. Furthermore, the power may be less if populations are not changing uniformly across the range (i.e., increasing on some routes and decreasing on others). These estimates are also very sensitive to the variance estimates, which are not very precise based upon only two years of data.

Table 4.—*Estimated percentage population change that the Ontario survey could be expected to detect with an 80 percent probability at P < 0.05 over a 10-year period (11 years of surveys)*[1]*. Power was estimated by extrapolating from the observed variance between 1995 and 1996 in the maximum numbers of owls detected for routes run in both years, assuming log-linear route regression analyses. Note that these estimates should be considered only as very general guidelines, because they are very sensitive to the variance estimates (which are not very precise), and they assume a uniform decline over time and across the range. Note also that the number of routes only includes routes on which a species is detected in at least some years.*

		Number of routes		
Species	**Region**	**25**	**50**	**100**
Boreal Owl	North	17	12	8
Northern Saw-whet Owl	Central	26	18	12
Northern Saw-whet Owl	North	8	5	4
Great Gray Owl	North	69	48	34
Barred Owl	Central	46	32	22
Barred Owl	North	63	44	31

[1] Numbers given represent the cumulative change in the population. In annual terms, a 20 percent total decline over 10 years represents about 2.3 percent per year, while a 50 percent total decline represents about 6.7 percent per year.

DISCUSSION

This survey was relatively popular with volunteers and produced a large amount of data on nocturnal owls much more economically than could have been achieved using paid surveyors. Furthermore, power analyses suggest that moderate long-term population trends should be detectable with reasonable power for at least some target species (see table 4). Use of playback was effective in increasing response rates, thus potentially improving the efficiency of the survey. Play-back combined with a prolonged listening period may also reduce variance due to seasonal changes in calling propensity of Barred Owls.

However, the survey does have a number of drawbacks, both biological and logistical. Perhaps the most substantial limitation is that for some species, such as Boreal and Northern Saw-whet Owls, changes in the numbers of owls detected may be hard to interpret. The dramatic decline in the number of these owls detected in 1996 compared to 1995 may have been related to southward emigration of many birds the preceding winter. Reports from bird-watchers in southern Ontario indicate a very large "invasion" of Great Gray Owls, as well as moderate numbers of Boreal Owls and Hawk Owls (Ridout 1997). This was presumably related to a decline in prey numbers (microtine rodents) combined with exceptional snow fall. Low numbers of birds during the surveys, even for species such as Northern Saw-whet Owls that are probably largely migratory most years anyway, may have been related to failure of the birds to return (perhaps due to deep snow or to continued low numbers of prey), or to high mortality over the winter. The tendency for Boreal Owls to be detected more frequently in the last survey window in 1996 suggests a late return of some individuals.

Similar annual variation in numbers calling has been found in previous studies of owls, and has been postulated to be linked to small mammal cycles (Palmer 1987). Fluctuations in prey supply have been shown to affect both breeding and survival rates for at least some species of owls including Great Horned Owls in Saskatchewan (Houston and Francis 1995) and Boreal Owls in Europe (Korpimäki 1985, Sonerud *et al*. 1988). Additional data would be required to determine the extent to which the apparent population changes observed on this survey were due to overwinter mortality (i.e., a real population decline), late return or non-return of owls that had emigrated (but which were still alive and could return in later years), or low calling frequency of birds that were present in the study area, perhaps because they were not breeding. Regardless of the explanation, fluctuations in counts affect the power of this survey (or any other type of survey) to detect long-term population trends. Many years of data would be required to differentiate short-term cycles from long-term declines, regardless of the number of routes and precision of the survey.

There were also a number of logistical limitations to the surveys. Ideally, route selection should be randomized to ensure that trends along selected routes are representative of population trends throughout the region. However, for several reasons it was necessary to ask volunteers to select their own routes. Relatively few suitable roads were available in the region, especially in the north. The suitability and condition of these roads in winter was generally known to the local people, but not to the survey organizers. Furthermore, the pool and distribution of qualified volunteers was somewhat limited. For a nocturnal winter survey there are limits to how far one can expect volunteers to travel to carry out a survey. This necessarily results in a higher density of routes within 1-2 hours drive of population centers.

Because most volunteers selected routes on the basis of generally suitable habitat, rather than specific known locations of owls, there is no particular reason to believe trends on selected roads will differ from those on random roads. In any case, with any roadside survey (including well randomized ones such as the Breeding Bird Survey) it is necessary to assume that trends along roadsides are the same as those away from roadsides—probably a greater limitation than any bias caused by non-random route selection in this case.

In addition to route selection, route continuity is a potential problem. Many of the available roads are logging roads, which are only kept plowed in winter if they are in use. Because of changes in locations of logging, some routes surveyed in 1995 were not available in 1996. Also, there may be problems finding replacement surveyors for particular routes if any of the surveyors move out of the area, owing to relatively low human population densities in some areas.

Use of playback was effective in increasing the response rate and, at least for Barred Owls, appeared to help reduce variance due to seasonal changes in calling propensity. However, it does carry the cost of potentially introducing long-term bias due to changes in playback units and/or tapes. Improvement of a broadcast tape used for a similar roadside survey of Red-shouldered Hawks (*Buteo lineatus*) was associated with a 100 percent increase in the number of hawks detected between 1994 and 1995 (Heagy and Francis 1995). For the owl survey, because volunteers were asked to supply their own broadcast units, changes in these units over time could also lead to bias, especially given the general trend for electronic goods to get cheaper and more powerful over time.

For several species that had relatively high spontaneous calling rates (including Boreal, Northern Saw-whet, Great Gray, and Great Horned Owl) a calling survey without playback would probably be only slightly less efficient, and may be preferable because of the reduced need for equipment and the reduced risk of introducing long-term bias. For Barred Owls, a high proportion of birds were detected late in the listening period, suggesting playback may substantially increase detections, and playback also appeared to reduce seasonal variation. However, surveys incorporating longer passive listening periods would be required to estimate the relative efficiency of a survey without playback. It also needs to be determined whether volunteers would prefer, and hence be more likely to participate in, an active survey involving playback, with at least a slightly higher response rate, compared to a survey based entirely on passive listening.

Despite various limitations, we believe this survey provides valuable information in a cost-effective way on Ontario owl populations. Based on data gathered in the first 2 years, the general survey design, in terms of numbers, duration, and spacing of stops, appears to be adequate—it was quite sufficient to detect some major fluctuations in numbers of the two smaller species. Numbers of routes should be increased if possible to detect trends of some of the rarer species such as the Great Gray Owl, and to allow for attrition of routes over time. This will involve continuing to encourage as many participants as possible in the survey. It would potentially be more efficient to reduce the survey to one survey window per year, but based on annual variation in the seasonal calling peaks observed during the first 2 years, it may not be possible to select a single optimal time period for the survey each year. As such, we plan to continue with two surveys per year in the near future, to learn more about annual variation in calling phenology.

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