International journal of application or innovation in engineering and management

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

Bird Species in the Woodlands of Automated Sound Recording and Analysis

Smitha

Yantra Inc, Cananda, Uk smitha123@gmail.com

Article Info

Received: 17-03-2018 ***Revised: 21 -04-2018*** ***Accepted: 06-05-2018*** ***Published:15/06/2018***

ABSTRACT: We conducted a field study to compare the effectiveness of acoustic recordings coupled with automated sound recognition versus traditional point counts in terms of their relative abilities to detect 3 bird species-at-risk in southwestern Ontario, Canada. The comparison was made in 50 woodlots, each of which contained a standard Forest Bird Monitoring Program plot of 5 point-count stations. An automated recording device was present at one of the point-count stations. We found that the automated recording and analysis system worked at least as well as the more traditional point-count method in identifying woodlots containing acadian flycatcher (*Empidonax virescens*) and cerulean warbler (*Setophaga cerulea*), but that both methods combined performed better than either method alone. The automated system also required considerably less effort in the field (a difference of 140 min/woodlot) with very little additional effort identifying vocalizations in the lab (approx. 22.5 min/woodlot, for all 3 species combined). The automated system was not as effective in detecting prothonotary.

KEY WORDS: Acoustic recording, automated recognition, bird song, bird species-at-risk, point counts, southwestern Ontario.

INTRODUCTION:

The point-count method is one of the most commonly used survey techniques for measuring avian species composition, abundance, and distribution (Ralph et al. 1995, Buckland 2006). It is the basis of such well-known surveys as the North American Breeding Bird Survey (Robbins et al. 1986) and the Forest Bird Monitoring Program (FBMP; Butcher et al. 1993), as well as various regional monitoring programs (e.g., Hanowski and Niemi 1995, Stadt et al. 2006, Blakesleyand Hanni 2009) and research studies (Rosenstock et al. 2002).

Despite its wide usage, the point-count method does have certain drawbacks. For one, the point-count method relies on highly trained personnel for making identifications of species in the field. In some regions, there may be too few trained individuals available to meet the demand (Hobson et al. 2002). For example, less than half of the active Breeding Bird Survey routes in Quebec, Canada, were surveyed in 2007, due primarily to a lack of volunteers in the northern part of the province (Falardeau 2009). In addition, differences in physical ability and skill level among point-count observers will lead to differences in ability

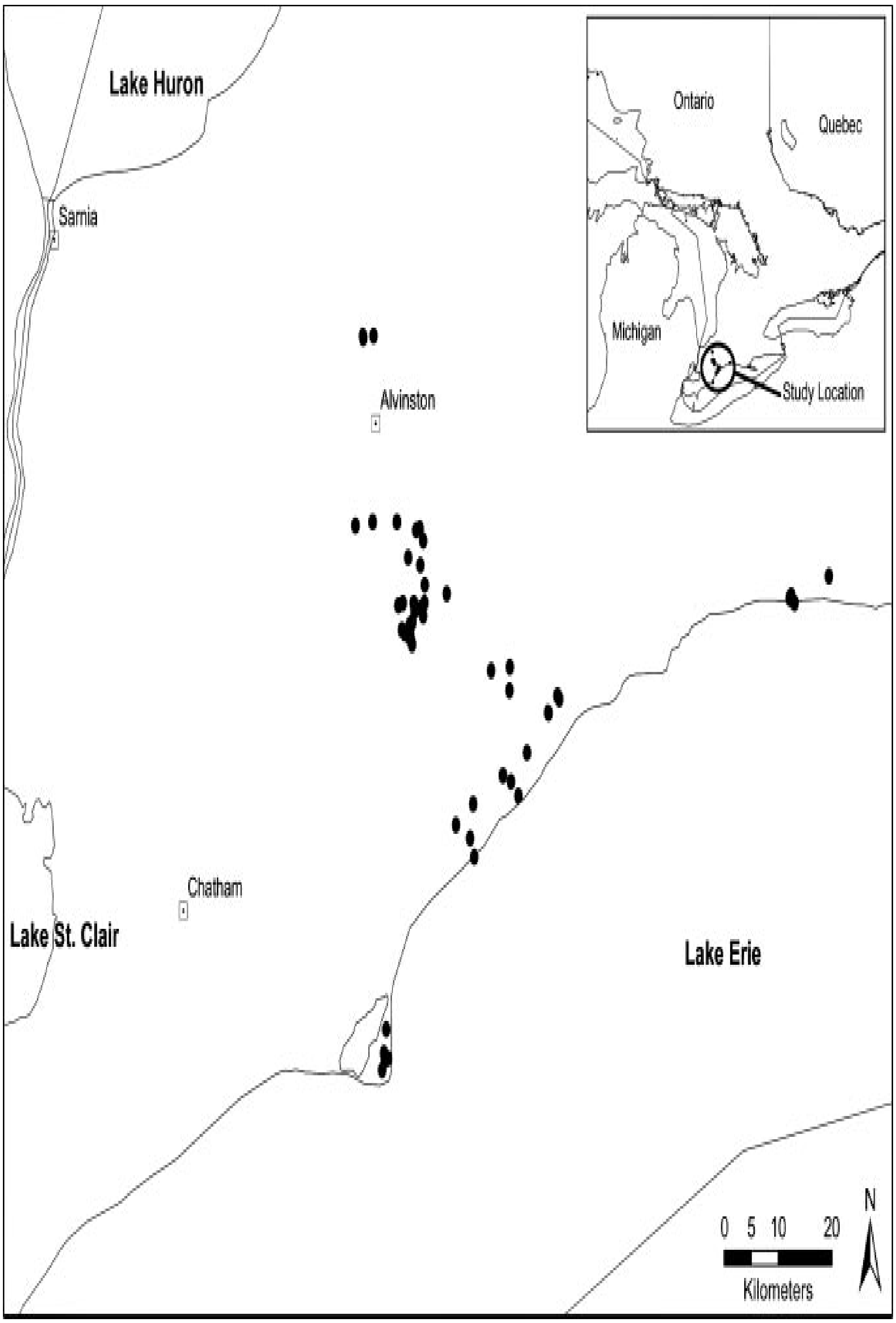
ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

to detect and correctly identify birds by sight and sound (Rosenstock et al. 2002,Rempel et al. 2005). This inter-observer variability makes itdifficult to make comparisons among observers (Brandes 2008), and may result in biased estimates of site occupancyand species abundance (Hutto and Stutzman 2009, Camp- bell and Francis 2011).

Acoustic recording has been suggested as an alternative method for surveying avian communities (Haselmayer and Quinn 2000, Hobson et al. 2002, Acevedo and Villanueva- Rivera 2006, Swiston and Mennill 2009, Venier et al. 2011).The use of recordings has a number of potential advantagesover point counts: 1) skilled observers are not needed to conduct field work, which may allow more survey data to becollected (Haselmayer and Quinn 2000); 2) inter-observer errors can be minimized by using a single interpreter for all recordings, or by cross-validating detections and identifica- tions with multiple interpreters (Celis-Murillo et al. 2009); and 3) sound recordings provide a permanent record

of thesurvey period from which all detections can potentially be identified (Haselmayer and Quinn 2000, Celis-Murillo et al. 2009), which may be particularly important when unambig- uous species identifications are required.

A potential disadvantage of using acoustic recorders is that they can generate large amounts of data that may be difficult and time-consuming to interpret (Rempel et al. 2005). This problem is compounded if a single interpreter is used to eliminate inter-observer biases. Using sound recognition software to automatically identify species of interest .


Lake Huron
Sarnia
Alvinston
Ontario
Quebec
Michigan
Study Location
Chatham
Lake St. Clair
Lake Erie
0 5 10 20
Kilometers
N

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

greatly reduce the amount of time required to scan large acoustic data sets (Acevedo and Villanueva-Rivera 2006, Brandes 2008, Hutto and Stutzman 2009, Swiston and Mennill 2009). An accurate and efficient automated sound-scanning method would make large-scale surveys more feasible, and would be particularly appropriate for finding rare or uncommon species, because the cost of detecting those species in extensive data sets would be substantially reduced (Venier et al. 2011). Although recorders have beenused to search for the critically endangered ivory-billedwoodpecker (*Campephilus principalis*) in its former habitat in the southeastern United States (Fitzpatrick et al. 2005, Hill et al. 2006), no one to our knowledge has conducted an evaluation of acoustic recorders combined with automated recognition software versus a more traditional monitoring approach for detecting bird species-at-risk at large spatial scales.

In 2010, we initiated a field study to assess the impact of emerald ash borer (*Agrilus planipennis*) on the bird communities of southern Ontario, Canada, woodlands. As part of the study, we installed Forest Bird Monitoring Program (FBMP) plots and acoustic recorders in 50 woodlots along the leading edge of the insect infestation. This part of Ontario is home to 3 forest bird species listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2012). Acadian flycatcher (*Empidonax virescens*) has an estimated Ontario populationof 27–35 pairs; prothonotary warbler (*Protonotaria citrea*) hasan estimated Ontario population of 10–25 pairs; and cerulean warbler (*Setophaga cerulea*) has an estimated Ontario population of 500–1,000 pairs (Cadman et al. 2007). The study design provided us with an opportunity to test the effectiveness of acoustic recordings and automated sound recognition software in detecting these 3 species-at-riskrelative to trained observers conducting point counts. We identified 3 possible outcomes: 1) no difference between the2 methods; 2) the FBMP method would detect more of thespecies of interest, because it covers more area (5 point-countlocations in each plot) than a single recorder; or 3) the acoustic recording method would detect more of the species of interest, because it can cover more time periods (multiple times during the day for multiple days) than a FBMP plot (1sample time on each of 2 days).

STUDY AREA

The study was conducted in 50 upland forest fragments (hereafter referred to as woodlots) in Middlesex, Lambton, Elgin, and Chatham–Kent counties in the Deciduous (Carolinean) Forest region of southwestern Ontario (Fig. 1). In these counties, the landscape was primarily agricultural and urban, with forest cover comprising only a small fraction (4–15.5%) of the land area (Couturier 1999). Upland forests within this region were dominated by sugar maple (*Acer saccharum*), with American beech.

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

grandifolia), red maple (*Acer rubrum*), red oak (*Quercus rubra*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), yellow birch (*Betula alleghaniensis*), and bitternut hickory (*Carya cordiformis*) as co-dominants (Ontario Ministry of Natural Resources 2000).

The 50 woodlots were chosen to meet the requirements of a study designed to investigate the response of forest bird communities to emerald ash borer infestation. The criteria used to select the woodlots were 1) located at the leading edge of the emerald ash borer infestation, 2) >30 ha in size, 3) >5% ash content, 4) a relatively homogeneous forest structure, 5) no obvious large-scale disturbances, and 6) accessible by landowner permission. Of the 50 woodlots chosen, 24 were privately owned either in whole or in part. Other woodlot owners include the province of Ontario, Chatham–Kent and Middlesex counties, and the municipal-ity of West Elgin.

METHODS

We established a bird survey plot in each woodlot following the FBMP protocol described by Welsh (1995). Each plot consisted of 5 survey stations located ≥250 m apart and >100 m from the nearest forest edge. Each plot was sampled twice during the breeding season in 2010. The first sample was between 24 May and 17 June, and the second between 13 June and 10 July, with a minimum of 6 days between samples. At each station within each plot, an observer counted all adult birds heard or seen during a 10-minute point-count. Observations were separated into those ≤100 m, and those >100 m, from the point-count center. Counts were conducted in fair weather (winds <15 km/hr and no rain) in the 4 hours immediately following local sunrise.

We used Song Meters (hereafter also referred to as recorders; Wildlife Acoustics, Inc., Concord, MA) to record bird vocalizations at one station in each woodlot. Recordings were made during the same early and late time periods as described above. The median number of days sampled per woodlot in each time period was 14 (range ¼ 3– 17 for the early time period and 7–15 for the late time period). We used Song Meter Configuration Utility software version 1.6 (Wildlife Acoustics, Inc.) to program the recorders to make 12 10-minute recordings each day: 9in the morning (0.25 hr before sunrise; at sunrise; and 0.25 hr, 0.75 hr, 1.75 hr, 2.25 hr, 2.75 hr, 3.25 hr, and 4.25 hr after sunrise) and 3 in the evening (0.25 hr before sunset, at sunset, and 0.25 hr after sunset). Sunrise and sunset times were determined by the program from the date and geographic coordinates of the individual sites. Record- ings were made at a sample rate of 24,000 Hz and saved as 16-bit PCM *.wav* files.

We analyzed the recordings using Song Scope version 4.1.1 automated recognition software (Wildlife Acoustics, Inc.). Song Scope uses patented algorithms to build recognizers from training data containing known samples of a particular species' vocalizations. Song Scope scans new recordings and produces a spreadsheet of candidate vocalizations that match the recognizer. Each candidate vocalization can then beexamined individually to confirm the identification. We built recognizers for acadian flycatcher and prothonotary warbler using training data from the Borror Laboratory of Bioacoustics, The Ohio State University, Columbus, Ohio, USA (199 vocalizations from 42 individuals of acadian flycatcher; 185 vocalizations from 30 individuals of prothonotary warbler). For cerulean warbler, we obtained a pre-built recognizer from Wildlife Acoustics, Inc. This recognizer was used previously to test the efficacy of autonomous recording units and Song Scope software in detecting cerulean warblers at 9 sites in the Allegheny National Forest, Pennsylvania, USA (Agranat 2007). For each detected vocalization, Song Scope calculates 2 values that indicate the probability of a match with the recognizer (range ¼ 0–99): 1) a Quality value that indicates where the particular candidate vocalization fits with respect to a statistical

International journal of application or innovation in engineering and management

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

distribution of parameters from the training data used to build the recognizer; and 2) a Score value that represents the statistical fit of the candidate vocalization tothe recognizer's model.

The sensitivity of the scan. Lower minimum values increase the sensitivity of the scan, resulting in more vocalizations beingcounted and displayed as candidates.

To set the Minimum Quality (MQ) and Minimum Score (MS) values, we first examined the average ð$\bar{x}$Þ and standard deviation (SD) of the fit of the training data to the models (84.22% 3.19% for acadian flycatcher, 80.42% 3.14% for prothonotary warbler, and 70.00% 2.60% for cerulean warbler). As a default,we set the Minimum Score at $\bar{x} - 1$ SD (MS ¼ 81 for acadian flycatcher, 77 for prothonotary warbler, and 67 forcerulean warbler) and the Minimum Quality 30 points below the Minimum Score (MQ ¼ 51 for acadian flycatcher, 47 for prothonotary warbler, and 37 for cerulean warbler). These values were based on our previous experience using the Song Scope software and were chosenas a compromise. Lower values would result in larger numbers of candidate vocalizations to screen, which would increase operator processing time, but higher values would result in missed vocalizations, increasing the probabilitythat a woodlot would be falsely classified as unoccupied. Additional scans were run at higher and lower sensitivities for comparison. At the highest sensitivity

Following a Song Scope run, the candidate vocalizations were evaluated by a single observer (SBH). In most cases, simply viewing the spectrogram was sufficient to confirm ordisprove the tentative identification. In some cases, however, it was necessary to listen to the audio as well. These processesare automated in Song Scope. The accuracy of each run wascalculated by comparing the number of confirmed vocal- izations to the number of candidate vocalizations ([no. confirmed/no. candidate] $\times$ 100).

We used Fisher's exact test (SigmaPlot for Windows[1] Version 11.0 software; Systat Software Inc., Chicago, IL) to compare detection rates from the 2 survey methods.

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

RESULTS

We scanned approximately 1,976 hours of recordings using the automated recognition software. At the default sensitivity setting, acadian flycatcher was detected in 8 woodlots using recorders versus 7 woodlots using the FBMP protocol (Table 1; Fisher's exact test, *P* ¼ 1.000); prothono- tary warbler was detected in 1 woodlot using recorders versus 3 woodlots using the FBMP protocol (Table 1; *P* ¼ 0.617); and cerulean warbler was detected in 2 woodlots using recorders versus 5 woodlots using the FBMP protocol (Table 1; *P* ¼ 0.436). Combining the methods resulted in a higher detection rate for acadian flycatcher, but the difference was not significant (13 woodlots combined vs. 7 woodlots FBMP, *P* ¼ 0.211; 13 woodlots combined vs. 8 woodlots recorders, *P* ¼ 0.326).

There was little correspondence between the 2 survey methods with respect to which woodlots were occupied (Table 1). Compared with the total number of detections for each species, acadian flycatcher was detected by both methods in only 2 of 13 woodlots, prothonotary warbler in 1 of 3 woodlots, and cerulean warbler in 2 of 5 woodlots. Recorders were present at 2 locations where acadian flycatcher was detected in point counts (Table 1). At one of these locations (woodlot 63), the automated system detected the species, but at the other (woodlot 41), it did not. Recorders were present at 3 locations where cerulean warbler was detected in point counts (Table 1). At the default sensitivity setting, the automated system was successful in detecting cerulean warbler at 2 of these locations (woodlots

46 and 60, but not 43; Table 1). When the sensitivity was increased, however, cerulean warbler was also detected in woodlot 43 (Table 2).

The number of candidate and confirmed vocalizations increased, but accuracy decreased, as the criteria for accepting recognizer results were relaxed (Table 2). Cerulean warbler was detected in 4 additional woodlots at the high-sensitivity settings (with no further improvement at the highest sensitivity setting) bringing the total to 6 versus 5 for the FBMP protocol (Tables 1 and 2). Combining the 2 methods, cerulean warbler was detected in 8 woodlots. None of these differences were significant, however (Fisher's exact test, FBMP vs. recorders, *P* ¼ 1.000; combined vs. FBMP, *P* ¼ 0.554; combined vs. recorders, *P* ¼ 0.774). Increasing the sensitivity beyond the default did not increase the number of woodlots where acadian flycatcher and protho- notary warbler were detected (Table 2). At the lowest sensitivity setting, acadian flycatcher was detected in 2 fewer woodlots than at the default setting, but the number of woodlots where prothonotary warbler and cerulean warbler were detected was unchanged (Table 2).

DISCUSSION

Automated analysis of sound recordings worked as well as the FBMP protocol (5 point counts) in identifying woodlots occupied by acadian flycatcher and cerulean warbler, whereas point counts outperformed recordings for prothonotary warbler. The recognizers were of similar quality, the recordings were made in the same environments and at

Table 1. Detections of acadian flycatcher, prothonotary warbler, and cerulean warbler in Song Meter (SM) recordings[a] and Forest Bird Monitoring Program (FBMP) point counts[b] in 50 woodlots in southwestern Ontario, Canada, 24 May to 8 July 2010.

	Acadian flycatcher warbler		Prothonotary warbler		Cerulean	
Woodlot	SM	FBMP	SM	FBMP	SM	FBMP
30	1(22)					
34	1(22)					
35_1	1(22)					
35_2						2
36						1
37		1				
39				1	þ[c]	
40		3				
41		3[d]			þ[c]	
43					þ[c]	1[d]
46					14/15(18)	3[d]
60					9/12(24)	4[d]
63	17(22)	2[d]		1		
66	1(27)				þ[c]	
94			1(21)	1[e]		
96	1(21)					
99		1				
143_1	1(22)					

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

209	1(21)	1[e]
210		2

[a] No. of days the species was detected, based on scans conducted at the default sensitivity setting (no. in brackets is the no. of recording days).
[b] No. of locations in which the species was detected. The max. was 5 (i.e., there were 5 point-count locations in each woodlot).
[c] The species was not detected at the default sensitivity setting, but was at the high-sensitivity setting. In each case, the species was heard in only a single recording.
[d] Indicates that a Song Meter was present at a point-count location where the species was detected.
[e] Indicates that the locations where the species was detected by Song Meter and by point-count were not the same.

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

Low (40/70)

No. of confirmed vocalizations by woodlot												
30	2	1	1	1								
34	19	17	10	4								
35_1	9	5	3	0								
39									4	2	0	0
41									4	1	0	0
43									1	1	0	0
46									965	641	300	130
60									398	270	136	64
63	396	331	225	90								
66	8	7	3	2					1	1	0	0
94					4	3	1	1				
96	48	38	17	3								
143_1	3	2	2	2								
209	6	2	2	0								
Total no. of confirmed vocalizations	491	403	263	102	4	3	1	1	1,373	916	436	194
Total no. of candidate vocalizations	18,751	3,715	661	124	36,342	19,657	7,990	1,790	27,194	10,745	2,648	750
Accuracy (%)[c]	2.6	10.9	39.8	82.3	<0.1	<0.1	<0.1	0.1	5.1	8.5	16.5	25.9
Estimated time required to confirm vocalizations (hh:mm)[d]	10:25	02:04	00:22	00:04	20:11	10:55	04:26	01:00	15:06	05.58	01:28	00:25

[a] ACFL, acadian flycatcher; PROW, prothonotary warbler; CERW, cerulean warbler.
[b] Minimum quality (MQ)/minimum score (MS). MS was set relative to the average fit (mean and SD) of the training data to the models (84.22% 3.19% for acadian flycatcher, 80.42% 3.14% for prothonotary warbler, and 70.00% 2.60% for cerulean warbler). At the highest sensitivity, MS ¼ $\bar{x} - 3$ SD, high-sensitivity MS ¼ $\bar{x} - 2$ SD, default MS ¼ $\bar{x} - 1$ SD, and low-sensitivity MS ¼ $\bar{x}$). MQ was always set 30 points lower than MS.
[c] Accuracy ¼ (no. of confirmed vocalizations/no. of candidate vocalizations) $\times$ 100.
[d] On average, it took about 2 seconds/candidate vocalization to confirm its identity, by examining the spectral signature and (if necessary) listening to the vocalization.

the same times, and the songs of all 3 species are loud and distinctive; therefore, the reasons for this difference are unclear. It could be related to differences in the non-breeding component of the species' populations. Both acadian flycatcher and cerulean warbler are much more common than prothonotary warbler in our study area (found in 26%,16%, and 8% of woodlots, respectively; see also Cadmanet al. 2007). Where suitable space is limited, larger pools of floaters (non-territorial males) tend to be associated with larger, more stable breeding populations (Winker 1998,Penteriani et al. 2011). Acadian flycatcher and ceruleanwarbler floaters would have been more effectively sampled bythe automated system, because it sampled many more days and many more times during the day than the point-count method,

International journal of application or innovation in engineering and management
ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

increasing the chances of detecting infrequently vocalizing, wandering males. The same argument would apply to males holding sub-optimal territories that were prospecting for vacancies (abandoned territories) in preferred habitat.

It is possible to roughly quantify the difference in effort required for the automated method versus the FBMP method. Both methods require 2 trips to a site, either to conduct 2 sets of point counts, or to install and remove a recording device. If one ignores the time required to develop the recognizer (discussed below), most of the difference in effort relates to the time required to confirm vocalizations in the lab versus the time required to conduct 5 point counts in the field. Welsh (1995) estimated that an FBMP site of 5

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

stations could be surveyed in as little as 100 minutes. Assuming 10 minutes to walk into a recording station, 10 minutes to set up (or remove) the recorder, and 10 minutes to walk out, the difference in effort between the 2 methods is 70 minutes/site. Point counts are conducted twice, so the total difference in effort is about 140 minutes/ site.

The time required to confirm vocalizations in the automated method will vary depending on the species, the distinctiveness of its vocalization(s), the quality of the recognizer, and the goal of the analysis (which determines the sensitivity settings in Song Scope). Based on the results of this study, we believe that setting the Minimum Score at 2 standard deviations below the average fit of the training data to the model and the Minimum Quality 30 points below the Minimum Score (our high-sensitivity setting) will provide the sensitivity necessary to identify occupied sites without generating an excessive number of false positives. Confirm-ing vocalizations at these settings required 2 hours and 4 minutes (approx. 2.5 min/woodlot) for acadian flycatcher, 10 hours and 55 minutes (approx. 13 min/woodlot) for prothonotary warbler, and 5 hours and 58 minutes (approx. 7 min/woodlot) for cerulean warbler. These times are inconsequential compared with the extra time required to conduct point counts in the field.

Developing a species recognizer can require substantial effort. In order to accumulate the necessary training data, recordings of the species vocalization(s) must be obtained

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

and annotated (i.e., representative vocalizations identified and defined using the Song Scope software). The time required for these steps depends primarily on the number and length of recordings available. For example, Agranat (2007) was able to annotate 137 vocalizations from 11 recordings in about 3 hours. Building, testing, and refining the recognizer may take an additional 2–3 hours (S. B. Holmes, personal observation). Although this amount of effort is not insignificant, we did not include it in the calculations above, because it is a one-time investment. Once the recognizer has been developed, it can be used repeatedly, in subsequent years, in different locations, or for different purposes.

Other differences between the 2 methods are more difficult to quantify. There may be considerable effort involved in transcribing field notes from point counts to electronic spreadsheets. Uploading and backing up data from SD cards and scanning *.wav* files using Song Scope software can require considerable computer time, but relatively little operator time. Computing time can be significantly reduced by simplifying the structure of the data directory so that it contains as few folders as possible, thereby reducing hard drive access times (S. B. Holmes, personal observation). In our calculations above, we assume that these operations more or less cancel each other out.

As applied, the 2 methods worked about equally well in detecting 2 of our 3 uncommon bird species. The comparison was not entirely fair, however. We surveyed 5 times as many locations with point counts as we did with recorders, and we conducted about 24 times as many 10-minute counts with the automated system as we did with the FBMP method. Presumably the FBMP method could be improved by adding more counts, although this would result in substantively higher labor costs (approx. 100 min/count, see above); and the automated method could be improved by adding more locations, either 1) by moving recorders among locations, which would also substantively increase labor costs, or 2) by increasing the number of recorders, which would increase both labor and capital costs. However, increasing the number of recorders would not entail additional visits to the woodlot, so increases in labor costs would be modest (approx. 15– 20 min/recorder added).

One of the most important advantages of the recording method is that it produces a permanent record (audio and spectrogram) of a species presence (Haselmayer and Quinn 2000, Acevedo and Villanueva-Rivera 2006), which can be verified by reference to an existing library of type vocalizations and/or by consulting known experts (Rempel et al. 2005, Celis-Murillo et al. 2009). In the field, the accuracy of point counts is dependent on the skill of the observer in detecting and identifying the species of interest in a complex and noisy environment. Their identifications can be confirmed if portable recorders are included as part of the formal point-count protocol (Hutto and Stutzman 2009), but this requires additional time, effort, and expense. Unambiguous identification should be an important consid-eration in conservation planning, especially for rare and endangered species.

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

In certain situations, point counts may be more effective than recordings at detecting uncommon or rarely heard species (Haselmayer and Quinn 2000, Hutto and Stutzman 2009), whereas in others, the opposite may be true (Celis- Murillo et al. 2009, 2012). In all of these studies, 10-minutepoint counts were compared with 10-minute recordings. Substantially increasing the recording time may increase the probability of detecting some species that are not detectedin point counts, however (Acevedo and Villanueva-Rivera 2006). The ability to survey for longer time periods (more dates and more time periods during the day), with little or no additional effort in the field, is what makes the recording system such a potentially effective survey tool. A major impediment to the full realization of this potential is the ability to analyze the massive amounts of acoustic datathat can be generated (Rempel et al. 2005). Automated recognition may be the key to resolving this problem (Acevedo and Villanueva-Rivera 2006, Swiston andMennill 2009), at least for some applications (such as detecting a species(s) of conservation concern within a restricted area (Celis-Murillo et al. 2009, Hutto and Stutzman 2009)).

Using the automated system, we were able to detect 6 acadian flycatchers and 3 cerulean warblers that were not detected in FBMP point counts. The recorders were located at point-count stations; therefore, these detections all represent birds that were missed by experienced field observers, probably because they were not singing when the observers were present. In contrast, FBMP point counts detected 5 acadian flycatchers, 2 prothonotary warblers, and
2 cerulean warblers that were missed by the automated system. However, for 8 of these detections, there were no recorders present at the point-count locations where the birds were observed, so it is not surprising that the automated system failed to detect the species. The failure of the automated recognition software to detect acadian flycatcher in recordings from a point-count location where the species was known to be present (woodlot 41) may be explained by differences between the vocalizations used to construct the recognizer (the training data) and thevocalizations recorded at the site. The recognizer was built to detect acadian flycatcher territorial song. A recorder was operating at this point-count location on one of the dates that acadian flycatcher was detected. We listened to all 9 morning recordings from this date, and in the fourth recording, which started at 0629 hours (approx. 15 min after the observer had completed her point count), 2 acadian flycatchers could be heard calling. One made 8 flutter calls (presumably the male; Whitehead and Taylor 2002) and theother (presumably the female) made 4 distinct “peet” calls. The entire vocal display lasted approximately 1.5 minutes. No acadian flycatcher vocalizations were heard on any of the other recordings (3 before and 5 after) from this date. We cannot explain why these birds apparently never sang at this location, although it is possible that their territory was located elsewhere and they were only temporarily attractedto the location by the presence of the observer (Gregoryet al. 2004). Acadian flycatcher was detected in point counts

ijaiem.com/June 2018/ Volume 7/Issue 1/Article No-1/22-38
ISSN: 2319-4847

at 2 other locations in this woodlot (309 m and 366 m away from this location).

Our default sensitivity setting worked well for detecting acadian flycatcher and prothonotary warbler, but a higher sensitivity was required to detect cerulean warbler. This difference is likely due to the relatively low fit of the training data to the cerulean warbler model (70.0% vs. 80.4% for prothonotary warbler and 84.2% for acadian flycatcher). As suggested above, scanning recordings with the Minimum Score set at 2 standard deviations below the average fit of the training data to the model and the Minimum Quality 30 points below the Minimum Score (our high-sensitivity setting) should be adequate to identify occupied sites when

fit is in the range of ≥70%. When the fit is lower, however, scans at higher sensitivity may be required.

MANAGEMENT IMPLICATIONS

An automated system, coupling acoustic recordings with automated sound recognition, can provide a useful tool for documenting the localized presence of species-at-risk and other uncommon forest bird species across extensive areas of their potential range. The method works at least as well as FBMP point-count surveys and requires less effort. Combining both methods will result in more detections than either method separately, which can be attributed to the fact that one of the methods is spatially more extensive (FBMP) and the other (acoustic recordings) temporally more extensive. Incorporating automated recording and detection systems into bird monitoring programs has the potential to increase efficiency and control costs, while at the same time provide more complete information on species distributions and trends in occupancy over time.

REFERENCES:

Villanueva-Rivera, L. J., and Acevedo, M. A. that year 2006. Bird and amphibian populations may be effectively monitored with the use of automated digital recording devices. The article is published in the Wildlife Society Bulletin, volume 34, pages 211–214.

I. D. Agranat (2007). Using Song Scope bioacoustics software and autonomous recording equipment, cerulean warblers may be automatically detected. Notify the United States Forest Service. Here is the link to the final report on Cerulean warblers: http://www.fs.fed.us/t-d/programs/im/ acoustic_wildlife/Cerulean%20Warbler_%20Report_Final.pdf. Accessed on December 4, 2012.

D. J. Hanni and J. A. Blakesley. in 2009. Collecting data on Colorado's bird population in 2008. Research Report M-MCB08-01, Rocky Mountain Bird Observatory, Brighton, Colorado, USA.

This is Brandes (2008). Instruments for the automated recording and analysis of bird calls for use in conservation efforts. Species of Birds in Peril, Vol. 18, No. S163–S173.

S. T. Buckland (2006). Robust methodology for point transect surveys of songbirds! The Auk 123:345-357 (2012).

Their names are G. S. Butcher, B. Peterjohn, and C. J. Ralph. the year 1993. A synopsis of databases and tools used to track the number of birds around the country. Within the edited volume of D. M. Finch and P. W. Stangel, pages 192–203. Estes Park, Colorado, 21–25 September 1992: A status report and management plan for Neotropical migrating birds. Rocky Mountain Forest and Range Experiment Station General Technical Report RM-229, United States Forest Service, Fort Collins, Colorado, USA.

With contributions from G. G. Beck, A. R. Couturier, D. Lepage, D. Cadman, and D. A. Sutherland, editors. that year. An inventory of Ontario's breeding birds, from 2001 to 2005. Organisations in Toronto, Canada, including Bird Studies Canada, Environment Canada, the Ontario Ministry of Natural Resources, and Ontario Nature, are involved in field ornithology.

C. M. Francis and M. Campbell. 2011. A study of observer variability in the North American Breeding Bird Survey point counts was conducted using stereo microphones. No. 128:303–312, The Auk.

J. L. Deppe, M. F. Allen, and Celis-Murillo, A. 2009. Assessing bird diversity, richness, and abundance via the use of soundscape recordings. Publishing in the Journal of Field Ornithology, volume 80, pages 64–78.

Authors: Celis-Murillo, A., Deppe, J. L., and Ward, M. P. Acoustic recordings for tropical bird surveys: their efficacy and practicality in 2012. This article is published in the Journal of Field Ornithology and has the running time of 83 pages. The year 1999 was dedicated by Couturier. Birds of southern Ontario: conservation priority. Research Report from the Canadian Institute of Bird Studies, Concealed. For more information, see http://www.bsc-eoc.org/conservation/municipal/report/cpmain.pdf. The date of access was October 29, 2012.
This is Falardeau (2009). Coverage analysis of breeding bird surveys in Quebec. Submitted by the Environmental Stewardship Branch of the Canadian Wildlife Service in Quebec City, Canada, this document is Technical Report Series no. 498.
The following individuals are affiliated with the organization: Fitzpatrick, J. W., M. Lammertink, M. D. Luneau, Jr., T. W. Gallagher, B. R. Harrison, G. M. Sparling, K. V. Rosenberg, R. W. Rohrbaugh, E. C. H. Swarthout, P. H. Wrege, S. B. Swarthout, M. S. Dantzker, R. A. Charif, T. R. Barksdale, J. V. Remsen, Jr., S. D. Simon, and D. Zollner. It is still possible to see ivory-billed woodpeckers (Campephilus principalis) in North America as of 2005. Research in Science 308:1460–1462.
R. D. Gregory, D. W. Gibbons, and P. F. Donald are authors. the year 2004. A method for counting and surveying birds! Chapters 17–55 in the edited volume by W. J. Sutherland, I. Newton, and R. Green. Ecology and conservation of birds: a methodological guide. Published by Oxford University Press in Oxford, England, UK.
Niemi, G. J., and J. M. Hanowski. 1995. Methodological issues in developing a point-count-based, off-road bird monitoring program. Sections 145–150 of C. As editors, J. Ralph, J. R. Sauer, and S. Droge presented the work. Counting birds as a means of population monitoring. Publication: PSW-GTR-149, United States Forest Service, Pacific Southwest Research Station, Albany, California, USA (2006).
Jonathan S. Quinn and J. Haselmayer. The year 2000. Two approaches to bird surveying in the Amazonian region of southeastern Peru: point counts and sound recording. There are 102 pages in The Condor, numbered 887-893. With contributions from G. E. Hill, D. J. Mennill, B. W. Rolek, T. L. Hicks, and K. A. Swiston.
that year 2006. The presence of ivory-billed woodpeckers (Campephilus principalis) in Florida has been suggested by some evidence. "Ecologie et conservation des oiseaux" (The Ecology and Conservation of Birds) 1:2. (article 2/page 121) http://www.ace-eco.org/vol1/iss3/art2/. Reached on December 11, 2012.
S. L. Van Wilgenburg, K. A. Hobson, H. Greenwood, B. Turnbull, and R. S. Rempel. The year 2002. Electronic bird sound surveys: novel opportunities presented by an omnidirectional microphone array. Animal Welfare Bulletin 30: 709–720.
Rudolph L. Hutto and Rudolph J. Stutzman. in 2009. Using point-count data, we compare human and autonomous recording devices. The article may be found in volume 80, issue 3, of the Journal of Field Ornithology.
Minister of Natural Resources of Ontario. The year 2000. Managing forests in southern Ontario: a silvicultural handbook. Publisher for the province of Ontario, Toronto, Canada, by the Queen's Printer.
M. M. Delgado, V. Penteriani, and M. Ferrer. 2011. Towards a better knowledge of nonbreeders in avian populations: the role of floater tactics and dynamics in conservation biology. Volume 14, Issue 2, Pages 233–241.
J. R. Sauer, S. Droege, and C. J. Ralph. 1995. Counting birds as a means of population monitoring. Publication PSW-GTR-149, Albany, California, USA: United States Department of Agriculture, Forest Service.
J. Elliott, G. Holborn, S. L. Van Wilgenburg, K. A. Hobson, and R. S. Rempel. year 2005. Using bioacoustics to track woodland songbirds: how interpreters differ and how lab setup and digital processing affect results. Number 76, pages 1–11, Journal of Field Ornithology.
Bystrak, D., Robbins, C. S., and Geissler, P. H. In 1986. From 1965 to 1979, the Breeding Bird Survey was conducted. Pub. no. 157 by the United States Fish and Wildlife Service, Washington, D.C., USA.
Giesen, K. M., Rosenstock, S. S., Leukering, T., and Carter, M. F. The year 2002. Counting landbirds: the standard method and an alternate viewpoint. Chapters 46–53 of The Auk-119.
John J. Stadt, Johann Schieck, and Herbert A. Stelfox. Sustainable forest management planning effectiveness monitoring in Alberta, 2006—the province's biodiversity monitoring program. Pages 33–46 of the journal Environmental Monitoring and Assessment, volume 121.
G. J. Mennill and K. A. Swiston. in 2009. Investigating the relative merits of human and machine approaches to target sound recognition in pileated, pale-billed, and presumed ivory-billed woodpecker recordings. Article

published in the Journal of Field Ornithology, volume 80, pages 42–50.
These authors are Venier, A., Holmes, S. B., Holborn, G. W., McIlwrick, K. A., and Brown, G. 2011. Assessment of a system for the automatic recording of forest bird populations. The article is published in the Wildlife Society Bulletin at volume 36, pages 30-39.