Disentangling the effects of roads and forest edge on bird species richness

By

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Abstract

Roads and traffic disturb nearby bird habitats by creating an additional habitat edge, traffic noise, increased mortality, and other forms of pollution. We investigated declines in bird species richness near high traffic roads and controlled for an edge effect by conducting bird surveys along two transects, forest edge and forest interior, which ran perpendicular to the road. Traffic volumes were obtained at each bird survey location to test if noisier areas had fewer species. For both transect types there was a positive relationship between species richness and distance from the roads, with species richness increasing to a threshold distance of 300 m from the roads. At a given distance, sites with louder traffic noise did not have fewer species. Species with lower dominant call frequencies were not the species most affected by roads. Our results show that roads, independent of edge effects, are causing a decline in bird species richness.

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Table of Contents

Abstract.....	ii
Acknowledgements.....	iii
Table of contents.....	v
List of tables.....	vi
List of figures.....	vii
List of appendices.....	viii
Introduction.....	1
Methods.....	4
Site selection.....	4
Bird surveys.....	4
Traffic noise.....	6
Vegetation surveys.....	7
Analysis.....	8
Results.....	10
Discussion.....	12
Conclusion.....	22
References.....	23

List of Tables

Table 1. Pearson correlations between the distance to the road and species richness for each of the vegetation characteristics measured at each point count location for both the edge and forest transects perpendicular to high traffic roads at 10 sampling sites.

Table 2. Piecewise regression analyses with total species as the dependent variable and the distance to the road and site as the predictor variables. N= 59 for edge transects x distances, N= 58 for forest transects x distances. Site was included in all models as a categorical co-variate (10 sites).

Table 3. ANOVA tables for the best fit piecewise regression model for the edge (break at 250m from the road) and forest transects (break at 300m from the road). Site was included in all models as a categorical co-variate (10 sites). Slope difference is the difference between the slopes of the two lines in the piecewise regression.

Table 4. Piecewise regression analyses with traffic noise as the dependent variable and the distance to the roads and site as the predictor variables. N= 59 for edge transects x distances, N= 58 for forest transects x distances. Site was included in all models as a categorical co-variate (10 sites).

Table 5. Separate regression analyses of total number of species on traffic noise at each distance from the roads.

Table 6. Results of the binary logistic regression for each species tested with distance to the roads and transect type (edge or forest) as the predictor variables. (n* is the number of individuals observed in the binary logistic regression from a total of 117 point count locations across 10 sites).

List of Figures

Figure 1. Location of the 10 bird survey sites in eastern Ontario, Canada. Thick lines represent the major highways in which study sites were located. Thin gray lines represent other local roads.

Figure 2. Illustration of a typical site. Circles represent locations of the 50m radius point counts. Arrows labelled 'A' and 'B' indicate the directions of the surveys. The direction was randomly chosen for the early morning survey on the first visit and the same direction was maintained for the rush hour survey. For the second visit the directions of the surveys were reversed, so if during the first visit the order was 'A', during the second visit the order was 'B'.

Figure 3. The total number of species observed at each point count location along 10 edge transects perpendicular to roads, with increasing distance from the roads. Total number of species is the number of unique species observed at each point count location over the two visits on two separate dates with two point counts per visit. The size of the circle represents the number of overlapping points (1,2 or 3). A significant linear piecewise regression estimated the break point at 250m ($F=4.816$, $P=0.001$, $R^2=0.425$).

Figure 4. Total number of species observed at each point count location along the 10 forest transects with increasing distance from the roads. Total number of species is the total number of unique species observed at each point count location over the two visits on two separate dates with two point counts per visit. The size of the circle represents the number of overlapping data points (1,2 or 3). A significant linear piecewise regression estimated the best break point at 300m ($F=6.11$, $P<0.001$, $R^2=0.497$).

Figure 5. The recorded levels of traffic noise at each point count location significantly decreased with increasing distance from the highway along the 10 edge transects ($F=135.0$, $P<0.001$, adjusted $R^2=0.822$).

Figure 6. The recorded levels of traffic noise at each point count location significantly decreased with increasing distance from the highway along the 10 forest transects ($F=75.188.1$, $P<0.001$, adjusted $R^2=0.691$).

Figure 7. The binary logistic regression coefficients of species occurrence on distance from the road for each of the 25 species recorded more than 10 times across all 10 sites vs. the estimated dominant call frequency of each species (Coeff= -0.0004, $F=1.263$, $P=0.27$, $R^2=0.011$).

List of Appendices

Appendix A (a). Additional general linear models results that tested the predictions that species richness increases with increasing distance from the road and that traffic noise is causing the decline along the edge transects. In all models species richness is the dependent variable. Site was included in all models as a categorical co-variate (10 sites).

Appendix A (b). Additional general linear models results that tested the predictions that species richness increases with increasing distance from the road and that traffic noise is causing the decline along the forest transects. In all models species richness is the dependent variable. Site was included in all models as a categorical co-variate (10 sites).

Appendix B. The results of general linear models used to examine the relationship between traffic noise and distance from the road for both the edge and forest transects. Average traffic noise from the four recordings (two dawn survey recordings, two rush hour recordings) was used as the dependent variable. Site was included in all models as a categorical co-variate (10 sites).

Appendix C (a). The results of several general linear models which used only the data in which there was the greatest increase in species richness along the edge transect (first 300m from the road) to test whether traffic noise could explain the change in species richness. Species richness was the dependent variable and site was included in all models as a categorical co-variate (10 sites).

Appendix C (b). The results of several general linear models which used only the data in which there was the greatest increase in species richness along the forest transect (first 300m from the road) to test whether traffic noise could explain the change in species richness. Species richness was the dependent variable and site was included in all models as a categorical co-variate (10 sites).

Appendix D (a). The results of several general linear models used to test whether there was a decrease in species richness near roads during the dawn surveys, when traffic noise was at a minimum. Species richness along the edge transects during the dawn surveys was the dependent variable and site was included in all models as a categorical co-variate (10 sites).

Appendix D (b). The results of several general linear models used to test whether there was a decrease in species richness near roads during the dawn surveys, when traffic noise was at a minimum. Species richness along the forest transects during the dawn surveys was the dependent variable and site was included in all models as a categorical co-variate (10 sites).

Appendix E (a). The results of several general linear models used to test whether there was a decrease in species richness near roads during the rush hour surveys and whether traffic noise during these surveys could explain the change in species richness. Species richness along the edge transects during the rush hour surveys was the dependent variable and site was included in all models as a categorical co-variate (10 sites).

Appendix E (b). The results of several general linear models used to test whether there was a decrease in species richness near roads during the rush hour surveys and whether traffic noise during these surveys could explain the change in species richness. Species richness along the forest transects during the rush hour surveys was the dependent variable and site was included in all models as a categorical co-variate (10 sites).

Appendix F (a). Box plots of the traffic noise (top figure) and species richness (bottom figure) at each distance from the road collected during the dawn and rush hour surveys along the edge transect.

Appendix F (b). Box plots of the traffic noise (top figure) and species richness (bottom figure) at each distance from the road collected during the dawn and rush hour surveys along the forest transects.

Appendix G (a). The results of several general linear models used to determine whether peak noise, the loudest recorded traffic noise level between the frequencies of 300 – 2000 Hz at each point count location along the edge transect could explain the decline in species richness close to the roads and whether there was a relationship between peak noise and distance from the road. Site was included in all models as a categorical co-variate (10 sites).

Appendix G (b). The results of several general linear models used to determine whether peak noise, the loudest recorded traffic noise level between the frequencies of 300 – 2000 Hz at each point count location along the forest transect could explain the decline in species richness close to the roads and whether there was a relationship between peak noise and distance from the road. Site was included in all models as a categorical co-variate (10 sites).

Appendix H(a). Descriptive analyses to examine the variance in traffic noise levels (dBA) across sites (n) at each distance from the road. Traffic noise is the averaged noise level (dBA) from four recordings (two recordings from dawn surveys, and two from the rush hour surveys) at each point count location.

Appendix H (b). Descriptive analyses to examine the variance in traffic noise levels (dBA) across sites (n) at each distance from the road during the dawn bird surveys. Traffic noise is the averaged noise level (dBA) from two recordings at each point count location during the dawn surveys.

Appendix H (c). Descriptive analyses to examine the variance in traffic noise levels (dBA) across sites (n) at each distance from the road during the rush hour bird surveys. Traffic noise is the averaged noise level (dBA) from two recordings at each point count location during the rush hour surveys.

Appendix I. Life history traits for the 25 species used in the binary logistic regression used to determine whether a particular life history traits (habitat preferences, nest location, diet, foraging method) is more prevalent in those species that were observed more often at distance far from the road. *Ground glean* are those that pick items from the ground surface. *Foliage glean* involves taking invertebrate or fruit from any vegetation directly on the ground. *Bark glean* involves taking invertebrates from woody trunks and branches. *Gleaning while hovering* are those that take food from plant that are above the ground while the bird continues to hover. *Hawking* involves short flights from a perch to catch an insect

Appendix J. Box plots of the coefficients from the 25 species used in the logistic regression grouped by their life history traits.

Appendix J (a). Logistic regression coefficients of the 25 most common species grouped by their preferred habitat: forest, forest edge or both.

Appendix J (b). Logistic regression coefficients of the 25 most common species grouped by their nest location.

Appendix J (c). Logistic regression coefficients of the 25 most common species grouped by their most common foraging method. *Bark glean* involves taking invertebrates from woody trunks and branches. *Foliage glean* involves taking invertebrate or fruit from any vegetation directly on the ground. *Ground glean* are those that pick items from the ground surface *Hawking* involves short flights from a perch to catch an insect.

Appendix K. The forest patch size for each of the sites surveyed for bird and the average annual daily traffic volume (AADT) of the major road adjacent to the forest patch.

Appendix L. Bird survey coordinates in decimal degrees (WGS 1984) for each distance from the road along the edge and forest transects of the 10 sites surveyed in eastern Ontario.

Appendix M(a). Vegetation survey data used for the correlation analysis between each of the vegetation characteristics and both distance from the road and bird species richness along the edge transects. Vegetation data was collected 5 m into the forest for each point count location along the edge transects for the 10 sites located in eastern Ontario between July 21st and August 1st 2008.

Appendix M (b). Vegetation survey data used for the correlation analysis between each of the vegetation characteristics and both distance from the road and bird species richness along the forest transects. Vegetation data was collected at each point count location along the forest transects for the 10 sites located in eastern Ontario between July 21st and August 1st 2008.

Appendix N (a). The number of individuals of each species observed at all point count locations during the early season visits (May 12th to June 11th 2008). Each table is labelled with the site number, and either **a**, the dawn surveys or **b** the rush hour surveys for both the edge and forest transects. A dashed mark (-) indicates a distance from the road where there was not a point count location due to inaccessibility or a short transect.

Appendix N (b). The number of individuals of each species observed at all point count locations during the late season visits (June 20th to July 17th 2008). Each table is labelled with the site number, and either **a**, the dawn surveys or **b** the rush hour surveys for both the edge and forest transects. A dashed mark (-) indicates a distance from the road where there was not a point count location due to inaccessibility or a short transect.

Appendix O (a). Traffic noise levels calculated as the average decibel (dBA) level recorded between the frequencies of 300 and 2,000 Hz for each 5 minute recording at each point count location along the edge transects. Visit 1 occurred on weekdays between May 12th and June 11th 2008 and visit 2 occurred on weekdays between June 20th and July 17th 2008). Dawn surveys began 30 minutes before sunrise and the rush hour surveys began at approximately 7:00 am. A dashed mark (-) indicates a recording in which traffic noise level could not be calculated due to playback errors in the recording.

Appendix O (b). Traffic noise levels calculated as the average decibel (dBA) level recorded between the frequencies of 300 and 2,000 Hz for each 5 minute recording at each point count location along the forest transects. Visit 1 occurred on weekdays between May 12th and June 11th 2008 and visit 2 occurred on weekdays between June 20th and July 17th 2008). Dawn surveys began 30 minutes before sunrise and the rush hour surveys began at approximately 7:00 am. A dashed mark (-) indicates a recording in which traffic noise level could not be calculated due to playback errors in the recording.

Appendix P. A list of all the bird species, their scientific names and their associated American Ornithologist Union (AOU) code, (Pyle and DeSante 2003) used to calculate bird species richness at each bird survey location.

Introduction

A growing body of research has demonstrated that bird abundance and species richness decrease with increasing proximity to high traffic roads in both forest (Reijnen et al. 1995; Kuitunen et al. 1998; Brotons and Herrando 2001) and grassland habitats (van der Zande et al. 1980; Reijnen et al. 1996; Forman et al. 2002). However, the effects of roads is species specific with some species showing a negative response to the road while other species show no effect or a positive response to the road (Ferris 1979; Reijnen et al. 1995; Kuitunen et al. 1998; Peris and Pescador 2004). For example, of the 43 species analyzed by Reijnen et al. (1995) in two habitat types, coniferous and deciduous woodland, 26 species showed evidence of reduced density near the road in at least one of the habitat types. The remaining species showed either an increase in density near the road or no change in density near the road.

One possible explanation for the species specific response to roads is the potential confounding effect of forest edge. The development of a road often fragments a continuous forest patch to create an additional edge habitat. Studies examining the effects of forest edges have shown increased bird densities at edges due to complimentary resource distribution, i.e, the availability of different resources from two habitat types created by the edge (Dunning et al. 1992). Other birds have also been shown to avoid edges due to increased nest predation (Chalfoun et al. 2002) or brood parasitism by the Brown-headed Cowbird (*Molothrus ater*) (Donovan et al. 1997) or to changes in microhabitat (Saunders et al. 1991; Murcia 1995). Forest bird species can thus be categorized as forest interior birds, those birds which show reduced occupancies near forest edges, forest generalists, those species that are equally abundant in the edge and the

forest interior, or edge species, those species showing preference for forest edges (Sisk et al. 1997; Villard 1998; Ries and Sisk 2004). Previous studies examining the effects of roads on bird abundance have not specifically controlled for a possible edge effect and it is unclear if species are showing a response to the road itself or to the edge created by the road. The first objective of this study was to test the prediction that when distance to the edge is controlled for, bird species richness will decrease with increasing proximity to high traffic roads.

Traffic noise has been suggested as the most likely cause of the decrease in birds close to roads (Reijnen et al. 1995; Reijnen and Foppen 1997; Stone 2000; Forman et al. 2002; Rheidnt 2003; Peris and Pescador 2004). Other potential causes such as visual disturbance, and chemical pollution have been dismissed because it is thought that their effects do not extend sufficiently far from the road (Reijnen et al. 1995, 1996; Forman et al. 2002). There are three main ways traffic noise is thought to affect birds. First, noise could increase the birds' stress level. Measuring stress levels in wild populations of birds is difficult because it requires the collection of blood, but elevated stress has been recorded in captive laying hens in the presence of noise (Campo et al. 2005). Second, noise could increase predation risk. In the presence of noise a bird's ability to hear an approaching predator is compromised and as a result the bird must rely more on visual cues to identify predators. This increased visual surveillance resulted in foraging behaviour changes in the Chaffinch's (*Fringilla coelebs*), which spent less time with their heads down foraging and more time scanning their surroundings (Quinn et al. 2006). Finally, because birds rely on vocal cues for mate attraction and other forms of communication, the masking or distortion of these calls can have serious consequences

for birds. Masking occurs when the frequency of the traffic noise is similar to part of or the entire bird song (Klump 1996). The response to traffic noise seems to be species specific; Peris and Pescador (2004) estimated that only 15% of the species examined were negatively affected by the presence of traffic noise. It has been suggested that the species specific response to traffic noise may be related to the calling frequency of the species. Those species with lower calling frequencies may be more susceptible to the effects of traffic noise because traffic noise is similarly low in frequency (Rheindt 2003).

Studies that suggest traffic noise as the cause of the decline in birds near roads have not actually measured traffic noise at the bird survey locations. Rather, they have modeled noise volumes for the bird survey locations (Reijnen et al. 1995), classified the bird survey locations as low, medium and high noise levels (Stone 2000) or have taken noise readings at the roadside rather than the survey locations (Peris and Pescador 2004) . Although modeling noise levels can give an estimate of the traffic noise it cannot account for all the effects of habitat characteristics such as vegetation type, density, height and complexity on the attenuation of noise (Bucur 2006). Measuring traffic noise levels at the location of the bird surveys would eliminate this problem. The second objective of this study was therefore to determine if traffic noise measured at the bird survey locations can explain the decrease in bird species richness with proximity to high traffic roads. We predicted that noisier locations would have fewer species than quieter locations and that those species most affected by traffic noise would be those with lower calling frequencies.

Methods

Bird surveys were conducted in 10 forest patches that were in close proximity to high traffic roads in eastern Ontario, Canada (Figure 1). A high traffic road was classified as a road having greater than 10,000 average annual daily traffic volumes (AADT) (Ministry of Transportation Ontario 2005). We avoided the shortcomings of previous studies in two ways. First, we compared bird species richness with distance from roads along transects both in forest patches and along forest edges perpendicular to the road (Figure 2). Second, we measured actual traffic noise at each bird survey location.

Site Selection

To control for the confounding effect of forest edge, forest patches with a distinct forest edge running perpendicular to a high traffic road were selected for surveys. This design effectively controls for a possible edge effect as bird surveys along this distinct edge have the same forest edge with varying distance from the road. The forest edge always bordered agricultural land, either row crops or pasture. The length of the forest edge running perpendicular the road was at least 600 m, except for one site where it was 500 m. All forest patches were mixed deciduous and coniferous forests.

Bird Surveys

Each site was surveyed on two separate visits between May 12th and July 18th 2008. This ensured that both early and late breeding birds were represented in the surveys. To control for typical rush hour traffic patterns, surveys were only conducted during weekdays. The order in which sites were surveyed was randomly chosen for the first visit and the same order was maintained for the second visit. All point count

locations at a site were surveyed twice on the same day, first in the early morning, beginning 30 minutes before sunrise and second during rush hour starting at approximately 7:00am. All surveys were completed before 9:00am.

At each site we conducted point counts along two separate parallel transects that ran perpendicular to the road. From the road one transect ran along the distinct forest edge and the other ran into the forest 100 m from the distinct edge. The first point count position for each transect was 50 m from the forest edge adjacent to the road, and following point counts were conducted every 100 m along the transect (Figure 2). Surveys were always started at the point count locations closest to the road; however the starting transect was randomly chosen for the early morning survey of the first visit. The rush hour survey was conducted in the same direction; for the second visit, the order was reversed (Figure 2).

Bird surveys consisted of 5 minute, 50 m radius point counts where all birds seen or heard during the point count were recorded (Bibby et al. 2000). Birds that flew through the point count area were not counted. To minimize any human disturbance on the signing behaviour of the birds, upon arriving at a point count location we remained still and quiet for at least a minute before starting the point count. Surveys were not conducted in rainy or windy (greater than 20 km/hr or 4 on a Beaufort scale) conditions.

To correct for the potential problem of detecting all birds in the presence of traffic noise, all point counts were recorded. The traffic noise (noise below the frequency of 2000 Hz) was removed from the recording and the recording was examined for additional species that were missed. In addition, the dawn surveys were conducted to ensure that

each point count location was surveyed during a time when there was little traffic noise. As birds are territorial during the breeding season, it was assumed that those birds calling during the dawn surveys were those birds which occupied a territory at that location.

Traffic Noise

The full duration of each point count was recorded using a Sampson Zoom H4 recorder with stereo unidirectional electret condenser microphone at a sampling rate of 48 kHz. A box was constructed that fit over the microphones to create dead air space for the purpose of decreasing wind noise on the recordings. The rectangular box frame was approximately (15 cm x 15 cm x 10 cm) in size and was covered in 'fun fur'. The box fit tightly over the recorder with flexible styrofoam. The recorder was placed on a tripod 1m from the ground.

Traffic noise readings were taken from these recordings and were calculated using Raven Pro 1.3 (Cornell Lab of Ornithology) as the average power (dBA) of the noise between the frequencies 300 – 2,000 Hz over the full 5 minute duration of the recording. Most human made noise, such as traffic noise, occurs at frequencies less than 2,000 Hz (Warren et al. 2006) and to control for the wind noise and vibration noise from the recorder, frequencies below 300 Hz were not used. Very few bird species have calls lower than 2,000 Hz; therefore noise from calling birds is not expected to be included in the traffic noise calculation (Slabbekoorn and Ripmeester 2008). Average traffic noise level was calculated from the 4 recordings at each point using the formula

$$L_p = 10 \log_{10} \left[\left(\frac{1}{n} \right) \sum_{i=1}^n \log_{10}^{-1} (L_{pi}/10) \right]$$

where L_p = the average decibel level L_{pi} = the decibel level at a given time and n = the number of decibel levels being averaged.

Vegetation Surveys

Vegetation surveys were carried out in a 10 x10 m plot at each point count location. As this study only surveyed the birds within the forest, the centres of the vegetation plots along the edge transects were placed 5 m into the forest. The point center quarter method was used to survey trees; we recorded the distance to the nearest tree in each quadrant, the species of the tree and its diameter at breast height (Cottam and Grant 1956). In addition, average shrub height and number of shrubs were estimated in each 10 x10 m plot. Average ground vegetation height and percent cover were also estimated. Canopy closure observations were taken using an ocular tube (1^{1/4} inch PCV pipe with cross hairs) at each corner and the center of the vegetation plots. A positive canopy observation was recorded if any leaf or branch intersected the center crosshairs of the ocular tube (Grushecky and Fajvan 1999). A coarse measure of percent canopy closure was calculated by dividing the number of positive observations by the total number of observations in each plot. We used the same locations within the vegetation plots to estimate percent ground cover, where sightings were made looking down through the ocular tube at the ground cover vegetation. A positive observation was recorded if any vegetation intersected the center of the crosshairs of the ocular tube and percent ground cover was calculated by dividing the number of positive observations by the total number of observations in each plot.

Analysis

The total number of different species from the four point counts (two visits, early and late season and two surveys per visit, dawn and rush hour) at each point count location was used as the response variable. Species richness at a point count location was considered equivalent to bird abundance at that location as it was unlikely to have two different breeding birds of the same species in a 50 m radius area. To test the prediction that bird species richness increased with increasing distance from the road a general linear model (GLM) was used with the distance to the forest edge adjacent to the road (hereafter, distance to the road) and site (a class variable) as predictors in SPSS for windows release 16.0.1 (2007). For both types of transects there appeared to be a threshold distance where species richness did not continue to increase. We used a piecewise regression using the segmented package in R version 0.2-4 (Muggeo 2008) to estimate the breakpoints. We began by visually estimating the breakpoints and then tested an additional four breakpoints smaller and four breakpoints larger than the initial estimated breakpoint.

To test if traffic noise explained the relationship between distance from the road and bird species richness we conducted four analyses. First, we conducted a GLM model of bird species richness, traffic noise and site based on the notion that if noise is the cause of the ‘distance from the road effect’ the relationship of species richness to noise should be stronger than the relationship of species richness to distance. Second, we tested for breakpoints in the relationship between traffic noise and distance from the road. The same distances that were used to test breakpoints with species richness vs. distance were

then tested with traffic noise vs. distance. This was based on the reasoning that if traffic noise explained the relationship (including the breakpoint) between species richness and distance to the road then there should be a similar breakpoint in the relationship of traffic noise vs. distance to the road. Since traffic noise (dBA) is measured on a log scale we also conducted a GLM model with traffic noise as the dependent variable with site and the log distance from the road as the predictors to examine the relationship between traffic noise and distance without a breakpoint. Third, we tested for the effect of traffic noise while controlling for distance by conducting a separate linear regression of species richness on traffic noise at each distance from the road. Finally, if noise is masking bird calls the cause of the species richness response we predicted that those species calling at a lower frequency would be more affected by the low frequency traffic noise and would therefore show stronger road avoidance. We tested for any effects of distance from the road on individual species occurrences for species with adequate representation (minimum 10 occurrences across all sites) using a binary logistic model. For each of these species we then examined three high quality recordings of a typical song from the Cornell University Lab of Ornithology Macaulay Library using Raven Viewer (Macaulay Library). For each recording the lowest and highest frequencies of the loudest portion of the call was estimated and the average of these frequencies across the three recordings, was considered the dominant calling frequency for that species. A cross-species regression was then performed using the logistic regression coefficients from the individual species occurrence vs. distance from road analyses as the dependent variable and the species' dominant calling frequencies as the predictor.

Results

A total of 63 bird species, (54 along the edge transects and 54 along the forest transects), were observed during the study period. The mean number of species recorded at a point count location along the edge transects was 7.15 (range 2-12 species) and along the forest transects 8.29 (range 3-13 species). In all statistical analyses (see below) the effect of site on bird species richness was very strong, indicating large differences in the bird species present among sites.

The most common dominant species of deciduous tree were *Acer rubrum*, *Acer saccharinum*, *Populus tremuloides*, *Ulmus americana*, and *Fraxinus nigra*. The most common species of coniferous tree were *Thuja occidentalis*, *Picea glauca*, and *Picea mariana*. There were no strong correlations between any of the vegetation variables (canopy cover, ground cover, shrub height, number of shrubs) and distance from the roads or bird species richness along the edge transects. Along the forest transects the number of shrubs was the only variable that had a significant positive correlation with bird species richness (Table 1).

For both the edge and forest transects there was a positive relationship between bird species richness and distance from the roads when site was controlled for (Edge $F = 4.382$, $P = 0.042$, adjusted $R^2 = 0.358$; Forest $F = 5.481$, $P = 0.024$ adjusted $R^2 = 0.408$). The largest increase in bird species richness occurring within the first 300m from the roads (Figures 3&4). Of the several breakpoints tested in a piecewise regression, the model with the highest adjusted R squared was one with a break at 250 m for the edge transects and at 300m for the forest transects (Tables 2&3). There was a significant

negative linear relationship between species richness and traffic noise when site was controlled for along the forest transects ($F = 5.827$, $P = 0.0002$, adjusted $R^2 = 0.506$). There was a marginally significant negative linear relationship between species richness and traffic noise when site was controlled for along the edge transects ($F = 3.779$, $P = 0.0578$, adjusted $R^2 = 0.350$).

There was a significant negative relationship between traffic noise and the distance from the road for both transect types when site was controlled for (Edge $F = 135.0$, $P < 0.001$, adjusted $R^2 = 0.822$; Forest $F = 75.188$, $P < 0.001$, adjusted $R^2 = 0.691$, Figures 5 & 6). Of the breakpoints tested in a piecewise regression the model with the highest adjusted R squared was one with a breakpoint at 200 m for the edge transect and at 225 m for the forest transect (Edge $F = 40.30$, $P < 0.001$ adjusted $R^2 = 0.882$; Forest $F = 19.58$, $P < 0.001$, adjusted $R^2 = 0.782$, Table 4). The model between traffic noise and the log distance to the road had comparable adjusted R squared values to the breakpoint model (Edge $F = 241.7$, $P < 0.001$, adjusted $R^2 = 0.885$; Forest $F = 113.1$, $P < 0.001$, $R^2 = 0.775$).

None of the regressions of bird species richness on traffic noise conducted separately for each distance from the road across sites were statistically significant and most coefficients were positive (Table 5).

Of the 63 species observed, 25 had a total of 10 or more observations. Separate binary logistic regressions were run for each of these species using the predictors distance from the road and transect type as a class variable (edge vs. forest). Four species showed a significant positive relationship with distance to the roads and two species showed a

significant negative relationship with distance to the roads (Table 6). There was no significant cross-species relationship between the regression coefficients and the dominant calling frequency ($F=1.263$ $P = 0.27$, Figure 7).

Discussion

Bird species richness significantly increased with increasing distance from the road for both the edge transects perpendicular to the roads and the forest transects perpendicular to the roads, to similar threshold distances of 250 m and 300 m from the roads respectively. On average, species richness was slightly higher along the forest transects than the edge transects at all distances; however both transect types had the same total number of species observed (54). There were some species composition differences with some species only found along the edge transects and some only found along the forest transects indicating the presence of some edge and interior bird species. The similar patterns of species richness along edge and interior transects indicates that findings of previous studies (Reijen et al. 1995; Kuitunen et al. 1998; Brotons and Herrando 2001; Peris and Pescador 2004) which confounded road and forest edge effects are nevertheless valid: birds show a response to the roads (and traffic), not just to the forest edge.

In comparison to previous studies examining the effects of high traffic roads on birds, our estimated effect distances are much smaller. Studies of birds in grassland habitats adjacent to high traffic roads estimated the maximum effect distance, where bird density did not continue to increase at a distance of 1,200 m from the road and a distance of 2,000 m where the maximum breeding density occurred (Forman et al. 2002; van der

Zande et al. 1980, respectively). Similar maximum effect distances of 2,800 m from a road with 60,000 cars per day were also calculated by Reijnen et al. (1995). However, because these studies measured maximum effect distance as the distance from the road in which there is no longer a decrease in bird density of any species examined, their estimated effect distance reflects that of one species and not the general effect of birds as a group. In attempts to gain a better estimate of the general effect distance for all birds combined, Reijen and Foppen (1997) used the results of several studies in a threshold model rather than a linear regression model and estimated the effect distance for all species combined to be 190 m – 560 m in grassland and 125 m-365 m in forested area depending on the traffic volume. A different study examining species diversity in proximity to traffic roads estimated a general effect distance of 300 m from the roadway (Palomino and Carrascal 2007). Our threshold distances of 250 m and 300 m are consistent with those studies that estimated a general effect for the majority of species. For some species high traffic roads can cause declines for thousands of meters however, for the majority of species the most noticeable decline occurs in the first few hundred meters from the road.

The prediction that traffic noise is causing the decline in species richness with proximity to roads was not strongly supported based on our findings. First, in support of the noise hypothesis we did find the most dramatic decline in traffic noise occurred in the first 300 m from the road which was the distance that we observed the largest increase in species richness. However this is only partially convincing as any disturbance from the road will decrease with increasing distance from the road. Second, although for the forest transects traffic noise was a better predictor of species richness than distance from the

roads, traffic noise was a weaker predictor of richness than distance from the road for the edge transects. Again, this is not a strong test of the noise hypothesis because of the strong correlation between noise and distance from the roads for both transect types. Third, our test of the noise hypothesis without the confounding distance effect showed that at any given distance from the road, traffic noise could not explain the variation in species richness across sites. In fact, for all but two distances there was a slight positive relationship between traffic noise and species richness. This is the opposite of what we would predict if the distance effect was due to disturbance from noise. Finally, there was no support for the idea that species with call frequencies closer to the frequency of traffic noise were more affected by roads.

Other studies have concluded that traffic noise is the most reasonable and likely cause for bird declines near roads; however this is not a strongly supported conclusion. Studies that estimate the maximum disturbance distance as thousands of meters from the road dismiss other factors such as visual or chemical pollution as potential causes for the bird decline, citing that it is unlikely these effects would extend thousands of meters from the road (Reijnen et al. 1995,1996; Forman et al. 2002). Only visual disturbances have been controlled for in one previous study which showed no evidence that visual disturbances were causing the decline in bird density near roads (Reijnen et al. 1995). It is important to realize that all sources of disturbances will decrease with increasing distance from the road and could therefore have some influence on birds. In their paired plot design study, with road plots adjacent to the road and control plots located an average of 400 m from the road, Reijnen et al. (1995) could have presented more convincing evidence of a noise effect if they had compared their high noise control plots

to their low noise control plots. If other factors such as chemical pollution are unlikely to have an effect at 400 m from the road, then noise would be the remaining factor affecting birds in these control plots. One would predict that the low noise control plots would have a higher breeding density than those of high noise control plots. However, their results show that only 10 of the 28 low noise control plots had a higher breeding density than the high noise control plots (Reijnen et al. 1995). If in fact it is the traffic noise that is causing the decline in birds near roads it would also be important to provide confirmation that those birds living in noisy conditions have some form of reduced fitness such as a reduced nesting success, or reduced ability to attract a mate. Yearling male Willow Warblers (*Phylloscopus trochilus*) were shown to have reduced mating success and significantly reduced breeding success in proximity to the road (Reijnen et al. 1994). In a similar study Kuitnen et al. (2003) showed a reduced breeding success for pied flycatchers (*Ficedula hypoleuca*) however, the majority of nest failures included the whole brood suggesting one or both parents were killed. Reijnen et al. (1994) dismissed road mortality as a potential cause of the road effect because the rate of returning males the following year was not reduced near the road; however they did not record female birds and the death of one parent can cause a partial or complete nest failure (Kuitnen et al. 2003). Although these studies may provide some evidence of reduced breeding success near roads, they did not provide evidence that this reduced breeding success was due to traffic noise.

If noise was causing the species specific response to roads than we should be able to identify why some species show a stronger response to roads than other species. One theory suggests that those species with lower calling frequencies would suffer a greater

masking of their call by traffic noise and show stronger road avoidance. Rheindt (2003) showed that species calling at higher frequencies had significantly less of a decline near the road than those species with lower calling frequencies. However, although there was a significant overall trend the theory could not explain why three species showed an increase in density near the road and it was these three species that had a strong influence in the analysis. Our study did not find any support for the theory that those species with lower calling frequencies show stronger road avoidance.

In order to properly test the traffic noise hypothesis studies must be designed such that no other confounding factors are present. A study that focused on industrial noise from compressor stations was able to effectively test for the noise hypothesis without other confounding factors such as visual disturbance, chemical pollution and mortality often present in roadside habitats. Bayne et al. (2008) demonstrated that species had reduced densities in forested areas near compressor stations that emitted constant noise compared to oil well pads which have the same landscape characteristic but do not have any noise. However, after correcting for detectability there was no longer a significant effect for all species combined (Bayne et al. 2008). In a similar study design using compressor stations Francis et al. (2009) showed no change in overall nest density between the noisy sites compared to the control site but they did find changes in the species present once again suggesting a species specific response to noise. Of the species recorded in the Bayne et al. (2008) study, the Ovenbird (*Seiurus aurocapillus*) showed the lowest densities near the noisy compressor stations. In an additional study in the same area Ovenbirds also showed a reduced pairing success near compressor stations (Habib et al. 2007). Interestingly, we also found that the Ovenbird was less abundant near the

roads. At best, one can conclude that noise may be a serious problem for some species, and noise does not affect all species to the same extent. Future research is needed to identify the mechanism, other than dominant call frequency, that can give insight as to why some species are more affected by the presence of noise than others.

There are several reasons why traffic noise may not affect birds. Traffic and other natural environmental noise contains the greatest energy at lower frequencies (<1.4 kHz) (Lohr et al. 2003) while the majority of song birds have calls between 3 and 6 kHz (Slabbekoorn and Ripmeester 2008) and have the highest hearing sensitivity at frequencies between 1 and 5 kHz (Dooling et al. 2000). This suggests that traffic noise may only rarely mask their calls. Without changing the structure of their calls, birds can increase their ability to receive a call by changing their positions (turning of the head, using a different perch) or the timing of their call (Dooling et al. 2000). Species have been observed to start the dawn chorus earlier in noisier environments (Bergen and Abs 1997) and Robins (*Turdus migratorius*) sing during the night in areas with high daytime noise (Fuller et al. 2007). In addition, an increasing number of studies of various species have demonstrated that some species can adjust their calls by either increasing the volume, known as the Lombard effect (Brumm 2004), or changing the frequency to reduce masking (Slabberkoorn and Peet 2003; Brumm 2004; Slabbekoon and der Boer Visser 2006). Woods (2006) not only demonstrated that Song Sparrows (*Melospiza melodia*) in noisier areas had different call characteristics than those in quieter areas, but that those in noisier areas only changed the lower frequency portion of their call that was being masked by traffic noise. This has also been shown for birds living in naturally noisy environments, ex. near waterfalls (Slabberkoorn and Smith 2002). It could be

possible that those species that lack the plasticity to change their call characteristics are the species that are most affected by the presence of noise.

If traffic noise is not the cause of declining bird richness with proximity to roads, what is? Habitat quality near roads could be reduced for reasons other than or in addition to noise. Although Reijnen et al. (1995) demonstrated that there was no difference in bird densities between sites with high and low visibility of cars, little research has been done examining the possible disturbance from artificial lights originating from the road. De Molenaar et al. (2000) (referenced in Longcore and Rich 2004) showed that Black-tailed Godwit (*Limosa limosa*) had lower breeding densities up to 300 m from roads with artificial lighting compared to roads without lighting. This 300 m disturbance distance is similar to our findings. Light from both headlights and streetlights may increase the risk of predation, or cause stress on nesting birds. A second possible explanation which requires further investigation is the effect of pollution from the road. Pollution from the road was dismissed as a possible cause in previous studies because it is unlikely to affect the birds directly, and it extends only a short distance away from the road (Reijnen et al. 1995; Forman 2002). In our study species richness declined only within the first 300 m of the road suggesting that there is a possibility of a pollution effect. Elevated levels of heavy metals have been found in plants up to 150 m from a road (Spellburg 1998). Oxides from nitrogen have also been found to penetrate areas up to 200 m from a road (Angold 1997) and 230 m downwind from the road (Bernhardt-Romermann et al. 2006) causing changes in plant species composition, ground cover, and soil properties. These changes could result in an unfavourable nesting habitat or a change in food abundance. Lastly, birds living near roads are at a greater risk of death from a vehicle collision,

particularly those living within the first 300 m from the road (Erritzoe et al. 2003). Although the number of birds killed by vehicles is not thought to have a large impact on the population (Forman 1998), hundreds of thousands to millions of birds are killed on roads annually (Erritzoe et al. 2003 for review). Those species which are found foraging on or beside roads, such as scavengers have a higher risk of mortality (Jacobson 2005). Interestingly three of the four species that showed the strongest road effect in our study are those species that nest and forage almost entirely on the ground. It is possible that because these species are mainly ground dwellers, they may be naturally low flying birds, thus possibly increasing their risk of road mortality (Jacobson 2005). Future studies should attempt to identify the cause of the negative effects of roads on specific bird species rather than assuming that noise is the cause of the decline for all bird species.

The construction of roads and the traffic traveling upon them continue to cause unfavourable living conditions for organisms living in close proximity to the roads. In order to mitigate the effects of roads we must first have good understanding as to what conditions or combinations of conditions the roads are causing to adjacent habitats. The proper identification of the cause is important as many mitigation measures are designed to reduce the impact of one main disturbance and may have negative consequences to other species.

If in fact some birds are showing road avoidance because of the traffic noise, there are several ways to reduce traffic noise on the road and surrounding area. Depressed roads and those roads constructed with porous surfaces will reduce traffic noise to a small extent (Erritzoe et al. 2003; Arenas 2008; Slabbekoorn and Ripmeester 2008). The use of quieter tires will also add to the reduction of noise (Jacobson 2005).

In order to reduce traffic noise to a greater extent, noise barriers constructed of concrete, wood, metal and plastic are placed along highways to reflect or absorb traffic noise. These barriers may also reduce other disturbance from the road including visual disturbances and chemical pollution (Reijnen et al. 1997; Jacobson 2005; Arenas 2008; Slabbekoorn and Ripmeester 2008). However, noise barriers are fairly expensive and the presence of the barriers will also cause that section of road to be impermeable to road-crossing for non flying organisms (Reijnen et al. 1997). Natural barriers constructed of earth mounds can provide as much sound attenuation as noise barriers constructed of a solid material (Arenas 2008). Earth mound barriers are also cheaper to construct and are more aesthetically pleasing and could potentially provide usable habitat for some species (Arenas 2008). Although earth mounds are more permeable to road crossing than most artificial barriers, they are unnatural elevations in the landscape which may discourage road crossings or cause hesitation to, resulting in animals spending additional time in the road verge. This in turn could result in an increased risk to drivers. Dense vegetation, such as tree belts or hedge rows, would also reduce both traffic noise and visual disturbances while maintaining a natural part of the landscape (Orlowski 2008). The type of vegetation used should be tall enough to encourage birds to fly over the traffic, and should not contain fruiting species which would attract birds to the area and likely increase the numbers of birds killed by traffic (Jacobson 2005). Studies have shown that birds are more likely to cross roads where there are gaps in vegetation and thus rows of vegetation must be continuous and dense (Erritzoe et al 2003; Orlowski 2008). Although any form of noise barrier is most effective when it is the closest to the noise source,

having natural barriers very close to the road can reduced the driver's field of view and the ability to see crossing animals.

Maintained grassy road verges are present alongside most roads to provide drivers with a clear view and have also been shown to be valuable habitat for some bird species (Underhill and Angold 2000). These verges act as a buffer zone between the pollutants originating from the road and the natural habitat (Angold et al. 1997; Forman and Alexander 1998; Underhill and Angold 2000). The wider the buffer zone the more chemical pollutants will be absorbed. However, increasing the amount buffer zone may decrease the amount of natural habitat and more research is needed to address the most effective size for these buffer zones to both reduce pollutants and maintain natural habitat (Angold 1997). Unfortunately road verges provide little mitigation for traffic noise or visual disturbance. Disturbances from street lights can be reduced without altering the road verge by using reflective stripes to highlight the road edge or by using lower wattage and flat lens fixtures that will project the light down towards the road (Jacobson 2005). The use of a single mitigation measure will not address all the potential causes of the decline in bird species richness along roads. Future research that addresses the effects of disturbances such as chemical pollution from cars and light pollution will provide valuable insight for the forms of mitigation best suited to reduce the effects of our roads and traffic on birds.

Conclusion

Our study adds to the growing body of literature which has demonstrated that high traffic roads have negative effects on birds. In addition, we conclude that it is in fact the roads and traffic which cause the declines and not the forest edge created by the road. Although traffic noise has been the most accepted cause for the decline in birds near roads, this study shows little support for this conclusion. The effect distance in this study was only 300m from the road, which leaves the possibility that other forms of pollution originating from the road, as well as increased mortality are also reasonable causes for the decline in birds near roads which warrant further investigation. For some species traffic noise may be the biggest cause for the road effect. However, traffic noise alone does not explain the overall decrease in species richness in proximity to high traffic roads and it is likely that this decline in bird species richness is caused by a combination of disturbances originating from the road and road mortality.

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Table 1. Pearson correlations between the distance to the road and species richness for each of the vegetation characteristics measured at each point count location for both the edge and forest transects perpendicular to high traffic roads at 10 sampling sites.

Transect type	Variable	Canopy cover	Ground vegetation cover	Shrub Height	Ground vegetation Height	# of shrubs
Edge	Distance from the road					
	Pearson Correlation	-0.065	0.014	-0.003	-0.147	0.074
	P Value	0.626	0.917	0.983	0.266	0.576
	Species richness					
	Pearson Correlation	-0.231	0.199	-0.016	0.036	0.046
	P Value	0.078	0.132	0.903	0.789	0.729
Forest	Distance from the road					
	Pearson Correlation	0.187	-0.052	-0.085	-0.129	-0.132
	P Value	0.159	0.700	0.527	0.334	0.322
	Species richness					
	Pearson Correlation	-0.102	0.060	0.165	-0.037	0.373
	P Value	0.445	0.657	0.217	0.783	0.004

Table 2. Piecewise regression analyses with total species as the dependent variable and the distance to the road and site as the predictor variables. N= 59 for edge transects x distances, N= 58 for forest transects x distances. Site was included in all models as a categorical co-variate (10 sites).

Breakpoint: Distance from the Road (m)	Slope before breakpoint	Standard Error	Pr>t	Residual Standard Error	Adjusted R ²	F	P value
Edge Transect							
150	0.015	0.008	0.061	1.929	0.376	4.172	0.0003
175	0.016	0.007	0.021	1.900	0.394	4.430	0.0001
200	0.015	0.006	0.008	1.877	0.409	4.648	0.0001
225	0.014	0.005	0.004	1.861	0.419	4.800	0.0001
250	0.012	0.004	0.002	1.851	0.425	4.896	0.0001
275	0.011	0.004	0.003	1.864	0.417	4.767	0.0001
300	0.010	0.003	0.005	1.882	0.406	4.599	0.0001
325	0.008	0.003	0.008	1.902	0.393	4.416	0.0002
350	0.007	0.003	0.013	1.921	0.381	4.241	0.0002
Forest Transect							
150	0.015	0.008	0.069	2.032	0.420	4.759	<0.0001
175	0.017	0.007	0.017	1.994	0.442	5.105	<0.0001
200	0.017	0.006	0.005	1.959	0.461	5.438	<0.0001
225	0.016	0.005	0.002	1.932	0.476	5.703	<0.0001
250	0.014	0.004	0.001	1.914	0.486	5.892	<0.0001
275	0.014	0.004	0.000	1.900	0.493	6.038	<0.0001
300	0.013	0.003	0.000	1.893	0.497	6.114	<0.0001
325	0.012	0.003	0.000	1.895	0.496	6.099	<0.0001
350	0.010	0.003	0.000	1.904	0.491	5.999	<0.0001

Table 3. ANOVA tables for the best fit piecewise regression model for the edge (break at 250m from the road) and forest transects (break at 300m from the road). Site was included in all models as a categorical co-variate (10 sites). Slope difference is the difference between the slopes of the two lines in the piecewise regression.

	D.F	Sums of Squares	Mean Square	F	P value
Edge Transects					
Site	9	145.16	16.13	4.71	<0.001
Distance to road	1	16.77	16.77	4.89	0.03
Slope difference	1	22.63	22.63	6.6	0.01
Residuals	47	161.07	3.43		
Forest Transects					
Site	9	184.48	20.5	5.72	<0.001
Distance to road	1	23.26	23.26	6.49	0.014
Slope difference	1	33.36	33.36	9.31	0.004
Residuals	46	164.91	3.59		

Table 4. Piecewise regression analyses with traffic noise as the dependent variable and the distance to the roads and site as the predictor variables. N= 59 for edge transects x distances, N= 58 for forest transects x distances. Site was included in all models as a categorical co-variate (10 sites).

Breakpoint:							
Distance from the Road (m)	Slope before breakpoint	Standard Error	P value	Residual Standard Error	Adjusted R ²	F	P value
Edge Transects							
150	-0.047	0.007	<0.001	1.741	0.875	37.80	<0.001
175	-0.045	0.006	<0.001	1.701	0.880	39.79	<0.001
200	-0.041	0.005	<0.001	1.692	0.882	40.30	<0.001
225	-0.037	0.004	<0.001	1.701	0.880	39.82	<0.001
250	-0.033	0.004	<0.001	1.718	0.878	38.93	<0.001
275	-0.032	0.003	<0.001	1.712	0.879	39.22	<0.001
300	-0.031	0.003	<0.001	1.721	0.878	38.82	<0.001
325	-0.029	0.003	<0.001	1.742	0.875	37.75	<0.001
350	-0.027	0.002	<0.001	1.774	0.870	36.25	<0.001
Forest Transects							
150	-0.053	0.010	<0.001	2.387	0.757	17.17	<0.001
175	-0.052	0.008	<0.001	2.310	0.773	18.62	<0.001
200	-0.048	0.007	<0.001	2.271	0.780	19.40	<0.001
225	-0.043	0.006	<0.001	2.263	0.782	19.58	<0.001
250	-0.038	0.005	<0.001	2.271	0.780	19.40	<0.001
275	-0.036	0.004	<0.001	2.300	0.775	18.82	<0.001
300	-0.033	0.004	<0.001	2.347	0.765	17.90	<0.001
325	-0.030	0.004	<0.001	2.407	0.753	16.81	<0.001
350	-0.024	0.003	<0.001	2.473	0.740	15.71	<0.001

Table 5. Separate regression analyses of total number of species on traffic noise at each distance from the roads.

Distance from the roads (m)	<u>Edge Transects</u>				<u>Forest Transects</u>			
	n	Standardized Coefficient	F	P value	n	Standardized Coefficient	F	P value
50	10	0.271	0.767	0.407	10	0.442	1.938	0.201
150	10	-0.212	0.33	0.581	10	0.166	0.228	0.646
250	10	0.098	0.116	0.743	10	0.175	0.252	0.629
350	10	-0.167	1.107	0.323	10	0.472	2.299	0.168
450	10	0.092	0.285	0.608	10	0.114	0.106	0.753
550	9	0.022	0.044	0.839	8	0.082	0.041	0.847

Table 6. Results of the binary logistic regression for each species tested with distance to the roads and transect type (edge or forest) as the predictor variables. (n* is the number of individuals observed in the binary logistic regression from a total of 117 point count locations across 10 sites).

AOU Code	Dominant song frequency (kHz)	n*	<u>Distance from the Roads</u>			<u>Transect Type</u>		
			Wald χ^2	Coeff	P value	Wald χ^2	Coeff	P value
AMGO	4.67	25	0.879	0.001	0.348	2.274	0.705	0.132
AMRE	6.00	28	6.476	-0.004	0.011	3.194	-0.828	0.074
AMRO	2.80	77	0.726	0.001	0.403	0.700	0.392	0.394
BAOR	2.75	16	0.105	0.000	0.746	0.002	-0.022	0.967
BCCH	4.00	67	3.484	0.002	0.062	10.76	-1.325	0.001
BHVI	3.83	24	1.337	0.002	0.247	0.004	-0.029	0.949
BLJA	4.17	12	0.333	-0.001	0.564	0.399	-0.39	0.528
BWWA	7.50	29	0.036	0.000	0.85	1.257	-0.486	0.262
CEDW	6.83	14	0.138	-0.001	0.71	1.204	0.649	0.273
CHSP	5.25	15	0.842	-0.002	0.359	0.646	0.454	0.422
COYE	4.33	60	0.073	0.000	0.787	4.471	0.798	0.034
DOWO	5.00	11	0.111	-0.001	0.739	0.117	-0.218	0.732
EAWP	4.25	19	1.770	0.002	0.183	3.191	-0.962	0.074
GCFL	3.05	13	0.407	0.001	0.523	5.768	-1.909	0.016
GRCA	3.42	11	0.026	0.000	0.871	0.832	0.599	0.362
OVEN	5.50	49	9.481	0.004	0.002	5.063	-0.911	0.024
RBGR	2.75	31	0.872	0.001	0.35	0.078	-0.117	0.781
REVI	3.67	44	6.240	0.003	0.012	4.203	-0.827	0.04
RWBL	3.58	25	6.984	-0.004	0.008	8.427	-1.584	0.004
SOSP	5.08	60	0.008	0.000	0.931	20.67	1.87	<0.001
SWSP	5.17	10	0.417	-0.001	0.518	4.871	-2.367	0.027
VEER	3.58	38	7.316	0.003	0.007	0.880	-0.379	0.357
WOTH	4.42	22	5.035	0.003	0.025	0.163	0.196	0.687
WTSP	4.08	22	0.065	0.000	0.798	9.543	-1.825	0.002
YWAR	5.46	32	0.060	0.000	0.806	0.130	0.15	0.718

Figure 1. Location of the 10 of bird survey sites in eastern Ontario, Canada. Thick lines represent the major highways in which study sites were located. Thin gray lines represent other local roads.

Figure 2. Illustration of a typical site. Circles represent locations of the 50m radius point counts. Arrows labelled 'A' and 'B' indicate the directions of the surveys. The direction was randomly chosen for the early morning survey on the first visit and the same direction was maintained for the rush hour survey. For the second visit the directions of the surveys were reversed, so if during the first visit the order was 'A', during the second visit the order was 'B'.

Figure 3. The total number of species observed at each point count location along 10 edge transects perpendicular to roads, with increasing distance from the roads. Total number of species is the number of unique species observed at each point count location over the two visits on two separate dates with two point counts per visit. The size of the circle represents the number of overlapping points (1,2 or 3). A significant linear piecewise regression estimated the break point at 250m ($F=4.816$, P 0.001, $R^2=0.425$).

Figure 4. Total number of species observed at each point count location along the 10 forest transects with increasing distance from the roads. Total number of species is the total number of unique species observed at each point count location over the two visits on two separate dates with two point counts per visit. The size of the circle represents the number of overlapping data points (1,2 or 3). A significant linear piecewise regression estimated the best break point at 300m ($F=6.11$, $P<0.001$, $R^2=0.497$).

Figure 5. The recorded levels of traffic noise at each point count location significantly decreased with increasing distance from the highway along the 10 edge transects ($F = 135.0$, $P < 0.001$, adjusted $R^2 = 0.822$).

Figure 6. The recorded levels of traffic noise at each point count location significantly decreased with increasing distance from the highway along the 10 forest transects ($F = 75.188.1$, $P < 0.001$, adjusted $R^2 = 0.691$).

Figure 7. The binary logistic regression coefficients of species occurrence on distance from the road for each of the 25 species recorded more than 10 times across all 10 sites vs. the estimated dominant call frequency of each species (Coeff = -0.0004, $F = 1.263$, $P = 0.27$, $R^2 = 0.011$).

Appendix F (a). Box plots of the traffic noise (top figure) and species richness (bottom figure) at each distance from the road collected during the dawn and rush hour surveys along the edge transect.

Appendix F (b). Box plots of the traffic noise (top figure) and species richness (bottom figure) at each distance from the road collected during the dawn and rush hour surveys along the forest transect.

Appendix H (a). Descriptive analyses to examine the variance in traffic noise levels (dBA) across sites (n) at each distance from the road. Traffic noise is the averaged noise level (dBA) from four recordings (two recordings from dawn surveys, and two from the rush hour surveys) at each point count location.

Transect type	Distance from the road (m)	n	Range (dBA)	Minimum (dBA)	Maximum (dBA)	Mean (dBA)	Standard Deviation	Variance
Edge transects								
	50	10	10.78	54.08	64.85	60.83	3.02	9.10
	150	10	10.85	50.55	61.40	56.48	3.27	10.71
	250	10	11.20	50.05	61.25	54.23	3.57	12.75
	350	10	12.33	46.98	59.30	52.52	3.88	15.05
	450	10	15.15	43.65	58.80	51.20	4.25	18.08
	550	9	13.35	43.85	57.20	51.43	4.67	21.79
Forest transects								
	50	10	6.28	57.64	63.92	60.42	2.26	5.11
	150	10	10.45	50.90	61.35	56.10	3.38	11.42
	250	10	14.10	45.47	59.56	52.62	4.23	17.93
	350	10	14.21	44.49	58.70	52.35	4.36	18.97
	450	10	15.23	44.76	59.99	51.60	4.25	18.03
	550	8	9.37	45.82	55.19	51.36	3.38	11.40

Appendix H (b). Descriptive analyses to examine the variance in traffic noise levels (dBA) across sites (n) at each distance from the road during the dawn bird surveys. Traffic noise is the averaged noise level (dBA) from two recordings at each point count location during the dawn surveys.

Transect type	Distance from the road (m)	n	Range (dBA)	Minimum (dBA)	Maximum (dBA)	Mean (dBA)	Standard Deviation	Variance
Edge transects								
	50	10	9.58	56.22	65.80	61.26	2.70	7.28
	150	10	10.29	51.61	61.90	56.72	3.43	11.80
	250	10	8.38	51.22	59.60	55.66	3.01	9.05
	350	10	10.88	48.19	59.07	53.54	3.80	14.46
	450	10	10.41	46.89	57.30	53.02	3.69	13.65
	550	9	12.47	45.33	57.80	52.23	4.30	18.49
Forest transects								
	50	10	7.67	55.74	63.40	59.96	2.67	7.10
	150	10	16.67	44.70	61.37	55.17	4.81	23.13
	250	10	19.61	40.99	60.60	52.32	5.58	31.15
	350	10	19.19	41.53	60.72	52.03	6.19	38.31
	450	10	16.41	42.59	59.00	50.75	5.15	26.49
	550	8	11.90	44.76	56.66	51.64	3.72	13.88

Appendix H (c). Descriptive analyses to examine the variance in traffic noise levels (dBA) across sites (n) at each distance from the road during the rush hour bird surveys. Traffic noise is the averaged noise level (dBA) from two recordings at each point count location during the rush hour surveys.

Transect type	Distance from the road (m)	n	Range (dBA)	Minimum (dBA)	Maximum (dBA)	Mean (dBA)	Standard Deviation	Variance
Edge transects								
	50	10	8.32	56.66	64.98	62.21	2.74	7.50
	150	10	12.22	50.68	62.90	57.93	3.68	13.56
	250	10	14.81	48.09	62.90	54.67	4.29	18.42
	350	10	16.54	46.26	62.80	53.57	4.73	22.34
	450	10	19.08	41.22	60.30	51.01	5.32	28.32
	550	9	13.69	42.91	56.60	52.43	4.83	23.34
Forest transects								
	50	10	7.07	57.73	64.80	60.67	2.46	6.03
	150	9	7.95	53.35	61.30	57.13	2.45	6.01
	250	9	10.58	47.62	58.20	52.77	3.38	11.41
	350	9	12.20	44.20	56.40	52.32	3.78	14.31
	450	10	14.60	46.20	60.80	51.93	3.92	15.37
	550	8	11.91	42.80	54.71	50.54	4.21	17.72

Appendix I. Life history traits for the 25 species used in the binary logistic regression used to determine whether a particular life history traits (habitat preferences, nest location, diet, foraging method) is more prevalent in those species that were observed more often at distance far from the road. *Ground glean* are those that pick items from the ground surface. *Foliage glean* involves taking invertebrate or fruit from any vegetation directly on the ground. *Bark glean* involves taking invertebrates from woody trunks and branches. *Gleaning while hovering* are those that take food from plant that are above the ground while the bird continues to hover. *Hawking* involves short flights from a perch to catch an insect

Species	Coefficient from logistic regression	Habitat	Nest location	Diet	Main foraging method	Other foraging methods used
AMGO	0.001282	edge	tree	seeds, some insect	foliage glean	ground glean
AMRE	-0.003646	forest	shrub	insects	foliage glean	glean while hovering
AMRO	0.000982	edge	tree	fruit, some insects	ground glean	foliage glean
BAOR	0.000052	edge	tree	insects, fruit nectar	foliage glean	hawking
BCCH	0.002250	both	tree	insects, seeds, fruit	foliage glean	bark glean
BHVI	0.001600	forest	tree	insects	foliage glean	hawk, bark glean
BLJA	-0.001060	both	tree	insects, eggs, fruit	ground glean	hawking
BWWA	0.000420	forest	ground	insects	bark glean	hawking
CEDW	-0.000635	edge	tree	fruit, insects	foliage glean	hawking
CHSP	-0.001543	edge	tree	insects, seed	ground glean	foliage glean, hawking
COYE	-0.000303	edge	shrub	insects	foliage glean	glean while hovering, bark glean, hawking
DOWO	-0.000632	both	tree	insects	bark glean	excavate
EAWP	0.002071	both	tree	insects	hawking	glean while hovering
GCFL	0.001166	both	tree	insects, berries	hawking	ground glean
GRCA	-0.000307	both	shrub	insects, fruit	ground glean	foliage glean,
OVEN	0.003825	forest	ground	insect	ground glean	none
RBGR	0.001173	both	shrub	seeds, fruit, buds	foliage glean	glean while hovering, bark glean, hawking
REVI	0.003055	both	tree	insect, fruit	foliage glean	glean while hovering
RWBL	-0.004150	edge	shrub	insects, seed, fruit	ground glean	foliage glean, hawking
SOSP	-0.000106	edge	ground, shrub	insects, seed, fruit	ground glean	foliage glean
SWSP	-0.001338	both	shrub	insects, seed	ground glean	none
VEER	0.003217	forest	shrub	insects, fruit	ground glean	swoops, foliage glean
WOTH	0.003405	both	tree	insects, fruit	ground glean	foliage glean
WTSP	0.000380	both	ground	insects, seeds, fruit	ground glean	foliage glean, hawking
YWAR	-0.000303	edge	shrub	insects	foliage glean	bark glean, hawking, glean while hovering

Appendix J. Box plots of the coefficients from the 25 species used in the logistic regression grouped by their life history traits.

Appendix J (a). Logistic regression coefficients of the 25 most common species grouped by their preferred habitat: forest, forest edge or both.

Appendix J (b). Logistic regression coefficients of the 25 most common species grouped by their nest location.

Appendix J (c). Logistic regression coefficients of the 25 most common species grouped by their most common foraging method. *Bark glean* involves taking invertebrates from woody trunks and branches. *Foliage glean* involves taking invertebrate or fruit from any vegetation directly on the ground. *Ground glean* are those that pick items from the ground surface *Hawking* involves short flights from a perch to catch an insect.

Appendix K. The forest patch size for each of the sites surveyed for bird and the average annual daily traffic volume (AADT) of the major road adjacent to the forest patch.

Site	AADT	Forest patch size (ha)
1	31400	50.1
2	14910	24.5
3	87100	112.3
4	32300	16.5
5	18600	59.0
6	17500	59.2
7	35300	143.5
8	20400	21.2
9	13700	43.8
10	13700	16.0

Appendix L. Bird survey coordinates in decimal degrees (WGS 1984) for each distance from the road along the edge and forest transects of the 10 sites surveyed in eastern Ontario.

Site	Distance from the road (m)	Edge Transect		Forest transect	
		Latitude	Longitude	Latitude	Longitude
1	50	45.38459	-76.26440	45.38530	-76.26535
	150	45.38414	-76.26546	45.38486	-76.26644
	250	45.38379	-76.26645	45.38455	-76.26744
	350	45.38364	-76.26810	45.38438	-76.26907
	450	45.38332	-76.26910	45.38407	-76.27007
	550	45.38287	-76.27013	45.38359	-76.27110
2	50	45.34158	-75.89011	45.34604	-75.89156
	150	45.34238	-75.89067	45.34526	-75.89111
	250	45.34311	-75.89109	45.34427	-75.89044
	350	45.34385	-75.89158	45.34352	-75.88987
	450	45.34482	-75.89230	45.34281	-75.88949
	550	45.34560	-75.89275	N/A	N/A
3	50	45.32952	-75.86019	45.32905	-75.86134
	150	45.32868	-75.85991	45.32820	-75.86106
	250	45.32783	-75.85961	45.32737	-75.86075
	350	45.32702	-75.85896	45.32655	-75.86015
	450	45.32623	-75.85860	45.32576	-75.85976
	550	45.32551	-75.85813	45.32507	-75.85927
4	50	45.31922	-75.80679	45.32001	-75.80678
	150	45.31915	-75.80795	45.31994	-75.80797
	250	45.31879	-75.80881	45.31960	-75.80881
	350	45.31826	-75.80986	45.31905	-75.80986
	450	45.31796	-75.81080	45.31878	-75.81080
	550	45.31756	-75.81181	45.31838	-75.81181

Appendix L. Continued

Site	Distance from the road (m)	Edge Transect		Forest transect	
		Latitude	Longitude	Latitude	Longitude
5	50	45.21838	-75.74266	45.21756	-75.74213
	150	45.21877	-75.74142	45.21794	-75.74087
	250	45.21924	-75.74031	45.21842	-75.73976
	350	45.21964	-75.73936	45.21881	-75.73880
	450	45.21999	-75.73836	45.21918	-75.73781
	550	45.22048	-75.73730	45.21966	-75.73673
6	50	44.81753	-75.39072	44.81772	-75.39230
	150	44.81617	-75.39003	44.81695	-75.39179
	250	44.81592	-75.38928	44.81620	-75.39111
	350	44.81516	-75.38858	44.81535	-75.39033
	450	44.81432	-75.38788	44.81456	-75.38963
	550	44.81408	-75.38805	44.81374	-75.38893
7	50	45.22232	-75.34122	45.22197	-75.34121
	150	45.22223	-75.34143	45.22182	-75.34164
	250	45.22207	-75.34185	45.22165	-75.34205
	350	45.22193	-75.34227	45.22149	-75.34244
	450	45.22178	-75.34268	45.22130	-75.34284
	550	45.22159	-75.34307	45.22118	-75.34324
8	50	45.31937	-75.27200	45.31989	-75.27340
	150	45.31919	-75.27254	45.31951	-75.27434
	250	45.31880	-75.27345	45.31916	-75.27535
	350	45.31843	-75.27443	45.31878	-75.27629
	450	45.31807	-75.27537	45.31846	-75.27722
	550	45.31773	-75.27634	45.31803	-75.27829
9	50	45.45087	-74.69904	45.45011	-74.70012
	150	45.45055	-74.69891	45.44934	-74.69957
	250	45.44979	-74.69839	45.44853	-74.69888
	350	45.44897	-74.69769	45.44775	-74.69828
	450	45.44820	-74.69707	45.44705	-74.69760
	550	45.44749	-74.69640	45.44626	-74.69697
10	50	45.45999	-74.68907	45.46069	-74.68846
	150	45.45923	-74.68842	45.45994	-74.68779
	250	45.45851	-74.68789	45.45922	-74.68726
	350	45.45774	-74.68716	45.45844	-74.68652
	450	45.45699	-74.68668	45.45769	-74.68607
	550	N/A	N/A	N/A	N/A

Appendix M (a). Vegetation survey data used for the correlation analysis between each of the vegetation characteristics and both distance from the road and bird species richness along the edge transects. Vegetation data was collected 5 m into the forest for each point count location along the edge transects for the 10 sites located in eastern Ontario between July 21st and August 1st 2008.

Site	Distance to the road (m)	Canopy cover %	Ground Cover %	Shrub height (cm)	Ground cover height (cm)	Number of Shrubs
1	50	60	80	80	60	10
1	150	40	60	150	60	15
1	250	60	80	80	50	50
1	350	60	100	70	50	5
1	450	40	100	100	40	100
1	550	60	40	100	20	100
2	50	60	60	80	15	60
2	150	60	80	150	20	60
2	250	60	100	80	15	25
2	350	60	80	100	10	80
2	450	80	60	80	15	60
2	550	60	60	80	15	30
3	50	40	80	100	60	40
3	150	60	40	80	20	10
3	250	60	40	60	30	15
3	350	60	60	100	50	20
3	450	80	20	60	15	10
3	550	60	20	60	15	5
4	50	100	20	300	10	20
4	150	60	60	300	20	10
4	250	80	40	200	30	30
4	350	40	60	100	20	10
4	450	60	40	200	20	50
4	550	40	60	200	10	10
5	50	60	80	80	50	30
5	150	60	40	60	40	15
5	250	40	80	80	60	20
5	350	60	60	200	80	5
5	450	40	40	150	60	5
5	550	60	60	150	60	5
6	50	60	60	150	100	10
6	150	80	40	60	40	20
6	250	60	60	80	15	10
6	350	60	100	200	15	10
6	450	100	60	100	15	10
6	550	60	100	100	40	10

Appendix M (a). continued

Site	Distance to the road (m)	Canopy cover %	Ground Cover %	Shrub height (cm)	Ground cover height (cm)	Number of Shrubs
7	50	80	20	100	45	25
7	150	60	40	80	40	100
7	250	40	60	200	60	50
7	350	40	100	80	50	40
7	450	60	100	80	55	100
7	550	60	100	80	70	20
8	50	80	60	10	25	40
8	150	60	100	70	30	20
8	250	40	80	100	0	25
8	350	20	60	80	20	30
8	450	60	40	150	30	5
8	550	40	80	150	60	15
9	50	40	60	0	10	0
9	150	80	40	0	70	0
9	250	40	100	80	90	10
9	350	80	100	0	80	0
9	450	80	20	0	20	0
9	550	80	40	0	20	50
10	50	60	100	100	60	2
10	150	80	100	0	70	0
10	250	80	80	0	40	0
10	350	100	100	0	40	0
10	450	60	100	0	50	0

Appendix M (b). Vegetation survey data used for the correlation analysis between each of the vegetation characteristics and both distance from the road and bird species richness along the forest transects. Vegetation data was collected at each point count location along the forest transects for the 10 sites located in eastern Ontario between July 21st and August 1st 2008.

Site	Distance to the road (m)	Canopy cover %	Ground Cover %	Shrub height (cm)	Ground cover height (cm)	Number of Shrubs
1	50	80	60	0	30	0
1	150	60	60	0	30	0
1	250	60	40	0	20	0
1	350	60	20	100	20	2
1	450	80	40	0	10	0
1	550	80	60	0	15	0
2	50	60	40	60	15	20
2	150	60	80	50	20	20
2	250	40	100	150	30	10
2	350	80	40	200	20	5
2	450	60	60	80	30	10
3	50	20	60	60	30	5
3	150	60	80	150	20	5
3	250	60	60	150	60	10
3	350	80	20	100	20	15
3	450	60	40	60	15	5
3	550	60	40	150	10	5
4	50	80	40	80	10	40
4	150	60	100	100	80	10
4	250	80	60	80	15	10
4	350	60	100	80	40	10
4	450	40	100	150	90	10
4	550	60	100	150	80	20
5	50	60	40	200	30	10
5	150	40	60	100	30	40
5	250	80	60	60	30	30
5	350	80	60	60	30	20
5	450	80	20	50	15	80
5	550	60	100	70	15	40
6	50	20	80	200	30	80
6	150	60	40	150	20	60
6	250	60	100	100	20	15
6	350	40	100	100	10	10
6	450	60	40	80	15	25
6	550	60	60	60	10	10

Appendix M (b). Continued

Site	Distance to the road	Canopy cover %	Ground Cover %	Shrub height (cm)	Ground cover height (cm)	Number of Shrubs
7	50	80	80	300	45	17
7	150	80	40	150	25	25
7	250	60	40	100	30	15
7	350	60	60	200	40	50
7	450	60	60	300	70	40
7	550	80	40	300	55	30
8	50	60	60	300	60	80
8	150	80	40	150	50	20
8	250	40	80	80	50	40
8	350	60	80	150	60	15
8	450	80	40	100	50	30
8	550	80	60	80	20	40
9	50	40	60	150	70	40
9	150	80	20	100	60	15
9	250	40	80	100	20	20
9	350	80	80	80	15	20
9	450	80	0	0	10	0
9	550	40	100	0	20	0
10	50	60	80	0	70	0
10	150	40	100	0	60	0
10	250	60	80	100	60	5
10	350	100	20	0	40	0
10	450	40	40	200	80	5

Appendix N (a). The number of individuals of each species observed at all point count locations during the early season visits (May 12th to June 11th 2008). Each table is labelled with the site number, and either **a**, the dawn surveys or **b** the rush hour surveys for both the edge and forest transects. A dashed mark (-) indicates a distance from the road where there was not a point count location due to inaccessibility or a short transect.

Site 1a*		Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species		50	150	250	350	450	550	50	150	250	350	450	550
AMGO							2						
AMRO			1								1		
BAOR			1							1			
BCCH					1					1			
BHCO						1							
BLJA			1										
BRCR													1
BWWA								1			1		
COYE	2			1	1	1	3						
CSWA													
NOWA										1			
OVEN				1	2	1	1		1	1		1	2
PIWA			1	1									
RBGR													
REVI											1		1
RUGR													
SCTA													1
SOSP	1			1	1	1	1						
VEER											1		1
WOTH				1	1		1				1	1	
YBSA				1					1	1			1
YWAR			1		1	2	2					1	

*The dawn survey of site 1 was conducted on May 23th 2008 starting with the edge transect at 5:00am. Cloud cover was 70% with some fog and a wind speed of 1 on the Beaufort scale.

Site 1b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMGO		1			1	1						
AMRO								1	1			1
BAOR												
BCCH				1	1							
BHCO				1								
BLJA												1
BRCR												
BWWA		1										
COYE	1	2		1	2	2						
CSWA		1										
NOWA									1			
OVEN				1				1	1	1	1	
PIWA												
RBGR					1					1		
REVI												
RUGR											1	
SCTA												
SOSP	1			1	1							
VEER									1	1		
WOTH											1	
YBSA												
YWAR	2		1	1	1	2						

*The rush hour survey of site 1 was conducted on May 23th 2008 starting with the edge transect at 6:55am. Cloud cover was 80% and a wind speed of 1 on the Beaufort scale.

Site 2a* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO				1							1	-
AMRO				1	1	1				1	1	-
BAOR								1			1	-
BCCH									1			-
BOBO		1	1									-
BRCR										1		-
BWWA												-
COYE	1						1					-
CSWA			1									-
DOWO												-
EAWP											1	-
GCFL												-
NAWA			1									-
NOCA							1					-
OVEN									1			-
RBGR	1		1		1			1	1			-
REVI				1						1	1	-
RWBL		1										-
SOSP							1					-
VEER					1	1				1	1	-
WAVI												-
WBNU									1			-
WOTH				1								-
YWAR												-

*The dawn survey of site 2 was conducted on May 20th 2008 starting with the forest transect at 4:56am. Cloud cover was 40% and a wind speed of 1 on the Beaufort scale.

Site 2b* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO			1									-
AMRO							1		1			-
BAOR						1		2				-
BCCH												-
BOBO		1										-
BRCR												-
BWWA									1			-
COYE												-
CSWA			1									-
DOWO		1									1	-
EAWP						1					1	-
GCFL								1	1		1	-
NAWA												-
NOCA												-
OVEN										1		-
RBGR			1		1			1				-
REVI									1	1		-
RWBL												-
SOSP				2								-
VEER					1							-
WAVI	1											-
WBNU												-
WOTH												-
YWAR		1					2					-

*The rush hour survey of site 2 was conducted on May 20th 2008 starting with the forest transect at 7:08am. Cloud cover was 60% and a wind speed of 2-3 on the Beaufort scale.

Site 3a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO			1								1	
AMRO		1	1	1	2		2	1	1	1		
BAOR						1						
BCCH							1	2				1
BHCO												1
BHVI		1				1						
BLJA									1			
BTGW						1						
BWWA									1			
EAWP												
FISP												
GCFL										1		
OVEN					1					1	1	
REVI											1	
SOSP											1	1
WOTH					1	1			1	1		
WTSP							1					

* The dawn survey of site 3 was conducted on June 4th 2008 starting with the forest transect at 4:48am. Cloud cover was 100% and a wind speed of 2 on the Beaufort scale.

Site 3b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO												
AMRO				1			1	1		2		
BAOR						1						
BCCH							1	1	2			
BHCO												
BHVI						1				1	1	
BLJA												
BTGW												
BWWA									1			
EAWP												1
FISP							1					
GCFL										1		
OVEN					1				1		1	
REVI			1									
SOSP										1		1
WOTH												
WTSP												

* The rush hour survey of site 3 was conducted on June 4th 2008 starting with the forest transect at 6:55am. Cloud cover was 95% and a wind speed of 3 on the Beaufort scale.

Site 4a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMGO							1					
AMRE	1							1	2			
AMRO	1	1	1							1	1	
BCCH				1	2	2	1	1				
BLJA										1		
COGR												
COYE			1	1	1			1	1	1	1	
EUST												
GCFL											1	
NAWA						1						
NOCA						1						
RBGR												
RWBL							1	2	1		1	
SOSP								1	1			
WOTH												
WTSP												1
YWAR					1						2	1

* The dawn survey of site 4 was conducted on May 16th 2008 starting with the edge transect at 5:00am. Cloud cover was 20% and a wind speed of 0 on the Beaufort scale.

Site 4b* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO				1	1			1	1			
AMRE	1	1	1					1				
AMRO			1								1	
BCCH							1				1	
BLJA												
COGR		1						1				
COYE			1	2	1	1		1	1		1	1
EUST								1				
GCFL												1
NAWA						1						
NOCA											1	
RBGR												1
RWBL							1		1			
SOSP									1			1
WOTH				1	1							
WTSP												
YWAR											1	

* The rush hour survey of site 4 was conducted on May 16th 2008 starting with the edge transect at 7:00am. Cloud cover was 60% and a wind speed of 1 on the Beaufort scale.

Site 5a* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMCR												
AMRE	1								1			
AMRO				1			2			1		1
BAOR					1					1		
BCCH								1		1		
BHCO	1											
BRCR												
BWWA									1	1		
CHSP							1					
COYE	1											
EAWP												1
GCFL			1						1			
LEFL							1					
MAWA								1				
NAWA											1	
NOFL								1				
NOPA												
OVEN				1	1	1			1	1	1	1
RBGR												
REVI		1			1						1	1
RTHU									1			
RUGR											1	
RWBL												
SOSP												
VEER						1				1		
WAVI	1						1	1				
WBNU			1									
WOTH											1	
WTSP											1	
YRWA									1			
YWAR							2					

* The dawn survey of site 5 was conducted on May 28th 2008 starting with the edge transect at 5:00am. Cloud cover was 20% and a wind speed of 0 on the Beaufort scale.

Site 5b* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMCR				1								
AMRE								1				
AMRO			1			1		1				
BAOR									1	1		
BCCH									1	1		
BHCO												
BRCR											1	
BWWA		1						1	1			
CHSP												
COYE							1	1				
EAWP												1
GCFL									1			
LEFL												
MAWA												
NAWA												
NOFL											1	
NOPA										1	1	
OVEN				1	1	1		1	1	1	1	1
RBGR											1	
REVI						1			1			1
RTHU												
RUGR												
RWBL											1	
SOSP							1					
VEER					1							1
WAVI							1					
WBNU												
WOTH							1					
WTSP												
YRWA									1			
YWAR							1			1		

* The rush hour survey of site 5 was conducted on May 28th 2008 starting with the forest transect at 7:00am. Cloud cover was 0% and a wind speed of 3 on the Beaufort scale.

Site 6a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL												1
AMRE	1						1		1			
AMRO												
BAOR								1				
BCCH				1	1							1
BHCO									1			
BHVI												
BWWA						1	1		1		1	
CEDW												
COYE	1			1	2	1				1		1
DOWO										1		
EAWP												
GCFL									1			
GRCA												
LEFL								1				
NOCA		1										
NOFL								1				
RBGR				1		1		1		1	1	1
REVI						1						1
RWBL	1							1	1			
SCTA		1	1									
SOSP	1	1	1	2	1	2	1					
SWSP		1								1		
VEER			1		1							
VESP	1											
WOTH			1									
WTSP					1		1				1	
YTVI									1			
YWAR	3						1			1		

* The dawn survey of site 6 was conducted on June 10th 2008 starting with the forest transect at 4:40am. Cloud cover was 70% and a wind speed of 1-2 on the Beaufort scale.

Site 6b* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL												1
AMRE		1	1				1		1			
AMRO							1		1		1	
BAOR								1				
BCCH					1	1					1	
BHCO				1								
BHVI		1										
BWWA		1			1	1					1	
CEDW	1											
COYE	1			1	1	1				1		1
DOWO					1							
EAWP										1		
GCFL												
GRCA			1									
LEFL												
NOCA			1									1
NOFL									1			
RBGR			1		1						1	
REVI						1						1
RWBL	2						1	2		1		
SCTA												
SOSP		2	1			1						
SWSP		1					1	1	1	1		
VEER								1				
VESP												
WOTH			1								1	
WTSP											1	1
YTVI												
YWAR	1	1				1						

* The rush hour survey of site 6 was conducted on June 10th 2008 starting with the edge transect at 6:55am. Cloud cover was 10% and a wind speed of 1 on the Beaufort scale.

Site 7a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMGO												
AMRE												
AMRO	1	1	1		2		1		1	2	1	1
BCCH	2	2		1	2	1	2	2	1	1	1	1
BHCO									1		1	
BTGW										1		
CHSP			1			1					2	
DEJU												
DOWO												
EUST												
GCKI									1	1		
HOWR				1	1							
NAWA								1				
OVEN			1	1			1			1	1	1
RBGR		1			1							2
RBNU												
SCTA												
SOSP	1			1		1						
WTSP	1								1	1		
YRWA							1	1				2
YWAR									1			

* The dawn survey of site 7 was conducted on May12th 2008 starting with the edge transect at 5:05am. Cloud cover was 40% and a wind speed of 2 on the Beaufort scale.

Site 7b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMGO			1		1	1						
AMRE	1							1				
AMRO	1	1	1				1	1	1			1
BCCH	1	1				2	1	1	1	1		2
BHCO									1			
BTGW												
CHSP					1					1	1	
DEJU						1						
DOWO							1					
EUST							1					
GCKI									2	1		
HOWR												
NAWA								1	2			
OVEN			1	1		1	1			1	1	1
RBGR											1	
RBNU											1	
SCTA												1
SOSP												
WTSP					1						1	
YRWA		1										1
YWAR												

* The rush hour survey of site 7 was conducted on May12th 2008 starting with the edge transect at 7:00am. Cloud cover was 50% and a wind speed of 2 on the Beaufort scale.

Site 8a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
ALFL										1	1	
AMCR						1						
AMRE							1	1				
AMRO					1				1			
BAOR												
BCCH												1
BHCO												1
BHVI										1		
BRCR						1						
BWWA												
CHSP										1		
COYE				1		2			1	1	1	
EAWP		1										
OVEN		1	1		1	1	1	1	1	1		
RBGR									1			
REVI				1				1				
RWBL			2	1							1	1
SCTA												
SOSP	1		1					1				
SWSP											1	
VEER			1									
WAVI												1
WTSP												
YRWA		1										
YWAR											1	1

* The dawn survey of site 8 was conducted on May30th 2008 starting with the edge transect at 4:49am. Cloud cover was 0% and a wind speed of 1 on the Beaufort scale.

Site 8b* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL				1							1	
AMCR												
AMRE							1	1			1	
AMRO												
BAOR		1										1
BCCH								1				1
BHCO												1
BHVI							1					
CAGO												
BRCR												
BWWA		1	1									
CHSP												
COYE	2		1						1	1	1	
EAWP								1				
OVEN					1		1	1	1			
RBGR												
REVI				1						1		
RWBL			1	1				1				1
SCTA									1			
SOSP		1		1		1			1			
SWSP										1	1	
VEER							1					
WAVI												
WTSP				1								
YRWA												
YWAR											1	

* The rush hour survey of site 8 was conducted on May30th 2008 starting with the edge transect at 6:50am. Cloud cover was 10% and a wind speed of 1 on the Beaufort scale.

Site 9a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL				2						1		
AMGO							1					
AMRE								1	1			
AMRO		2	1									
BAOR												
BCCH				1								1
BHCO		1										
BLJA												
BRCR												1
CEDW							2					
CHSP	1											
COYE				1		1		1				
CSWA												
GCFL					1							
HOWR												
INBU									1			
MAWA												
MODO	1											
NOFL				1								
OVEN						1						
RBGR							1	1		1		
REVI									1			1
RUGR												
RWBL							1					
SOSP	1		2		1		1					
YWAR										1		

* The dawn survey of site 9 was conducted on June 11th 2008 starting with the edge transect at 4:45am. Cloud cover was 10% and a wind speed of 2 on the Beaufort scale.

Site 9b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL				1								
AMGO	1		2	1			1					
AMRE									1	1		
AMRO					1					1		1
BAOR		1								1		
BCCH			2									
BHCO											1	
BLJA									2			
BRCR												
CEDW	1			1		1	2					
CHSP							1					
COYE					1	1						
CSWA					1							
GCFL										1		
HOWR					1							
INBU												
MAWA	1											1
MODO												
NOFL												
OVEN												
RBGR												
REVI		2							1		1	1
RUGR									1			
RWBL	1									1		
SOSP	1		1	1			1					
YWAR												

* The rush hour survey of site 9 was conducted on June 11th 2008 starting with the edge transect at 6:55am. Cloud cover was 10% and a wind speed of 2 on the Beaufort scale.

Site 10a*		Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species		50	150	250	350	450	550	50	150	250	350	450	550
BHVI													
BLJA													
BWWA								1			1		
COGR						1							
COYE		1	1		2	2						1	
EAWP				1									
GCFL								1					
HOSP													
OVEN				1						1	1	1	
RBGR			1	1									
REVI											2		
RWBL													
SOSP													
VEER		1		1							1	1	
VESP													

* The dawn survey of site 10 was conducted on June 5th 2008 starting with the edge transect at 4:50am. Cloud cover was 100% and a wind speed of 2 on the Beaufort scale.

Site 10b*		Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species		50	150	250	350	450	550	50	150	250	350	450	550
BHVI							-			1			-
BLJA							-				1		-
BWWA				1			-			1			-
COGR							-						-
COYE		1				2	-					1	-
EAWP					1		-			1			-
GCFL							-						-
HOSP					1		-						-
OVEN							-				1		-
RBGR							-						-
REVI				1			-		1		2		-
RWBL							-	1					-
SOSP				4		1	-	1				1	-
VEER				1			-					1	-
VESP						1	-						-

* The rush hour survey of site 10 was conducted on June 5th 2008 starting with the edge transect at 6:50am. Cloud cover was 90% and a wind speed of 2 on the Beaufort scale.

Appendix N (b). The number of individuals of each species observed at all point count locations during the late season visits (June 20th to July 17th 2008). Each table is labelled with the site number, and either **a**, the dawn surveys or **b** the rush hour surveys for both the edge and forest transects. A dashed mark (-) indicates a distance from the road where there was not a point count location due to inaccessibility or a short transect.

Site 1a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL						1						
AMGO				1								
AMRE			1									
AMRO			1			1			1	1		1
BAOR				1								
BCCH							1	1				
BHVI				1							1	
BLJA		1										1
BRCR											1	
BWWA		1										
CHSP	2											
COYE					1	1						
DOWO		1										
EAWP											1	1
GCFL										1		
OVEN				1	1		1	1	1			1
REVI										1		
RWBL												
SOSP			1	1		1						
VEER												1
WAVI												
WBNU										2		
WOTH											1	
YBSA								1				
YWAR		1			1	2						

*The dawn survey of site 1 was conducted on June 26th 2008 starting with the forest transect at 4:50am. Cloud cover was 80% and a wind speed of 1 on the Beaufort scale.

Site 1b* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
ALFL												
AMGO				1								
AMRE										1	1	
AMRO					1	1		1				1
BAOR												
BCCH					1							
BHVI				1					1		1	
BLJA								1				
BRCR												
BWWA		1										
CHSP		1	1									
COYE	1				1	1						
DOWO				1								
EAWP									1		1	
GCFL												
OVEN				1				1	1	1		1
REVI												
RWBL							1					
SOSP				1	1	1						
VEER		1										
WAVI										1	1	
WBNU												
WOTH												
YBSA									1			2
YWAR		2	1		1	2						

*The rush hour survey of site 1 was conducted on June 26th 2008 starting with the forest transect at 7:00am. Cloud cover was 60% and a wind speed of 1 on the Beaufort scale.

Site 2a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMRO	2											
BCCH					1					1		
BHVI										1		
BLJA			1									
BTBW												
CEDW									1			
COYE												
DOWO						1			1			
EAWP					1						1	
GCFL											1	
GRCA			1				1					
HOWR				1								
NOCA												
REVI				1	1	1					2	
SOSP	1	1			1		1					
WAVI		1										
YWAR	1											

**The dawn survey of site 2 was conducted on June 25th 2008 starting with the edge transect at 4:50am. Cloud cover was 100% with some fog and a wind speed of 1 on the Beaufort scale*

Site 2b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMRO												
BCCH					2					1	2	
BHVI											2	
BLJA												
BTBW			1									
CEDW												
COYE									1			
DOWO												
EAWP												
GCFL												
GRCA												
HOWR				1								
NOCA										1		
REVI						1					1	
SOSP					1	1	1					
WAVI												
YWAR												

**The rush hour survey of site 2 was conducted on June 25th 2008 starting with the edge transect at 6:55am. Cloud cover was 100% with some fog and a wind speed of 1 on the Beaufort scale*

Site 3a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO							1					
AMRO		1									1	
BAOR												
BCCH			1					1			1	
BHVI										1		
BRCH				1					1			
BTGW												1
COYE	1		1	1								
DOWO												
EAWP				1								
GCFL							1					
OVEN									1			
REVI			1	1	1					1	1	
SASP	1											
SOSP	1					1						1
WTSP												

*The dawn survey of site 3 was conducted on July 8th 2008 starting with the edge transect at 4:55am. Cloud cover was 90% and a wind speed of 2 on the Beaufort scale.

Site 3b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMGO												
AMRO						1						
BAOR						1						
BCCH								1	1		2	1
BHVI												
BRCH									1			
BTGW												
COYE	1	1										
DOWO					1							
EAWP												
GCFL												
OVEN										1		
REVI		1		1	1						1	
SASP												
SOSP				1								2
WTSP								1				

*The rush hour survey of site 3 was conducted on July 8th 2008 starting with the edge transect at 6:55am. Cloud cover was 20% and a wind speed of 1 on the Beaufort scale.

Site 4a*		Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species		50	150	250	350	450	550	50	150	250	350	450	550
ALFL													1
AMGO							1					1	
AMRE			1						1				
AMRO											1	1	
BAOR													
BCCH					2	1				1			
BHVI			1										
BWWA				1									
CEDW									1				
COYE								1			1	2	
GRCA							1		1				
HAWO			1		1								
NOCA						1							
SOSP									1				2
WTSP											1		

*The dawn survey of site 4 was conducted on June 24th 2008 starting with the forest transect at 4:55am. Cloud cover was 80% and a wind speed of 1 on the Beaufort scale.

Site 4b*		Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species		50	150	250	350	450	550	50	150	250	350	450	550
ALFL													
AMGO													1
AMRE		1							1				
AMRO				1	1				1		1	1	
BAOR		1											
BCCH		1			2								
BHVI													
BWWA													
CEDW													
COYE						2	1				2	1	
GRCA							1						
HAWO													
NOCA							1						
SOSP								1		1		1	1
WTSP													1

*The rush hour survey of site 4 was conducted on June 24th 2008 starting with the forest transect at 7:10am. Cloud cover was 60% and a wind speed of 2-3 on the Beaufort scale.

Site 5a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)							
	Species	50	150	250	350	450	550	Species	50	150	250	350	450	550
AMRE										2	1			
AMRO		2			1	1					1	1		1
BCCH					1									
BHVI														1
BWWA					1	1								
CEDW														
COGR														
EAWP														
GRCA												1		
INBU				1			1							
LEFL								1						
OVEN				1		1	1					1		1
REVI			1	1			1							
SOSP		1	1			1								
SWSP								1						
VEER			1	1	1	1						1	1	
WAVI								1	1					
WOTH				1				1						
YRWA											1			

**The dawn survey of site 5 was conducted on June 30th 2008 starting with the edge transect at 4:55am. Cloud cover was 10% and a wind speed of 1 on the Beaufort scale.*

Site 5b*		Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550		50	150	250	350	450	550
AMRE									2		1	1	
AMRO					1						1		
BCCH					2	1							1
BHVI	1					1							
BWWA									1		1		
CEDW													2
COGR					1								
EAWP													1
GRCA			1										
INBU	1												
LEFL								1					
OVEN						1			1	1		1	1
REVI										1	1	1	
SOSP			1	1		1							
SWSP													
VEER		1		1	1					1		1	
WAVI								1	1				
WOTH													
YRWA													

**The rush hour survey of site 5 was conducted on June 30th 2008 starting with the forest transect at 7:10am. Cloud cover was 10% and a wind speed of 2 on the Beaufort scale.*

Site 6a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
ALFL												
AMRO					1		1					2
BCCH				1				1		1	1	1
BHVI	1										1	
BLJA												
BWWA												1
CEDW							1					
COYE						1					1	
DOWO									1			
GRCA												
HAWO												
NOCA						1						
OVEN											1	1
REVI			1					1		1		
SOSP	1		2	1	1					1		
SWSP							1	1				
VEER				1	1						1	
WBNU												
WOTH			1					1				
WTSP							1	1				1
YWAR	2	2										

*The dawn survey of site 6 was conducted on July 17th 2008 starting with the forest transect at 5:10am. Cloud cover was 80% and a wind speed of 1 on the Beaufort scale.

Site 6b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
ALFL	1											
AMRO		1	1				1	1				
BCCH				2					1		1	
BHVI										1		
BLJA					2							
BWWA											1	
CEDW			1									
COYE	1					1	1				1	1
DOWO									1			
GRCA		1				1				1		
HAWO												1
NOCA												
OVEN												
REVI												
SOSP		1		1	1	1						
SWSP							1	1	1			
VEER											1	1
WBNU				1								1
WOTH										1		
WTSP								1			1	1
YWAR	1	2										

*The rush hour survey of site 6 was conducted on July 17th 2008 starting with the forest transect at 7:10am. Cloud cover was 60% and a wind speed of 2 on the Beaufort scale.

Site 7a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMRE										1		
AMRO						1	1		1			
BCCH	2				1		2	1			1	1
BLJA												
BWWA												1
CHSP							1					
COYE			1									1
EAWP										1		
EUST												
GRCA												
HOWR					2							
OVEN				1	1		1		1			
PIWA		1						1			1	
RBGR				1				1				1
RBNU										1		
REVI											1	
SOSP												
VEER						1			2	1	1	
VESP						1						
WBNU												
WTSP								1		1	1	
YWAR	1											

**The dawn survey of site 7 was conducted on June 20th 2008 starting with the forest transect at 4:50am. Cloud cover was 90% and a wind speed of 1 on the Beaufort scale.*

Site 7b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMRE			1									
AMRO		1		1					1		1	1
BCCH						1					1	
BLJA			2									
BWWA										1		1
CHSP		1					1					
COYE	1											
EAWP												
EUST							1					
GRCA			1									
HOWR					2							
OVEN				1		1	1			1		1
PIWA			1					1	1			
RBGR												
RBNU										1		
REVI												
SOSP					1							
VEER					1						1	1
VESP												
WBNU										1		
WTSP								1	1			1
YWAR												

**The rush hour survey of site 7 was conducted on June 20th 2008 starting with the forest transect at 7:10am. Cloud cover was 60% and a wind speed of 2 on the Beaufort scale.*

Site 8a*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
ALFL									1			
AMRO		1						1				
BAOR												
BCCH				2				2	1	1		1
BHVI					1							
BTGW			1									
CEDW					1	3						
COYE					1	1		1	1	1	1	2
MOWA						1						
NOPA		1	1									
OVEN							1					
RBGR			2									
REVI							1	1	1		1	
RWBL				1					1	1	1	1
SCTA												
SOSP												
SWSP									1		2	
VEER					1		1					
WBNU			1									
WTSP									1			
YWAR				2	1						1	

*The dawn survey of site 8 was conducted on July 2th 2008 starting with the forest transect at 5:00am. Cloud cover was 20% and a wind speed of 1 on the Beaufort scale.

Site 8b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
ALFL												
AMRO			1					1				
BAOR												
BCCH						1	1	2	2			
BHVI						1						
BTGW												
CEDW						2						
COYE		1								1	1	2
MOWA									1			
NOPA												
OVEN							1	1				
RBGR				1						1		
REVI		1								1		
RWBL	1			2			1				1	1
SCTA											1	
SOSP		2							1			
SWSP									1		1	1
VEER												
WBNU												
WTSP									1			
YWAR		1	1	1						1	1	

*The rush hour survey of site 8 was conducted on July 2th 2008 starting with the forest transect at 7:10am. Cloud cover was 10% and a wind speed of 3 on the Beaufort scale.

Site 9a*	Distance from the road along the edge transect (m)							Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550		50	150	250	350	450	550
AMRE									1				
AMRO				1		1							
BCCH	1									1		1	
BLJA	1												
BWWA													
CEDW		1											
CHSP	1					1		1					
COYE						1					1		
DOWO													
EAWP													
INBU									1				
MAWA										2			
REVI										1	1	1	
SCTA												2	
SOSP		1		2		1		1					
WOTH													

*The dawn survey of site 9 was conducted on July 16th 2008 starting with the forest transect at 5:05am. Cloud cover was 60% and a wind speed of 1 on the Beaufort scale.

Site 9b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMRE												1
AMRO				1								
BCCH	1		2								1	
BLJA												
BWWA												1
CEDW												
CHSP											1	
COYE			1			1	1					
DOWO							1					
EAWP									1			
INBU									1			
MAWA												
REVI									1			
SCTA					1			1			1	
SOSP	1			2								
WOTH						1					1	

*The rush hour survey of site 9 was conducted on July 16th 2008 starting with the forest transect at 6:55am. Cloud cover was 80% and a wind speed of 1 on the Beaufort scale.

Site 10a* Species	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
	50	150	250	350	450	550	50	150	250	350	450	550
AMCR	1					-						-
AMRO			1			-						-
BCCH	1					-		1	1	1	2	-
BHVI			1			-						-
BLJA						-						-
BWWA				1		-						-
COYE				1	1	-						-
EAWP						-	1	1				-
REVI						-			1	1		-
SOSP			1	1	1	-					1	-
VEER						-		1				-
WTSP						-		1				-

*The dawn survey of site 10 was conducted on July 14th 2008 starting with the forest transect at 5:00am. Cloud cover was 80% and a wind speed of 2 on the Beaufort scale.

Site 10b*	Distance from the road along the edge transect (m)						Distance from the road along the forest transect (m)					
Species	50	150	250	350	450	550	50	150	250	350	450	550
AMCR	1					-						-
AMRO				1		-						-
BCCH						-						-
BHVI				1		-						-
BLJA						-		1				-
BWWA						-						-
COYE					1	-						-
EAWP						-						-
REVI						-			1	1		-
SOSP				1	1	-						-
VEER						-		1	1		1	-
WTSP						-	1			1		-

*The rush hour survey of site 10 was conducted on July 14th 2008 starting with the forest transect at 7:00am. Cloud cover was 60% and a wind speed of 2 on the Beaufort scale.

Appendix O (a). Traffic noise levels calculated as the average decibel (dBA) level recorded between the frequencies of 300 and 2,000 Hz for each 5 minute recording at each point count location along the edge transects. Visit 1 occurred on weekdays between May 12th and June 11th 2008 and visit 2 occurred on weekdays between June 20th and July 17th 2008). Dawn surveys began 30 minutes before sunrise and the rush hour surveys began at approximately 7:00 am. A dashed mark (-) indicates a recording in which traffic noise level could not be calculated due to playback errors in the recording.

	Traffic noise along the edge transects during the dawn surveys (dBA)						Traffic noise along the edge transects during the rush hour surveys (dBA)					
	50 m	150m	250m	350m	450m	550m	50m	150m	250m	350m	450m	550m
Site 1												
Visit #1	56.5	52.9	50.5	46.3	44.8	47.0	58.6	53.5	47.1	47.4	42.8	43.2
Visit #2	61.1	57.9	54.3	49.5	48.3	42.6	58.1	52.7	48.9	44.7	38.7	42.6
Site 2												
Visit #1	59.1	55.5	53.5	52.1	50.7	49.3	56.3	51.2	51.1	52.0	50.0	49.0
Visit #2	43.9	45.4	46.1	40.1	40.5	36.1	57.0	50.1	49.5	45.7	46.3	42.6
Site 3												
Visit #1	66.9	63.2	59.9	59.1	57.3	56.9	56.3	51.2	51.1	52.0	50.0	49.0
Visit #2	58.5	53.2	50.2	49.1	49.1	49.5	61.8	56.3	51.3	51.6	50.7	54.0
Site 4												
Visit #1	-	-	-	-	-	-	-	-	-	-	-	-
Visit #2	61.4	54.6	56.8	50.2	50.9	53.8	62.0	60.1	52.1	52.3	45.8	55.8
Site 5												
Visit #1	65.7	61.6	59.6	59.9	58.7	56.1	66.2	59.0	60.3	59.2	54.5	57.6
Visit #2	52.5	49.9	49.2	53.6	52.9	49.3	60.2	55.1	50.1	51.6	52.6	53.7
Site 6												
Visit #1	65.8	61.9	59.5	54.8	54.2	52.1	63.9	58.5	56.0	51.2	48.9	50.3
Visit #2	-	-	-	-	-	-	-	-	-	-	-	56.4
Site 7												
Visit #1	61.2	59.9	59.6	55.8	57.3	57.8	64.6	62.9	62.9	62.8	60.3	56.6
Visit #2	-	-	-	-	-	-	-	-	-	-	-	-
Site 8												
Visit #1	61.4	57.1	59.1	61.9	60.1	59.2	62.8	60.7	57.7	57.6	56.0	56.6
Visit #2	59.2	53.9	50.0	48.2	44.4	47.6	60.4	53.6	49.9	47.1	47.4	44.9
Site 9												
Visit #1	62.9	50.8	53.1	55.0	54.1	50.2	65.6	60.7	55.3	53.4	50.8	49.1
Visit #2	57.4	52.3	50.9	49.1	48.9	48.7	59.6	49.8	43.1	45.2	49.8	50.3
Site 10												
Visit #1	52.3	52.6	49.4	48.0	47.6	N/A	58.0	54.2	50.2	50.4	50.2	N/A
Visit #2	62.4	56.5	55.7	52.3	53.9	N/A	64.3	60.7	55.3	53.5	53.5	N/A

Appendix O (b). Traffic noise levels calculated as the average decibel (dBA) level recorded between the frequencies of 300 and 2,000 Hz for each 5 minute recording at each point count location along the forest transects. Visit 1 occurred on weekdays between May 12th and June 11th 2008 and visit 2 occurred on weekdays between June 20th and July 17th 2008). Dawn surveys began 30 minutes before sunrise and the rush hour surveys began at approximately 7:00 am. A dashed mark (-) indicates a recording in which traffic noise level could not be calculated due to playback errors in the recording.

	Traffic noise along the forest transects during the dawn surveys (dBA)						Traffic noise along the forest transects during the rush hour surveys (dBA)					
	50m	150m	250m	350m	450m	550m	50m	150m	250m	350m	450m	550m
Site 1												
Visit #1	64.7	57.6	50.7	45.9	44.5	46.2	62.2	53.2	49.0	43.5	41.6	48.7
Visit #2	56.9	49.8	41.3	43.2	43.4	42.6	58.1	56.6	47.2	44.8	51.0	42.7
Site 2												
Visit #1	47.6	44.8	42.2	43.8	45.1	N/A	59.5	53.4	49.0	54.3	48.6	N/A
Visit #2	58.4	44.6	39.3	36.5	36.0	N/A	60.8	53.3	45.6	43.8	40.4	N/A
Site 3												
Visit #1	55.8	53.7	52.1	50.0	53.1	54.7	61.2	60.0	56.2	54.6	56.2	56.9
Visit #2	59.3	59.5	50.9	51.8	49.3	50.3	55.9	54.0	47.6	47.0	46.7	50.1
Site 4												
Visit #1	-	-	-	-	-	-	-	-	-	-	-	-
Visit #2	57.6	50.9	48.7	51.1	48.7	50.5	58.5	-	-	-	52.6	42.8
Site 5												
Visit #1	58.0	51.1	52.1	54.5	49.9	53.1	62.2	59.9	54.1	55.8	53.5	49.9
Visit #2	59.9	53.8	53.8	54.6	54.1	51.9	59.0	52.9	52.9	52.8	48.5	51.1
Site 6												
Visit #1	61.1	60.9	57.7	57.4	51.9	54.6	64.8	61.3	55.8	56.4	51.7	54.7
Visit #2	64.9	61.8	57.9	-	51.9	49.8	-	-	-	-	-	-
Site 7												
Visit #1	61.4	58.8	60.6	59.7	59.0	53.8	58.5	56.2	58.2	55.9	60.8	53.0
Visit #2	-	-	-	-	-	-	-	-	-	-	-	-
Site 8												
Visit #1	64.5	57.8	58.7	63.5	60.1	59.4	60.2	57.9	52.0	57.5	56.5	55.7
Visit #2	55.7	51.2	47.3	50.8	46.5	47.5	66.9	54.9	49.9	46.2	42.9	43.4
Site 9												
Visit #1	64.5	61.4	55.1	51.9	52.7	46.4	63.2	62.4	55.8	54.0	49.7	50.5
Visit #2	58.2	56.5	54.7	53.3	52.4	49.4	58.3	54.8	48.7	43.1	48.4	46.5
Site 10												
Visit #1	57.6	56.0	53.9	48.0	48.1	N/A	58.5	57.1	54.3	48.4	52.6	N/A
Visit #2	57.5	51.7	52.6	48.4	48.7	N/A	56.8	53.7	51.6	50.8	49.9	N/A

Appendix P. A list of all the bird species, their scientific names and their associated American Ornithologist Union (AOU) code, (Pyle and DeSante 2003) used to calculate bird species richness at each bird survey location.

AOU Code	Scientific name	AOU Code	Scientific name
ALFL	<i>Empidonax alnorum</i>	LEFL	<i>Empidonax minimus</i>
AMCR	<i>Corvus brachyrhynchos</i>	MAWA	<i>Dendroica magnolia</i>
AMGO	<i>Carduelis tristis</i>	MODO	<i>Zenaidura macroura</i>
AMRE	<i>Setophaga ruticilla</i>	MOWA	<i>Oporornis philadelphia</i>
AMRO	<i>Turdus migratorius</i>	NAWA	<i>Vermivora ruficapilla</i>
BAOR	<i>Icterus galbula</i>	NOCA	<i>Cardinalis cardinalis</i>
BCCH	<i>Poecile atricapillus</i>	NOFL	<i>Colaptes auratus</i>
BHCO	<i>Molothrus ater</i>	NOPA	<i>Parula americana</i>
BHVI	<i>Vireo solitarius</i>	NOWA	<i>Seiurus noveboracensis</i>
BLJA	<i>Cyanocitta cristata</i>	OVEN	<i>Seiurus aurocapillus</i>
BOBO	<i>Dolichonyx oryzivorus</i>	PIWA	<i>Dendroica pinus</i>
BRCR	<i>Certhia americana</i>	RBGR	<i>Pheucticus ludovicianus</i>
BTBW	<i>Dendroica caerulescens</i>	RBNU	<i>Sitta canadensis</i>
BTGW	<i>Dendroica virens</i>	REVI	<i>Vireo olivaceus</i>
BWWA	<i>Mniotilta varia</i>	RTHU	<i>Archilochus colubris</i>
CEDW	<i>Bombcilla cedrorum</i>	RUGR	<i>Bonasa umbellus</i>
CHSP	<i>Spizella passerina</i>	RWBL	<i>Agelaius phoeniceus</i>
COGR	<i>Quiscalus quiscula</i>	SASP	<i>Passerculus sandwichensis</i>
COYE	<i>Geothlypis trichas</i>	SCTA	<i>Piranga olivacea</i>
CSWA	<i>Dendroica pensylvanica</i>	SOSP	<i>Melospiza melodia</i>
DEJU	<i>Junco hyemalis</i>	SWSP	<i>Melospiza georgiana</i>
DOWO	<i>Picoides pubescens</i>	VEER	<i>Catharus fuscescens</i>
EAWP	<i>Contopus virens</i>	VESP	<i>Poocetes gramineus</i>
EUST	<i>Sturnus vulgaris</i>	WAVI	<i>Vireo gilvus</i>
FISP	<i>Spizella pusilla</i>	WBNU	<i>Sitta carolinensis</i>
GCFL	<i>Myiarchus crinitus</i>	WOTH	<i>Hylocichla mustelina</i>
GCKI	<i>Regulus satrapa</i>	WTSP	<i>Zonotrichia albicollis</i>
GRCA	<i>Dumetella carolinensis</i>	YBSA	<i>Sphyrapicus varius</i>
HAWO	<i>Picoides villosus</i>	YRWA	<i>Dendroica coronata</i>
HOSP	<i>Passer domesticus</i>	YTVI	<i>Vireo flavifrons</i>
HOWR	<i>Troglodytes aedon</i>	YWAR	<i>Dendroica petechia</i>
INBU	<i>Passerina cyanea</i>		