New Brunswick Nocturnal Owl Survey

20-year preliminary report (2001–2020)

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Already 20 years since the beginning of the Nocturnal Owl Survey in New Brunswick! Our knowledge of the abundance and population trends of owl species in North America has been greatly improved for the past decades, notably thanks to the involvement and dedication of hundreds of volunteers. THANK YOU FOR YOUR EFFORTS!

INTRODUCTION

Owls are excellent indicators of environmental health, as they occupy a position high on the food chain and are vulnerable to environmental disturbances such as contaminants and habitat loss. Some owl species have specialized habitat requirements, such as the Barred Owl, which depends upon cavities in large diameter trees, mostly hardwood, for nesting (New Brunswick Department of Natural Resources 2005). Because of their nocturnal habits, owls are not well monitored through programs such as the North American Breeding Bird Survey, the Christmas Bird Count, or the Breeding Bird Atlas of the Maritimes. Also, these programs usually take place outside of the breeding season for owls. Hence, the New Brunswick Nocturnal Owl Survey (NB NOS) was initiated in 2001 as a volunteer-based program to monitor population trends for NB's most common owl species, especially Barred Owls. The survey was also designed to address NB's need for information on several rare owl species of conservation concern (Long-eared and Boreal Owls), and to provide a tool to assess forest management practices in NB.

For 20 years, the NOS and its volunteers have been helping track owl populations in NB. Now entering its 21st year, the survey provides a large dataset that allows for in-depth analysis of long-term owl population trends, and relating those trends to changes in habitat and landscape structure. The NB NOS is also about engaging New Brunswickers in active wildlife monitoring, and meaningful research and conservation. Thanks to the high volunteer participation every spring – over 100 New Brunswickers involved – and the strong dedication to their routes, the program has a bright future ahead of it!

The survey was carefully designed to examine owl population trends separately on public and private land so that these and other questions about crown land management could be answered. This report provides a 20-year trend analysis for Barred, Great Horned and Northern Saw-whet Owls on both public and private lands, and compares trends and forest habitat between public and private lands. It also provides a brief insight about owl habitat associations in NB.

METHODS

Route creation

Routes were systematically selected across NB by dividing up the province into a grid of 50 km x 50 km squares and placing routes within each square. One route on public land and one route on private land were placed in each square. The starting point for each route was chosen by randomly selecting a smaller 10 x 10 km square from within the larger square and placing the starting point at the closest point to a road from the center of the smaller square. The direction of travel from the starting point was randomly selected and the route stayed on the same road as much as possible. See "New Brunswick Nocturnal Owl Survey 2001 Annual Report" (Whittam 2001) for more details on route selection. A total of 100 routes were created in 2001, and a further 10 routes were added the following year, for a total of 110 routes (Appendix 1). Each route is made up of 10 stops, spaced approximately 2 km apart.

Survey protocol

Standardized owl surveys using broadcasted owl calls are used across North America and in Europe as a means of detecting owls and assessing population trends. Owls vocalize to communicate with their mates, and also to defend their territories from other owls. Broadcasting recordings or imitating owl calls within an owls' territory can provoke a response by the resident owl in an attempt to warn away an intruder. This method can be used to survey many owl species, and is particularly useful for detecting Barred Owls (Francis and Whittam 2000). Each region for the NOS has selected a playback protocol targeting species of particular interest to their region. Playback helps increase the number of detections, increasing the power of a survey to detect population change, and also helps insure the continued interest of volunteers.

In NB, each route is surveyed in its entirety on any one night between April 1st and May 15th. Surveyors in the southern part of the province are encouraged to run their route during the first two weeks of the survey to avoid noise interference from the sounds of frogs and spring runoff. The survey begins approximately 30 minutes before sunset, and is generally completed before midnight. Volunteers are provided with standardized data sheets and record general weather conditions at the start and end of their survey. This includes temperature, precipitation, and wind direction and speed (using the Beaufort scale). At each stop on the route, volunteers start by recording the time and distance from the last stop. They then play the broadcast CD that contains a standardized playback protocol. Each stop takes approximately 13 minutes and begins with 2 minutes of silent listening, followed by a 20-second Boreal Owl playback, then 2 more minutes of silent listening, then 4 sets of 20-second Barred Owl playback separated by 2-minute silent listening intervals. The playback CD was produced and donated by Wildlife Technologies Inc. and Birds Canada provides training, playback CDs and instruction kits.

When an owl is detected, the surveyor notes the listening period in which it was detected, and estimates the direction and distance to the owl using the following

categories: < 200 m, 200–500 m, 500–1000m, or > 1000 m. They also indicate whether they believe the owl to be one that was heard at a previous stop. In addition, volunteers count the number of vehicles that pass by while at each stop, and estimate the overall noise level (from 1 to 4, with 4 being excessive noise preventing listening). Lastly, volunteers count the number of Wilson's Snipe, American Woodcock and Ruffed Grouse heard while listening for owls. In 2020, a few volunteers were able to safely do their routes, but most surveys were cancelled due to the COVID-19 pandemic. As a result, the 2020 dataset is not complete, and we did not include it in the 20-year analysis (see Appendix 2 for the number of survey years for each route since 2001).

Data management

Data are kept and managed in a Microsoft Access database which is stored on Birds Canada servers in Ontario. The database is structured according to the Guidelines for Nocturnal Owl Monitoring in North American (Takats et al. 2001). All data is publicly available upon request, through Birds Canada's Nature Counts database (available at: https://www.birdscanada.org/birdmon/default/main.jsp).

Trend analyses

Population trends for Barred Owl, Northern Saw-whet Owl and Great Horned Owl for 2001-2019 were calculated by fitting a generalized linear model (GLM) with negative binomial distribution, where the trend is the slope of the negative binomial regression on year. As these slopes represent instantaneous rates, they were also transformed into their discrete time equivalents to show the percent change per year. To examine whether trends were similar between routes/stops in public versus private lands, routes/stops were grouped according to landbase and analyzed as a group. Comparisons of trends between landbase categories were made using Analysis of Covariance (ANCOVA). All models were fit using the GLM function in the R statistical language version R 3.4.3 (R Development Core Team 2017).

Habitat analyses

To analyze owl habitat associations and the potential implication of habitat cover variables to explain trends, we used the land cover dataset from The Nature Conservancy' Northeast Terrestrial Habitat Map (for a description of the original dataset, see Ferree & Anderson 2013, The Nature Conservancy 2015). The Habitat Map was extended to cover Atlantic Canada in 2015, and encompasses the most recent private and government datasets that were made available from a variety of contributors. Using the original habitat classification categories of the dataset, we extracted land cover categories related to the age of forest stands: All Forest, Mature Forest (Boreal Upland Forest, Northern Hardwood-Conifer, Central Oak-Pine, Cold-Temperate Upland Forest, Cold-Temperate Wet Forest, Northern Swamp, Boreal Forested Peatland), Young Forest (Plantation and Ruderal Forest, Ruderal Shrubland and Grassland), and Non Forest (Built, Agriculture, Coastal Grassland and Shrubland, Rocky Areas, Open Wetland, Inland Water). Using ArcGIS 10.3 (ESRI, Redlands, CA,

USA), we calculated percent land cover for these categories within a 1000-m, 2000-m and 4000-m radius around each survey site. In this report, we only present results at the 1000-m spatial scale, as we found similar results with the other spatial scales. In addition, a 1000-m radius: (1) is relevant when studying the home range of owls, (2) allowed less overlapping between the 2-km spaced sites, (3) appeared to be a scale at which owls respond to forest variables in other Atlantic provinces (Studholme 2020).

As a response variable, we used presence-absence data for the 3 main species of owls, and for the period 2010-2015 (i.e. just before the publication of the land cover dataset). Presence-absence data at a survey site were recoded as follows: "presence" if at least one detection between 2010 and 2015; "absence" if no detection between 2010 and 2015, and a minimum of three years of data for each survey site over the period. We then fitted logistic regression models to analyze the probability of occupancy at a survey site as a function of percent land cover category.

RESULTS

Abundance

Barred Owls have been the most abundant owl during each year of the survey, averaging between 1.5 and 4 owls per route (Appendix 3). Northern Saw-whet Owls have been the next most abundant owl, with almost one owl per route per year in average, followed by Great Horned Owls, twice less abundant than Northern Saw-whet Owls. The other owl species have very low abundances, and have not been observed every year of the survey. Boreal Owls were recorded at a number of routes during the first three years, and then more regularly since 2014. Since 2004, efforts were made by Birds Canada to increase volunteers' ability to differentiate Boreal Owl calls from similar Common Snipe courtship displays. Long-eared, Short-eared and Eastern Screech-Owls have been rarely and irregularly detected in NB (11, 4, and 7 years of detections, respectively). 2017 was the year with the highest number of owl detections per route in NB, all species combined.

Trends

The number of Barred Owls detected during the survey has increased significantly, by +2.6% annually, since 2001 (Table 1). Barred Owls appear to have peaked from 2006-2010 and again around 2017 (Figure 1). Detections of Northern Saw-whet Owl have remained steady during the survey, with cycles of high abundance every 2 years (Table 1; Figure 2). No obvious trend appears in NB for that species. Great Horned Owls have been showing a significant decline of -3.7% per year (Table 1; Figure 3).

On public lands, Great Horned Owls detections have decreased by -4.8% per year, while there has been no significant difference in either Barred Owl or Northern Saw-whet Owl detections between years (Table 1). On private lands, Barred Owl detections have increased by +3.9% per year, whereas Great Horned Owls have undergone significant declines at a rate of -2.9% per year (Table 1). Over the 19-year period,

Barred Owls showed a significant difference in trend between public and private lands (P<0.01; Figure 4), being more abundant in recent years on private lands. There was no statistically significant difference in trends between public and private lands for the other two species (see Figures 5 and 6). However, Northern Saw-whet Owls were consistently more abundant on public lands over the past 20 years (Figure 5).

Table 1. Results of trend analyses by species from 2001–2019 in New Brunswick, for the whole province, and according to landbase (public versus private lands). Trends were analyzed at the route level for the whole province, whereas trends were analyzed at the stop level when accounting for landbase category. LCL and UCL represent lower and upper confidence limits (95%). Significant rates of change (P<0.05) are highlighted in grey. Significant differences in trends between landbase categories were determined using ANCOVA.

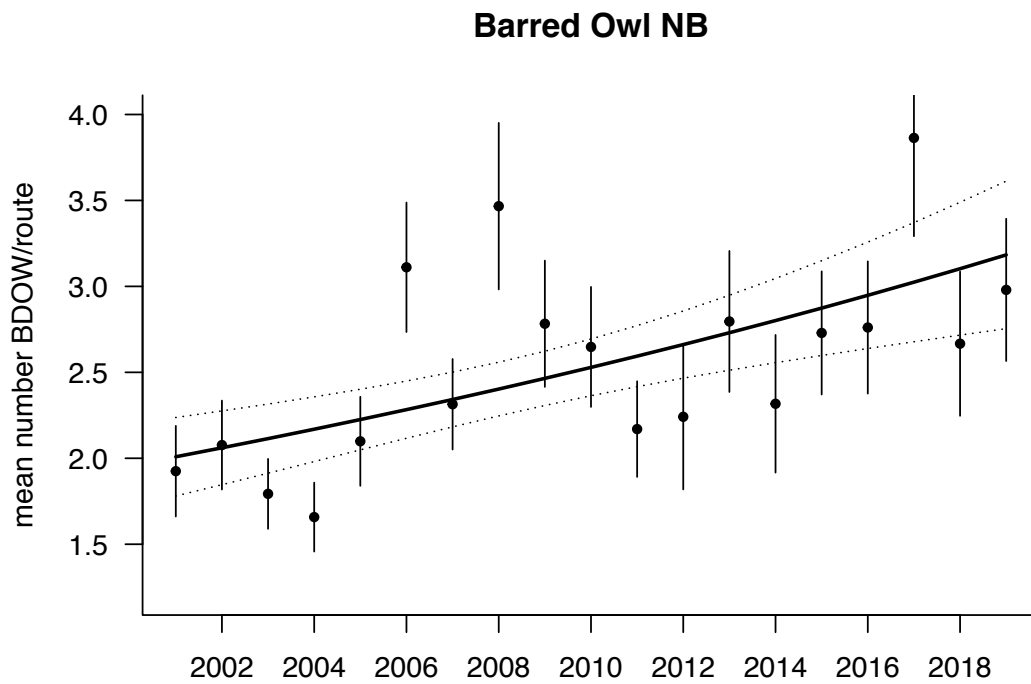|	% annual change	SE (%)	LCL (%)	UCL (%)
All New Brunswick				
Barred Owl	2.6	0.6	1.4	3.8
Northern Saw-whet Owl	0.4	0.9	-1.3	2.3
Great Horned Owl	-3.7	1.1	-5.8	-1.5
Public lands				
Barred Owl	0.6	0.7	-0.8	2.1
Northern Saw-whet Owl	1.0	0.9	-0.8	2.9
Great Horned Owl	-4.8	1.4	-7.6	-1.9
Private lands				
Barred Owl	3.9	0.5	2.8	5.0
Northern Saw-whet Owl	0.4	0.9	-1.3	2.1
Great Horned Owl	-2.9	1.2	-5.2	-0.6

Barred Owl NB

Figure 1. Average number of Barred Owls per route in New Brunswick from 2001-2019. The dashed lines represent 95% confidence intervals. Points with error bars indicate annual variation, whereas trend lines indicate trajectory over time.
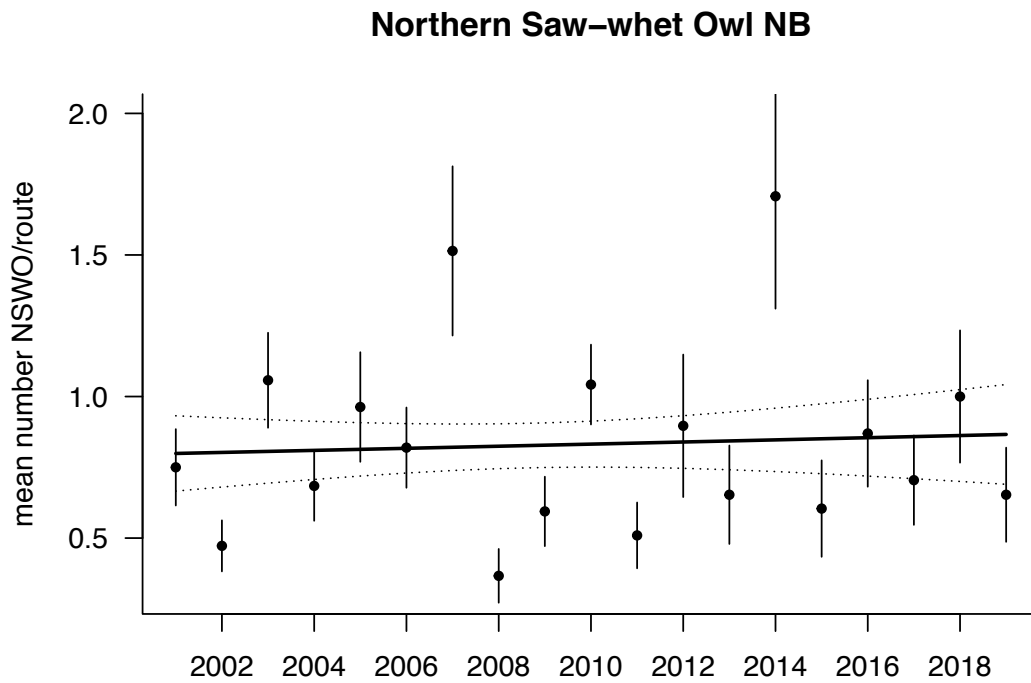
Northern Saw–whet Owl NB

Figure 2. Average number of Northern Saw-whet Owls per route in New Brunswick from 2001-2019. The dashed lines represent 95% confidence intervals. Points with error bars indicate annual variation, whereas trend lines indicate trajectory over time.
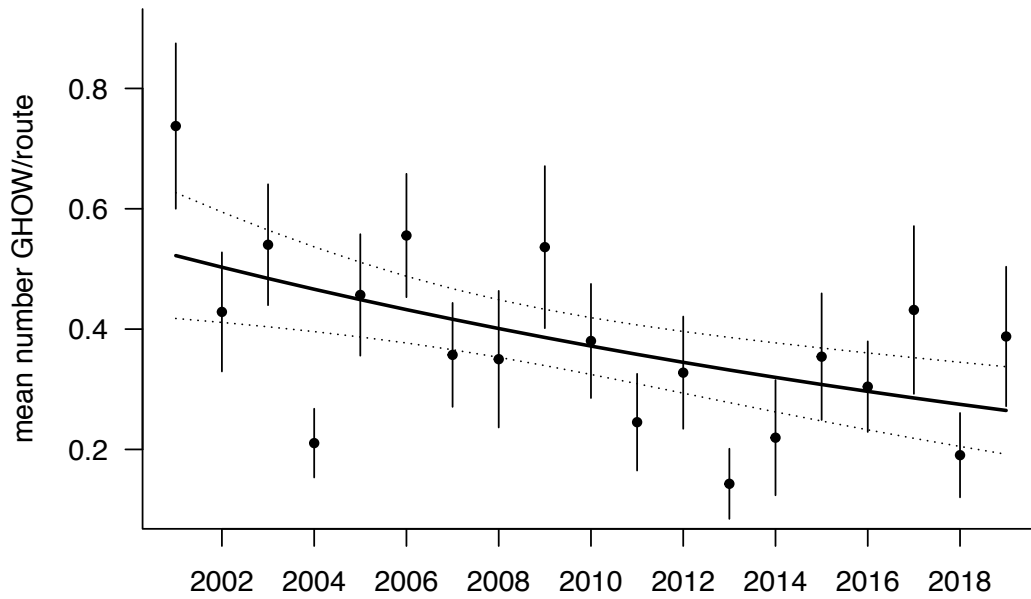
Great Horned Owl NB

Figure 3. Average number of Great Horned Owls per route in New Brunswick from 2001-2019. The dashed lines represent 95% confidence intervals. Points with error bars indicate annual variation, whereas trend lines indicate trajectory over time.
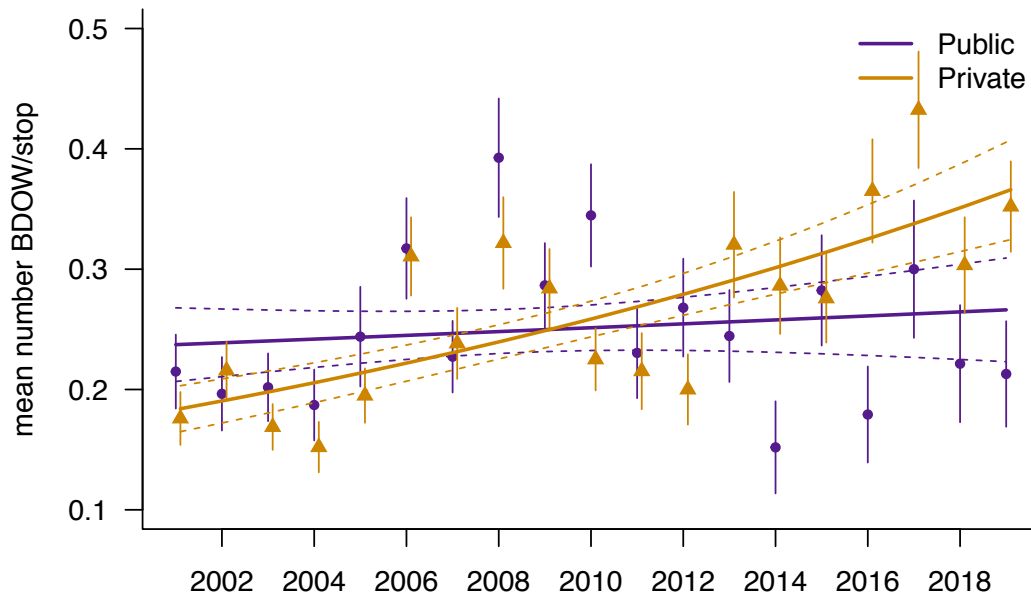
Barred Owl

Figure 4. Average number of Barred Owls per stop in New Brunswick from 2001-2019, according to landbase. The dashed lines represent 95% confidence intervals. Points with error bars indicate annual variation, whereas trend lines indicate trajectory over time.

Northern saw–whet Owl

Figure 5. Average number of Northern Saw-whet Owls per route in New Brunswick from 2001-2019, according to landbase. The dashed lines represent 95% confidence intervals. Points with error bars indicate annual variation, whereas trend lines indicate trajectory over time.
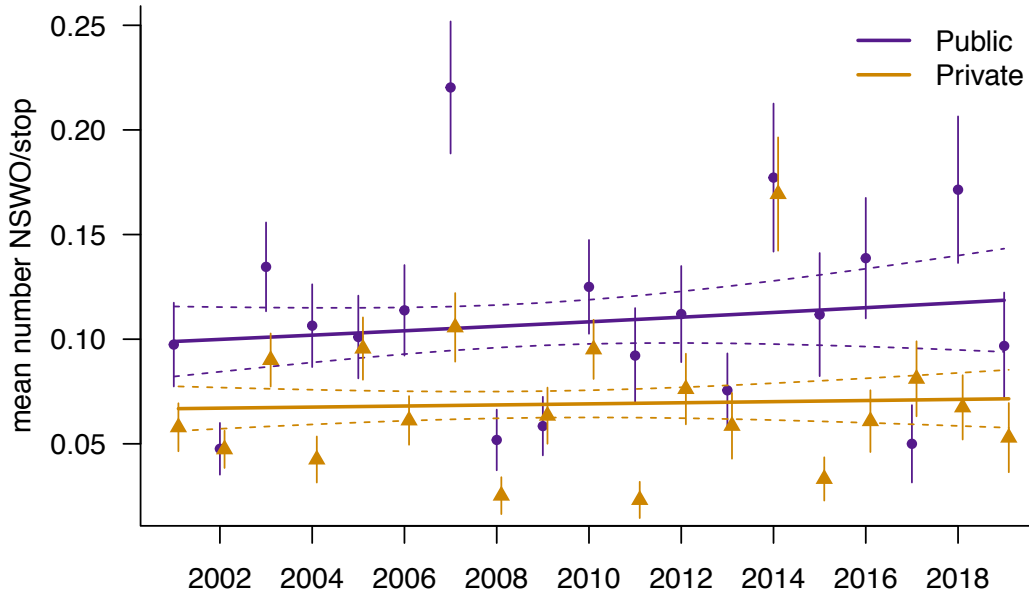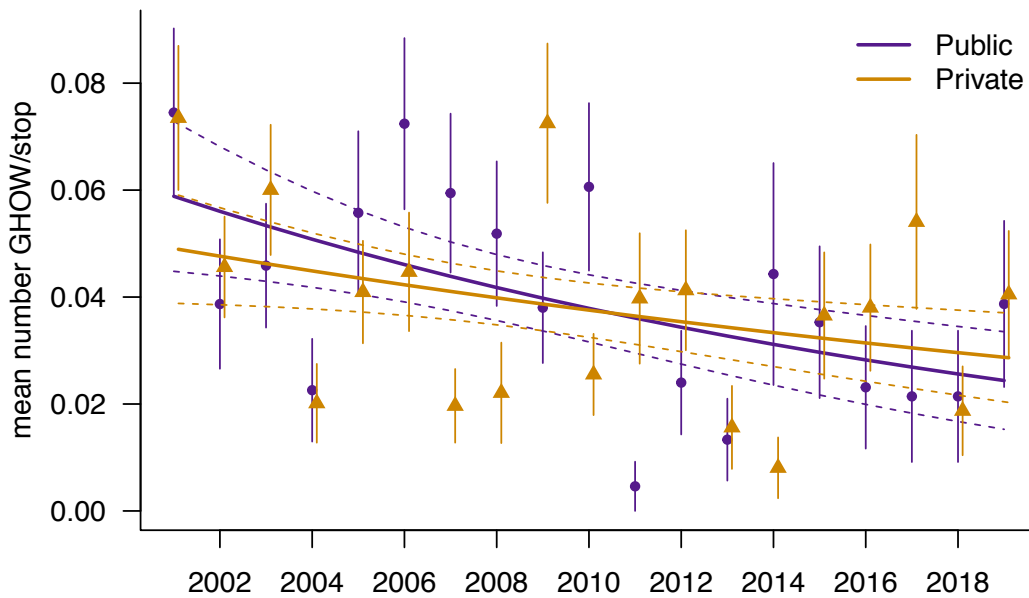
Great Horned Owl

Figure 6. Average number of Great Horned Owls per route in New Brunswick from 2001-2019, according to landbase. The dashed lines represent 95% confidence intervals. Points with error bars indicate annual variation, whereas trend lines indicate trajectory over time.

Land cover and owl habitat associations

Percent land cover categories at a 1000-m radius around a survey site differed a lot between private and public lands. Public lands had significantly more area covered by forests, either mature, young, or all types (Figure 7). They also had significantly more wetlands. Private lands had significantly more agricultural and grassland areas, more built areas, and more non-forested areas in general. The proportion of mature forest among forested areas did not differ between private and public lands (Figure 7).
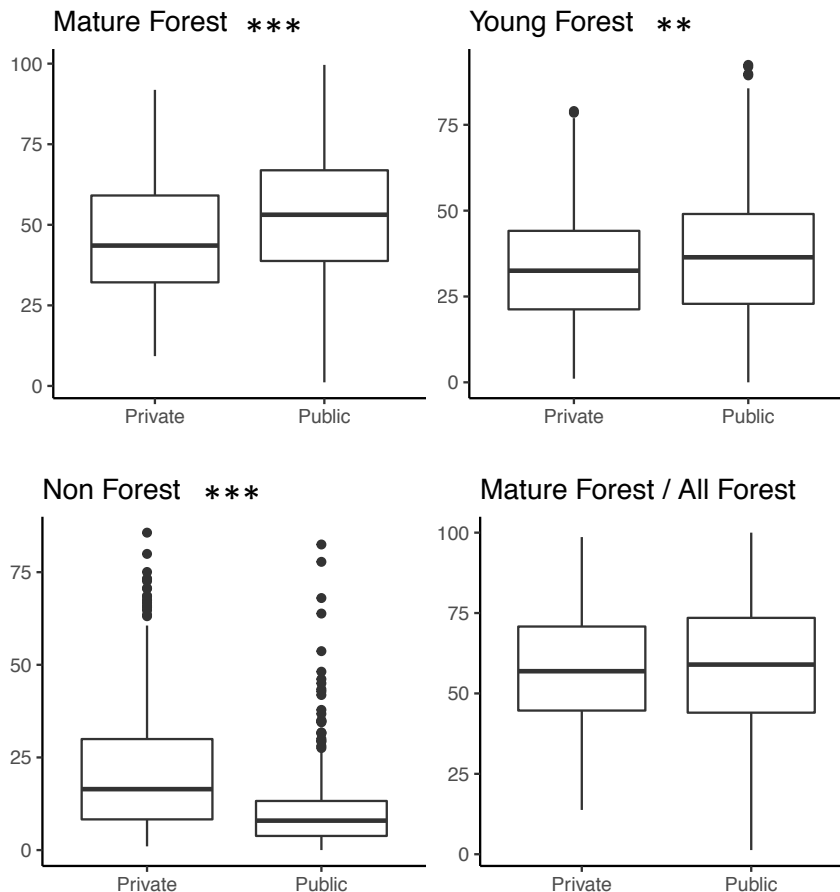
Figure 7: Difference in habitat characteristics (% land cover at a 1000-m radius around owl survey points) between private and public lands. Stars represent the level of statistical significance.

Logistic regression models showed contrasting habitat associations between the three owl species in NB. While Barred and Northern Saw-whet Owls responded positively to percent total forest cover around a survey point, Great Horned Owls showed no significant response (Table 2; Figure 8). Barred Owls were neither associated with Mature Forest, nor Young Forest. In fact, they exhibited more of a quadratic relationship with those variables, i.e. their probability of presence increased at intermediate values of percent land cover (Figure 8). Finally, Northern Saw-whet Owls exhibited a positive response to Mature Forest, and Great Horned Owls tended to be negatively associated with Young Forest.

Table 2: Results of logistic regression models by species, analyzing their probability of presence from 2010–2015 as a function of percent forest cover variables (1000-m radius around owl survey points). LCL and UCL represent lower and upper confidence limits (95%). Significant effects (P<0.05) are highlighted in grey.

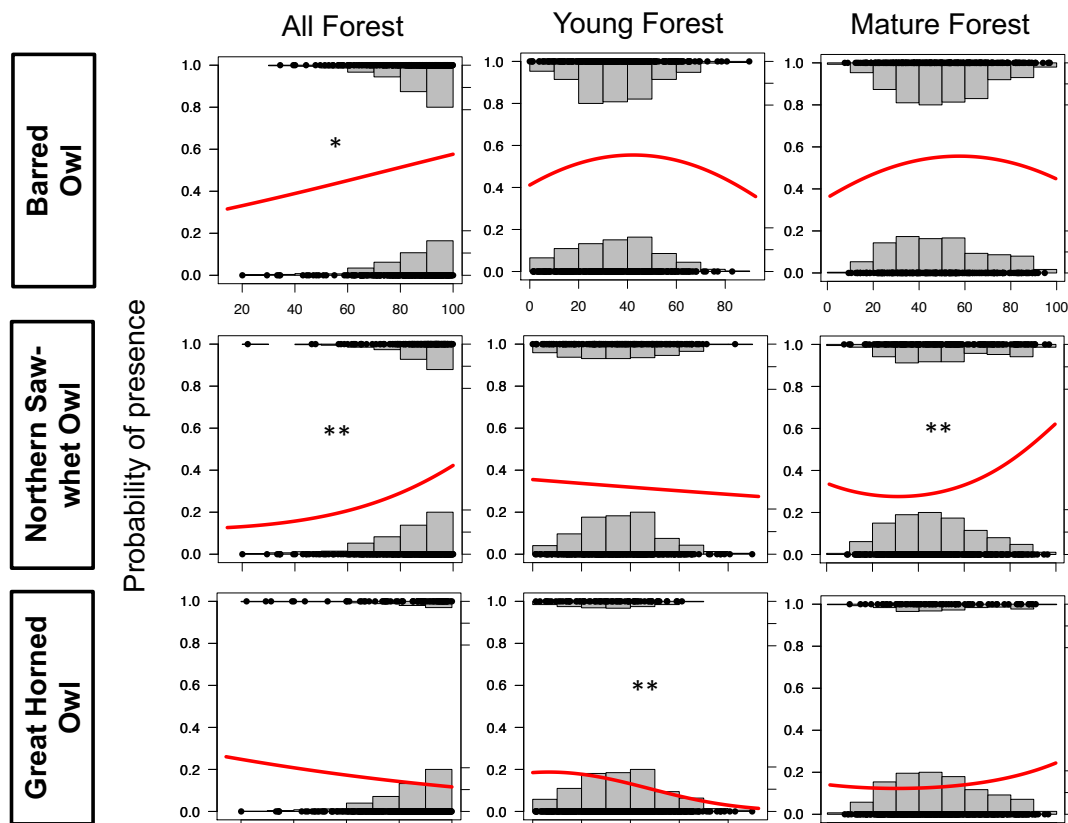|	Estimate	SE	LCL	UCL
Barred Owl				
All Forest	0.013	0.006	0.001	0.025
Young Forest	0.004	0.005	-0.006	0.013
Mature Forest	0.003	0.004	-0.005	0.011
Northern Saw-whet Owl				
All Forest	0.025	0.008	0.010	0.040
Young Forest	-0.004	0.005	-0.015	0.006
Mature Forest	0.013	0.005	0.004	0.022
Great Horned Owl				
All Forest	-0.011	0.008	-0.027	0.005
Young Forest	-0.020	0.008	-0.035	-0.005
Mature Forest	0.008	0.006	-0.004	0.020

Figure 8: Logistic regression models predicting the probability of presence of the three main species of owls in New Brunswick (2001–2015) as a function of percent forest cover variables. Bars show the frequency distribution of presences (1), and the frequency distribution of absences (0). Stars represent the level of statistical significance.

DISCUSSION

Overall, the long-term trends for the three most common species in NB show mixed results because of substantial annual variation (often cyclical) in abundance, and also likely because of inherent differences in the ecology and habitat preferences of each species.

Barred Owl

Barred Owls are increasing annually along routes across the province (Figure 1). These results are consistent with the second Breeding Bird Atlas of the Maritimes which has shown that the probability of observing Barred Owl in NB has significantly increased over the 20 years separating the two atlas periods (Stewart et al. 2015), and particularly in the northern part of the province. The same pattern has been observed in both Nova Scotia and Prince Edward Island as well (Birds Canada, unpublished data). It should be noted that the atlas data partly reflect the Atlantic Nocturnal Owl Survey data because of the inclusion of the latter. Increases have also been observed throughout Ontario, with both the Ontario Nocturnal Owl Survey (Allair & Jones 2016) and the Ontario Breeding Bird Atlas (Cadman et al. 2007). This may be attributable to the gradual aging of forests in some parts of the owl range (Stewart et al. 2015).

The response of Barred Owls to forest habitat cover variables between 2010 and 2015 suggests that its probability of presence is the highest when there is a combination of mature (ca. 60%) and young (ca. 40%) forest in the landscape. Actually in NB, as large intact stands of mature forests have become very rare (because of past history of forest management), Barred Owls seem to accommodate a wider range of stand ages. The species is usually not limited to old-growth forests, but stands must contain mature trees (Stewart et al. 2015).

In NB, we found significantly different population trends between public and private lands. The population increase is more marked on private lands than on public lands, especially in the last decade (Figure 4). As the species depends more on mature forests for nesting (e.g. old trees with large open cavities), this may reflect the recent maturation of forests on private lands, thus providing suitable structures for nesting. Although private lands have significantly lower amounts of forest habitat around survey sites than public lands in NB, habitat may be less fragmented at a larger scale (e.g. larger patches of forests owned by forestry companies, and stands of uniform age), thus benefitting the species.

Northern Saw-whet Owl

Overall, Northern Saw-whet Owl numbers still appear relatively stable since the 15-year report (Campbell 2016). They show steady peaks in abundance every two years (Figure 2; Shawn Craik, Université Sainte-Anne, unpublished data). Such variations in abundance have been related to fluctuations in small mammal populations: when the abundance of preys is lower, Northern Saw-whet Owls tend to move and establish

territories in areas with higher prey availability (Bowman et al. 2010). This makes detecting trends particularly difficult for this species, in addition to its secretive and nocturnal behavior.

Though after 20 years of surveys, there does not appear to be any difference in trend between public and private lands, we found consistently higher abundances on public lands (Figure 5). This may reflect more intense forest management and intervention on crown lands, allowing for between-stand diversity and heterogeneity of habitat structures, and within-stand greater vertical complexity. Indeed in the Maritimes, the species seems to favor areas with a variety of forest types and ages (Stewart et al. 2015). The higher abundances on public lands may also be associated with the overall higher forest habitat availability, relative to private lands where there is a larger proportion of non-forested landcover (Figure 7). This is also supported by the fact that this species was the one with the strongest response to forest cover.

Great Horned Owl

Great Horned Owls have been showing a globally declining trend across NB for the past 20 years, despite a slight increase in numbers in recent years, and despite the fact that they are considered habitat generalists. On private lands, we can even observe a reverse trend from 2010 (Figure 6). Other surveys, including the Breeding Bird Atlas of the Maritimes, similarly indicate that Great Horned Owls may be declining in some parts of their range, while increasing in others (Stewart et al. 2015). For example, they seem to decline in western NB, while increasing in the eastern part. However the reasons for the declines are unknown.

The recent increase on private lands might reflect both the maturation of forests, and more open areas as a proportion of total land cover. This is supported by both our results and the literature. A preference for older forests has been documented in some regions (Artuso et al. 2020), including in the Maritimes (Studholme 2020). Also open areas are key habitat features for the species (Artuso et al. 2020, Studholme 2020): their home ranges typically includes field, pasture, cropland, or wetland – i.e. areas used for foraging.

CONCLUSION

The New Brunswick Nocturnal Owl Survey continues to be a valuable tool in assessing population trends of owls in the province. It has also met its objective of engaging the public in wildlife monitoring, with increasing numbers of New Brunswickers willing to participate in the survey year after year.

One of the original goals of the survey was to compare trends between public and private lands, especially for the Barred Owl, which is an Indicator of Sustainable Forest Management for the Old Tolerant Hardwood Habitat (OTHW). Our results suggest that prior forest management decisions may have influenced owl populations in NB. While some private owners who have left tracts of forest mature enough may have greatly

contributed to the population increase of Barred Owls, in NB public forests, forest management practices that limit the availability of older stands may not be adequate in the long term for preserving the integrity of OTHW and the species that depend on it.

One of the next steps to better understand long-term owl population trends is to relate them to changes in habitat and habitat cover over time. We are currently moving in this direction, and this requires habitat layers for different time periods to allow comparison. In order to better predict owl occupancy, we are also implementing models that take into account the imperfect detection of owls (i.e. the fact that, due to secretive owl behavior, surveyors cannot be 100% confident of always finding them when they are present). These models will be used to refine this 20-year analysis and extend it to all the Atlantic dataset, and then to the Nocturnal Owl Survey dataset across Canada.

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Appendix 1: Location of survey routes from 2001 to 2019 in New Brunswick, according to landbase (private versus public/crown lands).
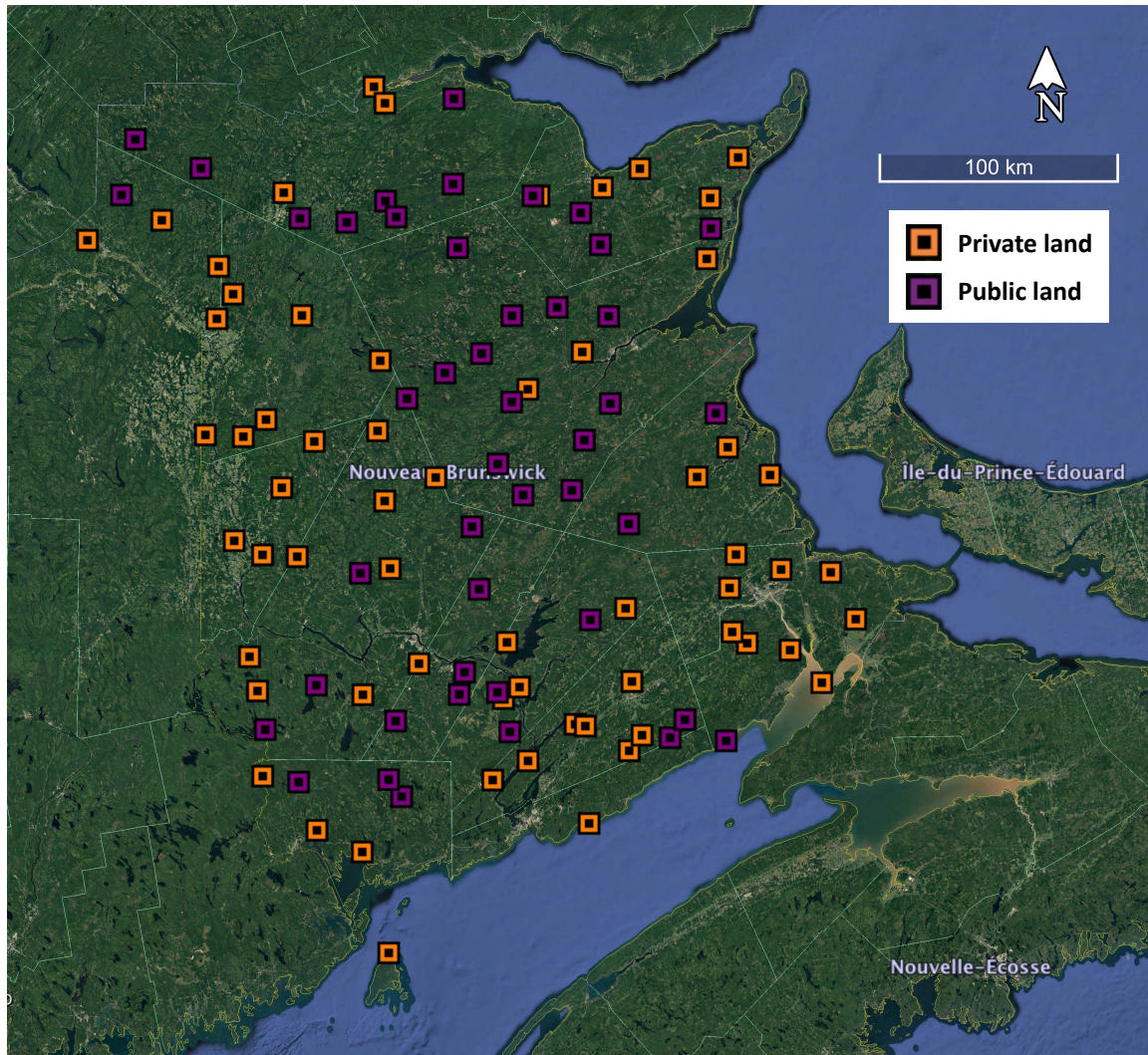
Appendix 2: Survey routes, coordinates, landbase and number of years with data from 2001 to 2019 (2020 was not included because the dataset is not complete).

Route	Latitude	Longitude	Landbase	Number of years of data
NB001	45.4489	67.4423	Private	16
NB002	45.424	67.2518	Public	14
NB003	45.7635	67.4708	Private	7
NB004	45.6212	67.4290	Public	15
NB005	46.2641	67.4476	Private	10
NB006	46.258	67.2627	Private	16
NB007	46.6981	67.5537	Private	5
NB008	46.5109	67.3463	Private	11
NB009	47.1319	67.7031	Private	15
NB010	47.1449	67.2421	Private	5
NB011	47.5034	67.2549	Public	12
NB012	47.5987	67.3437	Private	3
NB013	47.5863	68.2273	Public	9
NB014	47.4179	68.4167	Private	5
NB015	47.9918	66.8505	Private	9
NB016	47.4889	66.9996	Public	6
NB017	47.5072	66.7301	Public	14
NB018	46.9692	66.8216	Private	4
NB019	46.9312	66.4709	Public	2
NB020	46.7202	66.8340	Private	12
NB021	46.8391	66.6760	Public	10
NB022	46.2146	66.7692	Private	14
NB023	46.1972	66.9275	Public	19
NB024	45.4708	67.0937	Public	11
NB025	45.6558	66.7404	Public	18
NB026	45.7738	66.8995	Private	9
NB027	45.4378	66.7814	Public	13
NB028	45.1702	66.9206	Private	18
NB029	44.5896	66.8977	Private	9
NB030	45.4707	66.0888	Private	14
NB031	45.4338	66.2357	Private	15
NB032	45.7335	66.1744	Private	11
NB033	45.9399	66.1524	Private	19
NB034	46.3659	66.3328	Public	3
NB035	46.4805	66.0595	Public	14
NB036	46.8688	66.0269	Private	19
NB037	46.8227	66.1135	Public	11
NB038	47.0016	66.2731	Public	14
NB039	47.3925	66.3966	Public	17
NB040	47.5803	65.9508	Private	4

NB041	47.5818	65.9834	Public	19
NB042	47.9306	66.7908	Private	10
NB043	47.9458	66.4098	Public	17
NB044	47.6089	65.6025	Private	8
NB045	47.5169	65.8240	Public	9
NB046	47.0031	65.7296	Private	19
NB047	47.1323	65.5828	Public	11
NB048	46.6797	65.7264	Public	9
NB049	46.8119	65.5839	Public	9
NB050	46.4952	65.7981	Public	10
NB051	46.0583	65.5225	Private	7
NB052	45.6439	65.2207	Public	17
NB053	45.6278	65.7456	Private	19
NB054	45.635	65.7994	Private	19
NB055	45.6217	65.3279	Private	5
NB056	45.2683	65.7333	Private	18
NB057	45.5326	65.5165	Private	14
NB058	45.9193	64.8820	Private	10
NB059	45.9622	64.9592	Private	10
NB060	46.2464	64.9289	Private	7
NB061	46.1252	64.7802	Private	18
NB062	46.1871	64.6901	Private	15
NB063	46.5356	64.7342	Private	11
NB064	46.5351	65.1266	Private	13
NB065	47.3385	65.0422	Private	4
NB066	47.4498	65.0143	Public	2
NB067	47.5628	65.0136	Private	4
NB068	45.7649	64.49	Private	12
NB069	45.9773	64.2930	Private	19
NB070	46.1705	64.4243	Private	15
NB071	47.6877	67.8001	Public	14
NB072	47.7947	68.1643	Public	11
NB073	47.1402	66.1067	Public	18
NB074	45.3749	66.7130	Public	5
NB075	46.379	65.4767	Public	17
NB076	46.0188	65.7110	Public	8
NB077	47.3978	65.6200	Public	2
NB078	45.8651	66.6182	Private	10
NB079	46.3153	67.5991	Private	8
NB080	45.775	66.0900	Private	19
NB081	45.7889	65.4965	Private	11
NB082	45.8891	64.6543	Private	7
NB083	47.3255	67.6962	Private	15

NB084	46.6422	64.9576	Private	14
NB085	47.6772	65.3951	Private	18
NB086	47.7115	64.8527	Private	12
NB087	46.7036	67.7579	Private	4
NB088	45.7567	66.2063	Public	5
NB089	45.7473	66.4044	Public	8
NB090	45.6108	66.1431	Public	4
NB091	45.5615	65.0048	Public	9
NB092	46.7682	65.0159	Public	9
NB094	47.4945	68.0102	Private	14
NB096	47.2231	67.6156	Private	16
NB097	46.7616	67.4321	Private	4
NB098	46.4098	66.7633	Private	3
NB099	46.5477	66.5241	Private	7
NB101	47.5666	66.7884	Public	14
NB102	47.6282	66.4190	Public	14
NB103	46.585	66.19	Public	6
NB104	46.1364	66.2875	Public	11
NB105	45.5789	65.3004	Public	6
NB107	47.1691	65.8611	Public	3
NB108	46.688	67.0181	Private	3
NB109	45.8892	67.5141	Private	8
NB110	45.2501	67.1574	Private	18
NB112	45.832	66.3783	Public	7
NB113	45.5905	65.4486	Private	14

Appendix 3: Average number of owls per survey route from 2001 to 2019.

Year	BDOW	NSWO	GHOW	BOOW	LEOW	SEOW	ESOW	UNOW	Total
2001	1.93	0.75	0.74	0.14	0.03	-	0.01	0.15	**3.74**
2002	2.08	0.47	0.43	0.09	-	-	-	0.15	**3.22**
2003	1.79	1.06	0.54	0.26	0.02	-	0.03	0.13	**3.84**
2004	1.66	0.68	0.21	0.07	-	-	-	0.13	**2.75**
2005	2.10	0.96	0.46	-	-	-	-	0.15	**3.67**
2006	3.11	0.82	0.56	0.03	0.06	0.01	0.03	0.10	**4.71**
2007	2.31	1.51	0.36	0.01	-	0.01	0.04	0.09	**4.34**
2008	3.47	0.37	0.35	-	-	-	0.02	0.08	**4.28**
2009	2.78	0.59	0.54	-	-	-	-	0.03	**3.94**
2010	2.65	1.04	0.38	0.04	0.03	-	-	0.08	**4.23**
2011	2.17	0.51	0.25	0.06	-	-	-	0.13	**3.11**
2012	2.24	0.90	0.33	-	0.02	-	0.03	0.09	**3.60**
2013	2.80	0.65	0.14	-	0.06	-	-	0.02	**3.67**
2014	2.32	1.71	0.22	0.12	0.02	-	-	-	**4.39**
2015	2.73	0.60	0.35	0.08	0.02	-	-	0.08	**3.88**
2016	2.76	0.87	0.30	0.04	-	0.04	-	-	**4.02**
2017	3.86	0.70	0.43	0.07	0.07	0.05	0.02	-	**5.20**
2018	2.67	1.00	0.19	0.29	0.05	-	-	0.02	**4.21**
2019	2.98	0.65	0.39	0.16	0.06	-	-	0.06	**4.31**
Mean	**2.55**	**0.83**	**0.38**	**0.10**	**0.04**	**0.03**	**0.03**	**0.09**	**3.95**

BDOW: Barred Owl;
NSWO: Northern Saw-whet Owl;
GHOW: Great Horned Owl;
BOOW: Boreal Owl;
LEOW: Long-eared Owl;
SEOW: Short-eared Owl;
ESOW: Eastern Screech-Owl;
UNOW: unidentified owl species.