DISTRIBUTION OF WILD TURKEY IN NEW BRUNSWICK

NBWC Contract W009-102

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Executive Summary

There is great interest in the eastern wild turkey (*Meleagris gallopavo silvestris*), with its recent arrival into many areas of New Brunswick. The nature of the relationship between wild turkey populations and environmental conditions remains poorly studied at the northern edge of their distribution, where climatic factors are most severe. As such, it was unknown how viable a population of wild turkeys would be in the province. This project has three goals: to establish the current distribution of wild turkey in New Brunswick, based on citizen science reports of observations; to document the naturalized establishment using brood surveys as an indicator of reproduction; and to predict where eastern wild turkeys may persist on the New Brunswick landscape based on availability of suitable habitat and favorable environmental conditions.

To establish the current distribution of wild turkey in New Brunswick, two sources of information were used to obtain historical observational data on wild turkeys - *eBird*, and *iNaturalist*. A review of historical observations in these two datasets disclosed that their first observation of wild turkeys occurred on Deer Island, Charlotte County in August 1998, where three birds were recorded. In the 21-year period since (1998 – 2019), 97 reports totaling 477 wild turkeys were reported into the eBird database from nine counties in NB. Most of the observations and reports were from Charlotte County, representing 76.9%, or 367 of birds sighted. Reports of wild turkey sightings obtained from *iNaturalist* database disclosed only seven different reports from five counties. The earliest record of wild turkeys in the iNaturalist database was in 2016, and during the period, 2016 - 2019 a total of 36 wild turkeys were recorded.

Current information of wild turkey distribution was obtained through citizen science reports obtained through the social media platform Facebook. We also implemented an on-line submission form through JotForm. This platform was used for both initial reporting of wild turkey observations and then later it was used for reporting observations of turkey broods during surveys designed to document the potential of breeding evidence.

Through the two social media sites, *NB Wild Turkey Research Facebook page*, and JotForm, 476 contributions were received, totaling 3,100 wild turkeys reported in the period January 1 – May 7 (Facebook), and January 1 - June 4 (JotForm), 2019 (Figure 5, and Appendix 3). This result does not indicate that the population of wild turkeys is 3100 in New Brunswick because an unknown animals were likely re-sighted. This project did not address population size.

Reported flock size ranged in size from 2 to 70 birds. Most of the observations (82.7%) were of groups of birds in flocks < 10 birds. The overall average number of birds reported in a flock was 6.5 birds, and the largest reported flock of wild turkeys totaled 70 birds, which was in Charlotte County during the winter of 2019.

A total of 19 volunteers contributed to the brood survey data. In all, 47 routes were completed of various lengths and time commitment. There were 38 occurrences where poults were observed with hens on 26 of the 47 routes. In total, 425 birds were observed and identified as poults (ranging in groups from 1 to 42) and overall, the average number of poults per hen encountered was 4.99/route. Based on these results, reproduction seems evident, which is an indicator of naturalized establishment, particularly in Charlotte County. In May 2019, 13 fresh eggs were found in a burned forest area near Waweig (Wilson 2019).

Part of this project focused on quantifying the area of suitable habitat for wild turkeys to occupy in New Brunswick. We used a GIS-based model described by Donovan (1987), as a habitat suitability index, and using open-sourced data from NBDNRED, to determine habitat composition for wild turkeys. The model incorporates seven variables, grouped into three components: *habitat composition*, the *spatial arrangement of habitats*, and *human occupation* to quantify habitat quality.

Results of the study disclosed that New Brunswick contains 1.66 million hectares of 'good' habitat, 1.54 million hectares of 'moderate' habitat, and 3.2 million hectares of 'marginal to poor' habitat. Definitions of habitat quality are noted in the report. The amount of available suitable habitat is however not the only consideration for wild turkeys to persist in a landscape.

Survival of wild turkeys through harsh winter conditions and predation are also important, particularly at the northern edge of their range.

Harsh winters for turkeys include snow accumulation on the ground >30cm for more than 10 days and temperatures colder than -16.2°C. In this study, we examined average snow depth for the most recent 5-year period (2015-2019) for 5 months (December through April) for each square kilometre in New Brunswick, and applied the equation derived from Lavoie et al., (2017) threshold effect of snow depth, to estimate winter survival of wild turkeys. From this, we obtained the predicted survivability of wild turkeys for each square kilometre in New Brunswick.

Based on average snow depth over the previous 5-year period, 2015-2019, wild turkeys are more likely to persist in Queens, Albert, Saint John, Westmorland, Charlotte, and Kings Counties, and less likely to persist in Northumberland, Restigouche, Gloucester, Victoria, York, and Madawaska Counties (Figure 9). We lack predictions on future snow depths and do not attempt to project future conditions.

The origins of the recorded wild turkeys remain unknown. They may be naturally expanding from the State of Maine's reintroduced program (Wilson 2019); and/or they may originate from unsanctioned releases by people in New Brunswick wishing to see a turkey population here; or they may be birds that have escaped from captive raised populations.

Recommendations that flow from this project include:

1) Wild turkey brood surveys should be more standardized with respect to length and location of route, time of day, time spent observing, number of times a route is travelled when completed by a volunteer.
2) More work needs to be done on the actual properties of snow, depth of snow, and survivability of wild turkeys at the northern limit of their range to completely understand this aspect of limiting factors on range.

3) A comprehensive study to assess anticipated climate change effects on New Brunswick snow levels would be of value to predicting future location and production of wild turkey in New Brunswick.

4) This study did not generate data to estimate population size and viability, as it was not the purpose of this study. To determine population size, pertinent information would require mark-recapture studies, demographic work on age class, as well as predation and survival rates of wild turkeys.

Introduction

There is great interest in the eastern wild turkey (*Meleagris gallopavo silvestris*), with its recent arrival into many areas of New Brunswick. The nature of the relationship between wild turkey populations and environmental conditions remains poorly documented at the northern edge of their distribution, where climatic factors are most severe.

The project goals are threefold: 1) to establish the current distribution of wild turkey in New Brunswick, based on citizen science observations and reporting; 2) to document naturalized establishment using brood surveys as a potential indicator of reproduction and: 3) to predict areas where eastern wild turkeys may persist where suitable habitat and favourable environmental conditions exist.

The eastern wild turkey is not considered to be a native bird species of New Brunswick (Godfrey 1966) but is now established (Wilson 2019). When European settlers arrived on the eastern seaboard, wild turkeys apparently occupied what are now 39 continental states and southern Ontario (Earl 2015). As European settlement in North America increased, the wild turkey populations quickly began to decline (Earl 2015). Wild turkeys were an important food source for pioneers and were hunted unsustainably year-round, without the protection of any game laws until at least the mid-20th century.

Even by 1626, the wild turkey's habitat was fast dwindling and changing, and under the pressure from market hunters to feed the growing number of colonists (4 million by 1790), the wild turkey was extirpated from much of its original range (Earl 2015). Connecticut had lost its wild turkeys by 1813. Turkeys were extirpated in Vermont by 1842, and other states soon followed. By 1920, the wild turkey was extirpated from 18 of the original 39 states, as well as Ontario (Godfrey 1966; Earl 2015).

Project Purpose

A series of re-introductions to northern Maine of birds taken from southern Maine eventually established a population along the Canadian border by 2008-2009 and some of these birds likely entered New Brunswick (Wilson 2019). An unknown number of birds are associated with illegal release and /or escapes. Regardless of origin, it is now clear that wild turkeys are present in New Brunswick. There is an abundance of interest from members of the New Brunswick Chapters of the Canadian Wild Turkey Federation in establishing a sustainable harvest; however, information on wild turkey distribution, abundance, and ability to persist is lacking in New Brunswick.

This project will: review historical observations and document the current (2019) distribution of wild turkey in New Brunswick, based on citizen science; document where reproduction is observed through targeted brood surveys, as a potential indicator of naturalized establishment; identify the amount and location of the best available habitat and: based on recent studies and available literature, produce a predictive survival map for wild turkeys in New Brunswick.

Study Area

The study area includes all New Brunswick for data collection and mapping, with special emphasis on Charlotte, Victoria, Carleton, York, Sunbury, Queens, Kings and St. John Counties (Figure 1) as they border the State of Maine, or have purported populations of wild turkey.
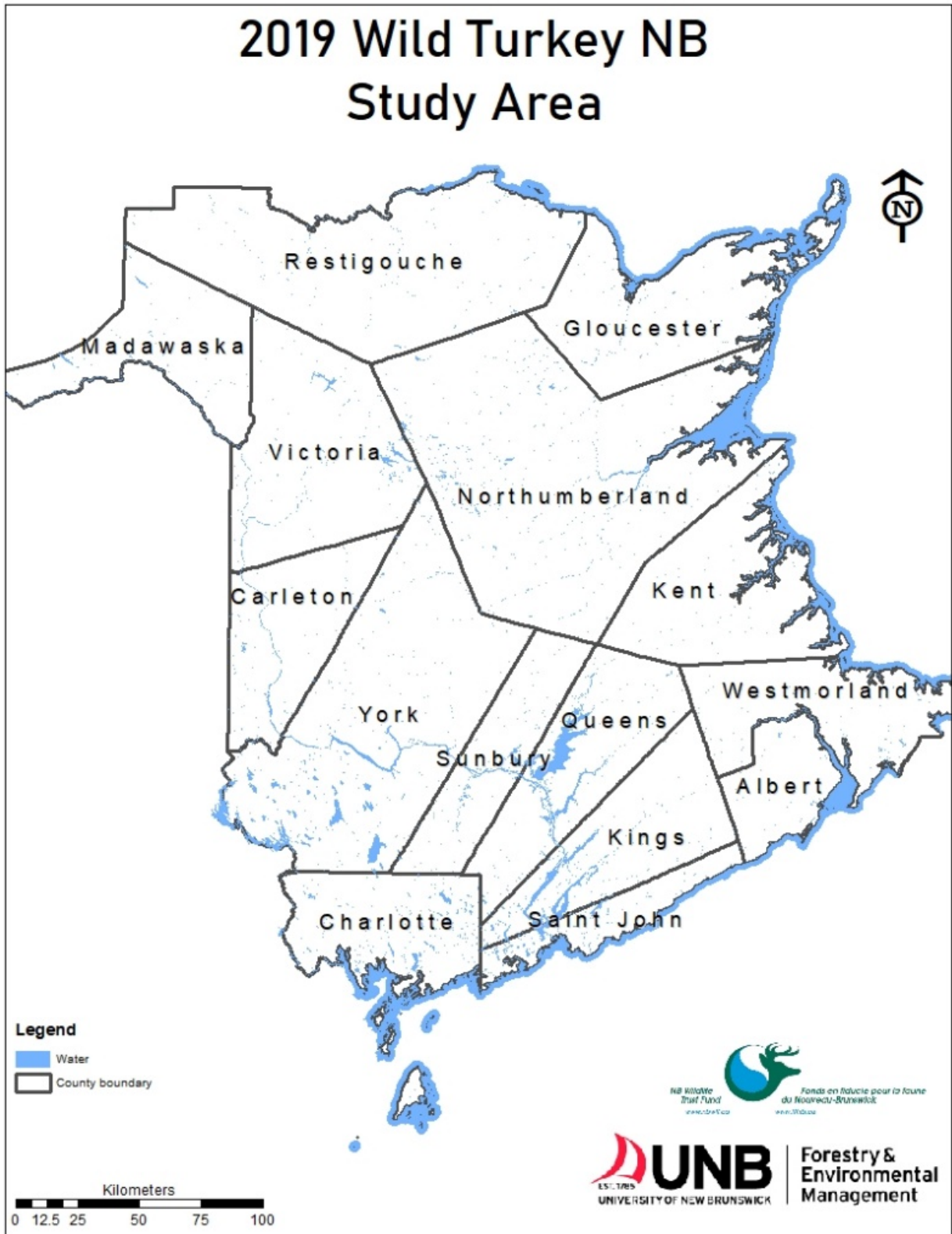
Figure 1. Map of New Brunswick depicting the study area, by County.

Methods

Historical Presence of Wild Turkey in New Brunswick

Two sources of information were used to obtain historical observational data on wild turkeys: *eBird*, and *iNaturalist*. *eBird* is a database of bird observations providing scientists, researchers, and amateur naturalists with real-time data about species distribution and abundance (eBird 2019). *iNaturalist* is a citizen science project and online social network of biologists, naturalists, and citizen scientists, used to share and map observations of biodiversity across the world (iNaturalist 2019).

A careful review of the datasets disclosed several duplicate or, based on the contributor's remarks, obviously incorrectly placed records. For example: one report in eBird listed for Kent County of eight turkeys observed July 1, 1989, had to be removed from the final data set as in the comment section noted the birds were observed on Route 95, in Maine, USA. Another example of data that were removed from the final data set was of two earlier reports in 2013 and 2014 indicating in the remarks section that the birds were from a known population of released birds that persisted and reproduced. Therefore, both sources of data required some quality control prior to analysis. All duplicates and improperly mapped records were removed from the final dataset.

Current Reports of Wild Turkey in New Brunswick

Current reports were obtained through citizen science contributions by establishing a Facebook page: *NB Wild Turkey Research*, that permitted followers to contribute their observations directly and submit a photo of the observation. Facebook Messenger was also used to correspond with individual contributors of the data, particularly to obtain exact date and location of the observation, if not previously submitted.

In addition, we used an online database submission solution (JotForm), which formalized submissions on which volunteers filled out all the requisite information to record the observation. JotForm also provided a platform for photo submission. JotForm was advertised on the Facebook page as the preferred method of submission for citizen science contribution to the project, but any form was acceptable.

Brood Surveys: Evidence of Survival and Reproduction in New Brunswick

Our brood survey protocol was modified from the Standardized Wild Turkey Brood Survey Protocol similar to what is done in Maine, as follows:

The brood survey remained completely volunteer-based where interested citizens and NB Wild Turkey Federation Chapter volunteers conducted and submitted observations. Those interested in conducting the survey were asked to participate in a brief training conference call, so that information collected would be consistent. The *Standardized Survey* recommends brood surveys be conducted between June 1 and August 31. For this modified targeted survey, acceptable dates for the survey were August 1 – 31, 2019; the same survey window as the State of Maine Department of Inland Fisheries and Wildlife Research and Assessment Section (K.M. Kelsey, personal communication, April 29, 2019). This would be the only modification done to the brood survey, otherwise it remained the same as the *Standardized Survey*. Participants were asked to record their mileage should they choose to be reimbursed. Each observation included the following information: date, location, total number of turkeys observed, total adults observed (male and female separately), total number of juveniles (jakes), total number of hens with poults, and total number of poults with each hen (may be difficult if multiple hens are together with poults). In addition, participants indicated whether they believed to have seen (reported) these bird(s) before. Records were submitted either through JotForm, or by fillable pdf and sent by email (Appendix 2).

Mapping Habitat and Predictions: Where Will Wild Turkeys Likely Persist in NB?

A species' range limit is dictated by biotic and abiotic environmental conditions: climate, resources, predators, and disease which influence where a species can persist (Caughley et al. 1988, Lesica and Allendorf 1995, Hardie and Hutchings 2010).

Recently, wild turkeys have experienced a range expansion north into New Brunswick. However, turkeys at their northern periphery experience increased challenges compared to individuals in the species' core range. These increased challenges include the ability to persist through severe winters, and locating available food and suitable habitat, while avoiding predation (Niedzielski and Bowman 2015).

This part of the study focused on quantifying the area of suitable habitat for wild turkeys to occupy in New Brunswick. We used a GIS-based model described by Donovan (1987), as a habitat suitability index, and using open-sourced data from NBDNRED, to determine habitat composition for wild turkeys in New Brunswick. The model incorporates seven variables, grouped into three components: *habitat composition*, the *spatial arrangement of habitats*, and *human occupation* to quantify habitat quality.

Optimal habitat for nesting and brood rearing was defined as ≥40% hardwood forest, ≥5% wetland, ≥20% shrubland or herbaceous rangeland, and ≥10% agricultural land, based on Donovan (1985), and in agreement with other studies (e.g., Porter 1980). Hardwood forests that included mast species of trees, such as red oak (*Quercus rubra*) and American beech (*Fagus grandifolia*) were given a higher rating, while conifer stands of spruce (*Picea* spp). and balsam fir (*Abies balsamea*) >80% were considered poor habitat.

The interspersion of the four habitat types (hardwood forest, wetland, shrubland, and agricultural land) in the quantities listed above comprised the *spatial arrangement of habitat*. This layer was calculated as the distance in which all four habitat types could be found in each km^2 area. The closer all four habitats are, the shorter the distance wild turkeys must travel to meet their needs, and the better the habitat quality rating.

For *human occupation*, two variables were used as a measure of the negative effect human presence has on turkey habitat quality. One variable was the percentage of area in settlement for human use. The greater the percentage of area designated for settlement in human use, the less suitable the area for wild turkeys. The other variable was the distance measurement to human development within an area. We followed criteria in Donovan et al. (1987) which notes increased human development is less suitable for wild turkeys. Human development closer than 600 m was considered a negative influence on wild turkey habitat. We recognize the bird feeders associated with housing could benefit wild turkey but we lack data needed for including this measure in any analyses.

Once suitable habitat was quantified, we explored which environmental conditions might limit turkey establishment and survivability at the northern limits of their range. Weather conditions are an important factor in natural range expansion of species by limiting populations at the edge of their range (Sunday et al. 2012). Previous studies (Porter 1997; Kane et al 2007; Lavoie 2017) showed that winter survival of wild turkeys decreased significantly when ground snow accumulation was >30cm for more than 10 days and survival decreased further when temperatures were colder than -16.2° C.

Data from Snow Data Assimilation System (SNODAS) was used to determine snow depth for this study. SNOw Data Assimilation System (SNODAS) is a database which contains snowpack properties, such as depth and snow water equivalent (SWE), from the NOAA National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) SNOw Data Assimilation System (SNODAS). SNODAS is a modeling and data assimilation system developed by NOHRSC to provide the best possible estimates of snow cover and associated parameters to support hydrologic modeling and analysis (National Operational Hydrologic Remote Sensing Center 2004).

Estimates of on-the-ground average snow depth were obtained for each km^2 in New Brunswick for the end of each month for December - April in the 5-year period (2015-2019). We then calculated an average snow depth for the 5-year period for each km^2.

A map was produced that visualizes the area of predicted survivability using the turkey survival equation based on snow depth from Lavoie et al., (2017) from southern Quebec (Figure 2) and applying that equation using GIS to the 5-year average snow depth for each km^2 in New Brunswick. The map is based upon the percentage of predicted survivability in five categories: 1-20%, 21-40%, 41-60%, 61-80%, and >80% survival.
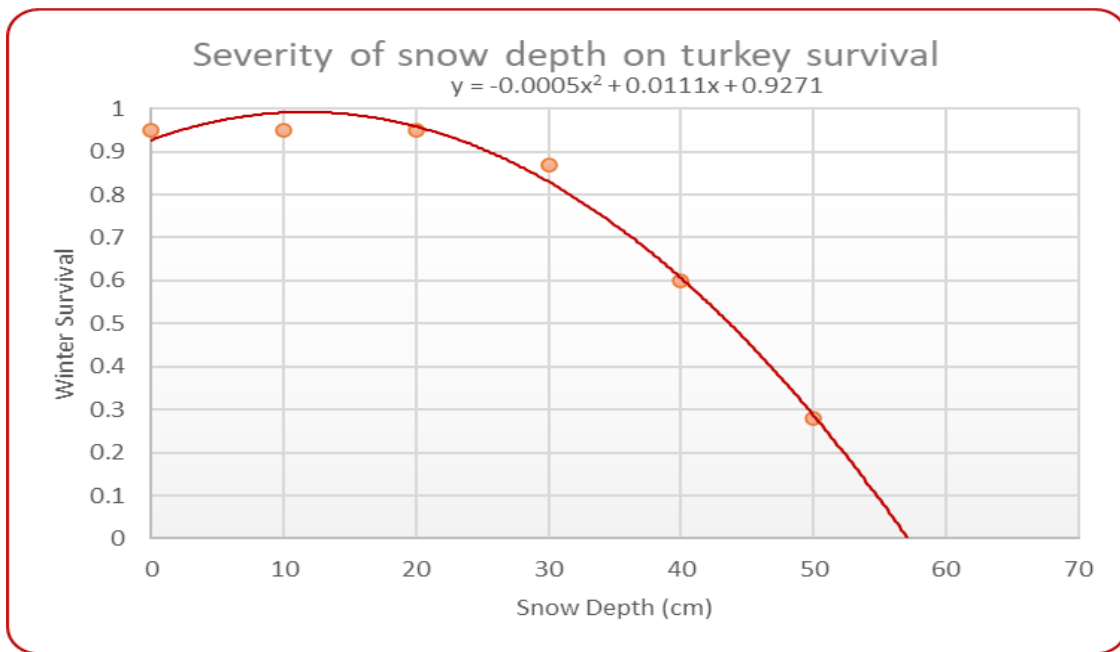
Figure 2. Threshold effect of snow depth used to estimate winter survival of female wild turkeys, southern Quebec. Source: Lavoie et al., 2017.

Results
Historical Reports of Wild Turkey in New Brunswick

The first documented report in our citizen science database of a wild turkey in New Brunswick was of three birds on Deer Island, Charlotte County, August 4, 1998 (eBird 2019). In the 21-year period since then (1998 – 2019), 97 reports with the total number of wild turkeys reported into the eBird database was 477 (Table 1) from nine counties in NB. Most of the

observations and reports were from Charlotte County, representing 76.9% or 367 of birds sighted. The next highest number of observations were in York County (8.0% or 38 birds), and Carleton County (6.1% or 29 birds reported). Reports of wild turkey sightings in the remaining six counties made up only 9% of the observation in the e-bird database. There has been a steady increase in observations of wild turkeys and reports since 1998, with the highest count of 218 birds reported in 2018 (Figure 3).

Table 1. Summary of reported observations of wild turkeys in New Brunswick, by year (1998-2019). Source: eBird Basic Dataset, 2019.

County/Year	Number of Reports	Number of Wild Turkeys reported
Carleton	10	29
2011	1	2
2018	6	18
2019	3	9
Charlotte	58	367
1998	1	3
2012	1	7
2014	2	16
2015	3	14
2016	8	28
2017	11	60
2018	19	170
2019	13	69
Kings	3	5
2019	3	5
Madawaska	3	12
2012	1	7
2013	1	1
2018	1	4
Northumberland	4	11
2015	1	1
2017	1	1
2018	1	8
2019	1	1
Sunbury	2	6
2017	1	5
2019	1	1
Victoria	2	2

2017	1	1
2018	1	1
Westmorland	2	7
2015	2	7
York	13	38
2006	1	1
2017	2	5
2018	7	17
2019	3	15
Total	**97**	**477**

A similar review of observations was obtained from the *iNaturalist* database, which disclosed only seven different reports from five counties. The earliest record in iNaturalist for wild turkey was in 2016, and during the period, 2016 - 2019 a total of 36 wild turkeys were recorded in this database.

The largest number of turkeys at one location was reported in Albert county where 17 birds (47.2%) were seen in 2016. Carleton, Charlotte, Sunbury, and York Counties comrpise the remainder of the locations from which reports of wild turkeys were documented (Table 2, Figure 4).
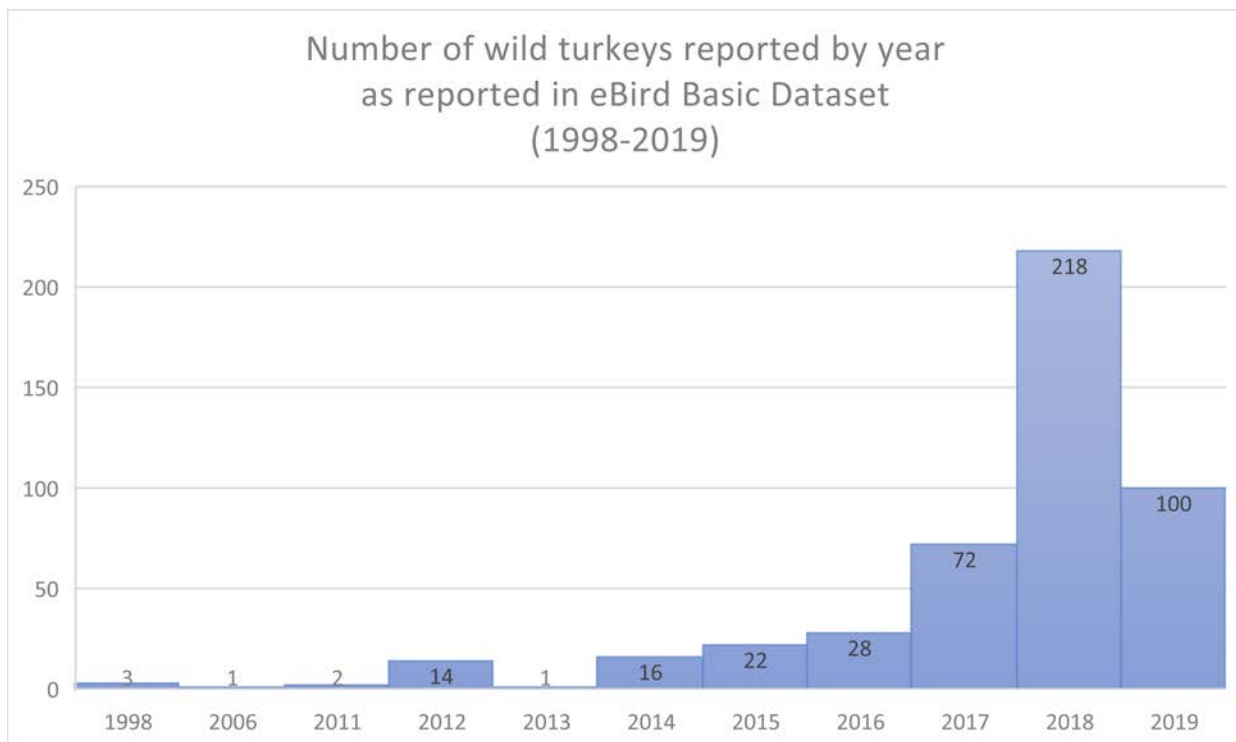
Figure 3. Graph depicting summary of reported wild turkey reports in New Brunswick by year (1998-2019). Source: eBird Basic Dataset, 2019.

Table 2. Summary of reported observation of
wild turkeys in New Brunswick, listed by County and
year (2016-2019). Source iNaturalist, 2019.

County Year	Number of Reports	Number of wild turkeys reported
⊟ Carleton	1	4
⊞ 2019	1	4
⊟ Charlotte	1	1
⊞ 2018	1	1
⊟ Sunbury	2	10
⊞ 2018	1	8
⊞ 2019	1	2
⊟ York	2	4
⊞ 2018	1	3
⊞ 2019	1	1
⊟ Albert	1	17
⊞ 2016	1	17
Total	7	36
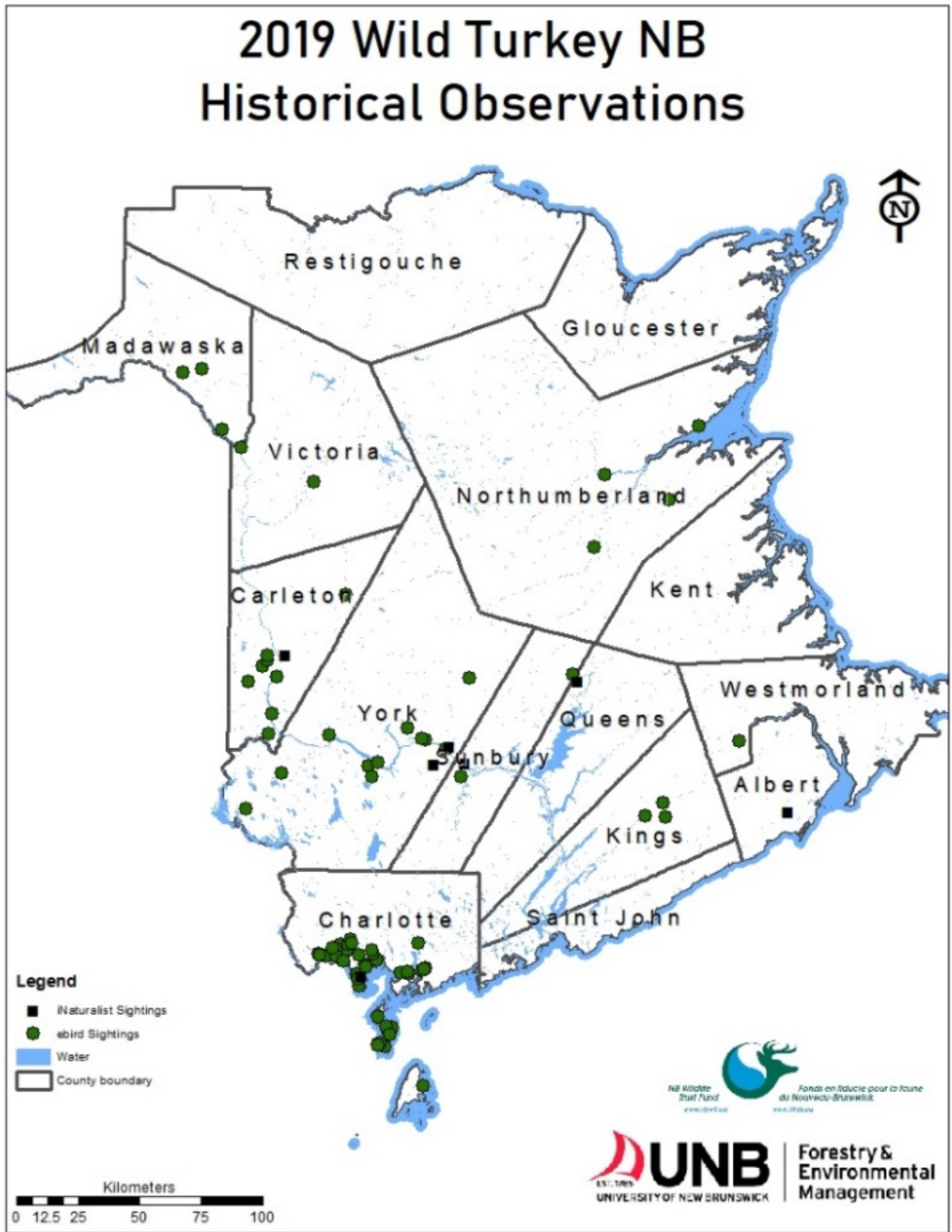
Figure 4. Historical reports (iNaturalist and eBird) of wild turkeys in New Brunswick.

Recent Reports of Wild Turkey in New Brunswick

Through the two social media sites, *NB Wild Turkey Research Facebook page*, and JotForm, 476 contributions were received, totaling 3,100 wild turkeys reported in the period January 1 – May 7 (Facebook), and January 1 - June 4 (JotForm), 2019 (Figure 5, Appendix 3). This result does not mean that the population of wild turkeys is 3100 in New Brunswick because an unknown number of records represent birds seen more than once. We removed records that were made on the same day in the same place but records over several days apart may be the same birds. Most observations appeared to be unrelated to each other; however, there were occasions when a contributor did submit the same observation on both Facebook and JotForm. In addition, there were occasions when more than one contributor submitted an observation of the same bird(s). This event happened when the bird(s) were in a highly visible location, such as busy commuter route for people in the City of Fredericton. In at least one instance, seven birds were documented travelling through northside Fredericton over a five-day period and reported by 12 different observers (see Figure 6). This project did not address population size.

Reported flock size ranged in size from 2 to 70 birds. Most of the observations (82.7%) were of groups of birds in flocks < 10 birds. The overall average number of birds reported in a flock was 6.5 birds, and the largest reported flock of wild turkeys totaled 70 birds, which was in Charlotte County during the winter of 2019.
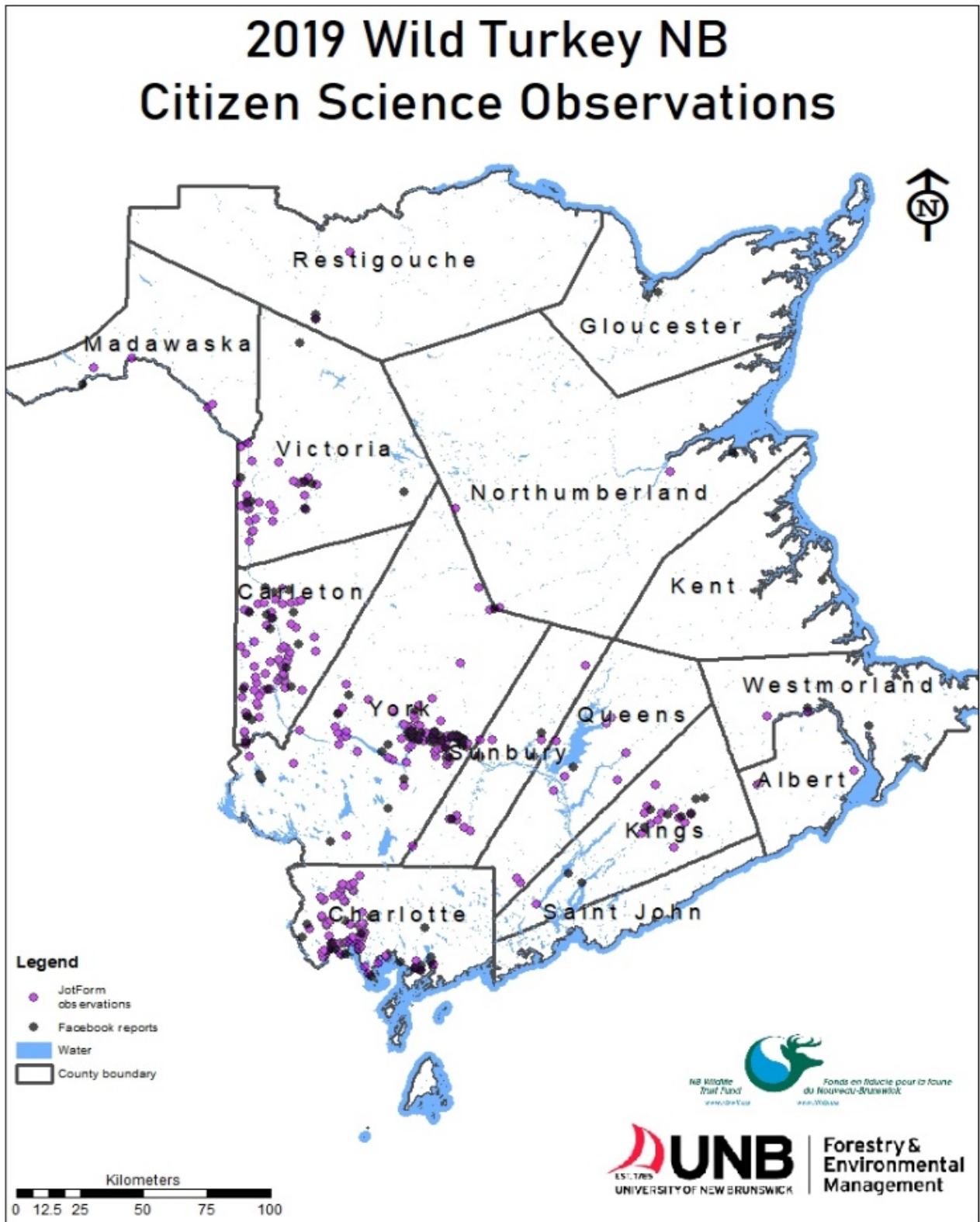
Figure 5. Locations of wild turkeys reported by citizen science in New Brunswick in 2019.

Figure 6. Recorded movement of seven wild turkeys through northside Fredericton, April 13-17, 2019.

Brood Surveys: Evidence of Survival and Reproduction in New Brunswick

A total of 19 volunteers contributed to the brood survey data. In all, 47 routes were completed, but of various length and time commitment. Information on exact route taken, total time spent observing, and total length of route was not consistently submitted, which is a significant weakness in the data because search effort can not determined.

The intent of the brood surveys was to determine whether there was successful breeding of wild turkeys in the province. The rationale is that evidence of brood production is a more useful indicator of survival than simply recording adult birds. An adult bird may simply represent birds released that year, and which may succumb to harsh winter conditions. It is noted though that young birds may also be released and a brood, particularly if comprised of older birds may not indicate local breeding. A brood with a hen would be the best indication of local breeding. Of note, 13 fresh eggs were retrieved from a burned forest area in May 2019, near Waweig, Charlotte County (Wilson 2019).

There were 38 occurrences where poults were observed with hens on 26 of the 47 routes. In total, 425 birds were observed and identified as poults (ranging in groups from 1 to 42) and overall, the average number of poults per hen encountered was 4.99 (Table 3).

No. of Volunteers	County	Total Routes	Routes with Poults	Total No. of Hens	Total No. of Poults	Total No. of Males	No. of birds Unidentified	Avg. poults /hen
5	Carleton	5	4	15	82	7	61	5.47
6	Charlotte	31	17	117	291	139	70	4.62
2	Kings	3	2	3	13	1	8	4.33
2	Sunbury	2	0	0	0	0	0	0
4	Victoria	4	3	7	39	1	21	5.57
2	York	2	0	0	0	0	0	0
Totals		47	26	142	425	148	160	4.99

Table 3. Summary of wild turkey numbers recorded from 47 brood survey routes, in New Brunswick, August 2019.

Habitat Mapping and Survival Predictions: Where Will Wild Turkeys Likely Persist in New Brunswick?

The categorization of suitable habitat area (as defined in *habitat composition* of Methods Section) indicated that New Brunswick contains 1.66 million hectares of good habitat, 1.54 million hectares of moderate habitat, and 3.2 million hectares of marginal to poor habitat (Table 4). The county with the most abundant moderate to good habitat is Restigouche County

with 447,000 ha, followed closely by York County, and then Northumberland County (Table 4). In addition, Northumberland, Restigouche, and York counties also have the largest areas of marginal to poor habitat for wild turkeys, but this result is biased because these are the largest counties in New Brunswick. We modeled human habitation as a negative factor but if bird feeders are vital and we made this factor positive, it would mean there is more habitat than predicted. But, even without this change, our results suggest that there is abundant suitable habitat in the province, and if wild turkey's survival were solely based on these criteria of habitat, wild turkeys could exist throughout most of New Brunswick (Figure 7).

Table 4. Summary of area of suitable habitat for wild turkey in 15 counties in New Brunswick.

COUNTY	Wild Turkey Habitat Quality (HA)				
	Poor	Marginal	Moderate	Good	Total
NORTHUMBERLAND	605,106	175,324	235,543	206,622	1,222,595
RESTIGOUCHE	291,663	116,971	170,448	276,577	855,659
YORK	248,231	97,048	194,607	248,003	787,889
GLOUCESTER	202,658	60,910	116,853	95,208	475,629
KENT	185,985	70,066	126,557	72,900	455,508
WESTMORLAND	144,032	46,230	108,153	71,082	369,497
KINGS	112,825	37,085	97,153	122,414	369,477
CHARLOTTE	121,914	44,157	87,718	99,593	353,382
QUEENS	120,157	45,108	75,278	77,685	318,228
CARLETON	74,858	29,615	99,881	86,328	290,682
SUNBURY	96,282	29,801	55,054	63,219	244,356
MADAWASKA	57,749	18,259	46,668	82,748	205,424
ALBERT	46,558	20,234	45,551	69,484	181,827
VICTORIA	46,295	18,344	55,967	54,496	175,102
SAINT JOHN	57,565	21,670	31,913	43,194	154,342
Total	**2,411,878**	**830,822**	**1,547,344**	**1,669,553**	**6,459,597**
Percent of total	37.3	12.9	24.0	25.8	100
Habitat area excludes water resources and area where forest data were unavailable.					

However, the amount of available suitable habitat is not the only consideration for wild turkeys to persist in a landscape. Survival of wild turkeys through harsh winter conditions and predation are also important.

Wright (1996) describes extensive mortality during severe winters being a concern in northern parts of the wild turkey known range. Wild turkeys curtail their movements when snow depths are 15-20 cm (Austin and Degraff 1975), and severely restrict movement at snow depths that reach 25-30 cm (Porter 1978, Healy 1992). In Wright's (1996) study in southwestern Wisconsin, 43.5% of winter mortality in turkeys occurred when there were 35 consecutive days with snow depths >25 cm, and minimum temperatures during the period averaging -16.2° C. Emaciation was the most diagnosed cause of death among wild turkeys in MacDonald (2016) study in Ontario. Furthermore, wild turkeys living at the northern extent of their range, and beyond the historical range in Ontario, had reduced survival and increased predation (Niedzielski and Bowman 2015).

A study conducted in southern Quebec (Lavoie et al., 2017) determined that snow depth was the main factor influencing winter survival of turkeys. Based on the average snow depth for the 5-year period (2015-2019) for the 5 months (December through April) for each square kilometre in New Brunswick, and applying the equation derived from Lavoie's threshold effect of snow depth to estimate winter survival of wild turkeys (Figure 2), we obtained the predicted survivability of wild turkeys for each square kilometre in New Brunswick. Through the use of GIS the results were categorized into five categories of predicted survivability: 1-20%, 21-40%, 41-60%, 61-80%, and >80%. Based upon these results wild turkeys are more likely to persist in Queens, Albert, Saint John, Westmorland, Charlotte, and Kings counties, and less likely to persist in Northumberland, Restigouche, Gloucester, Victoria, York, and Madawaska counties (Figure 8- 9).
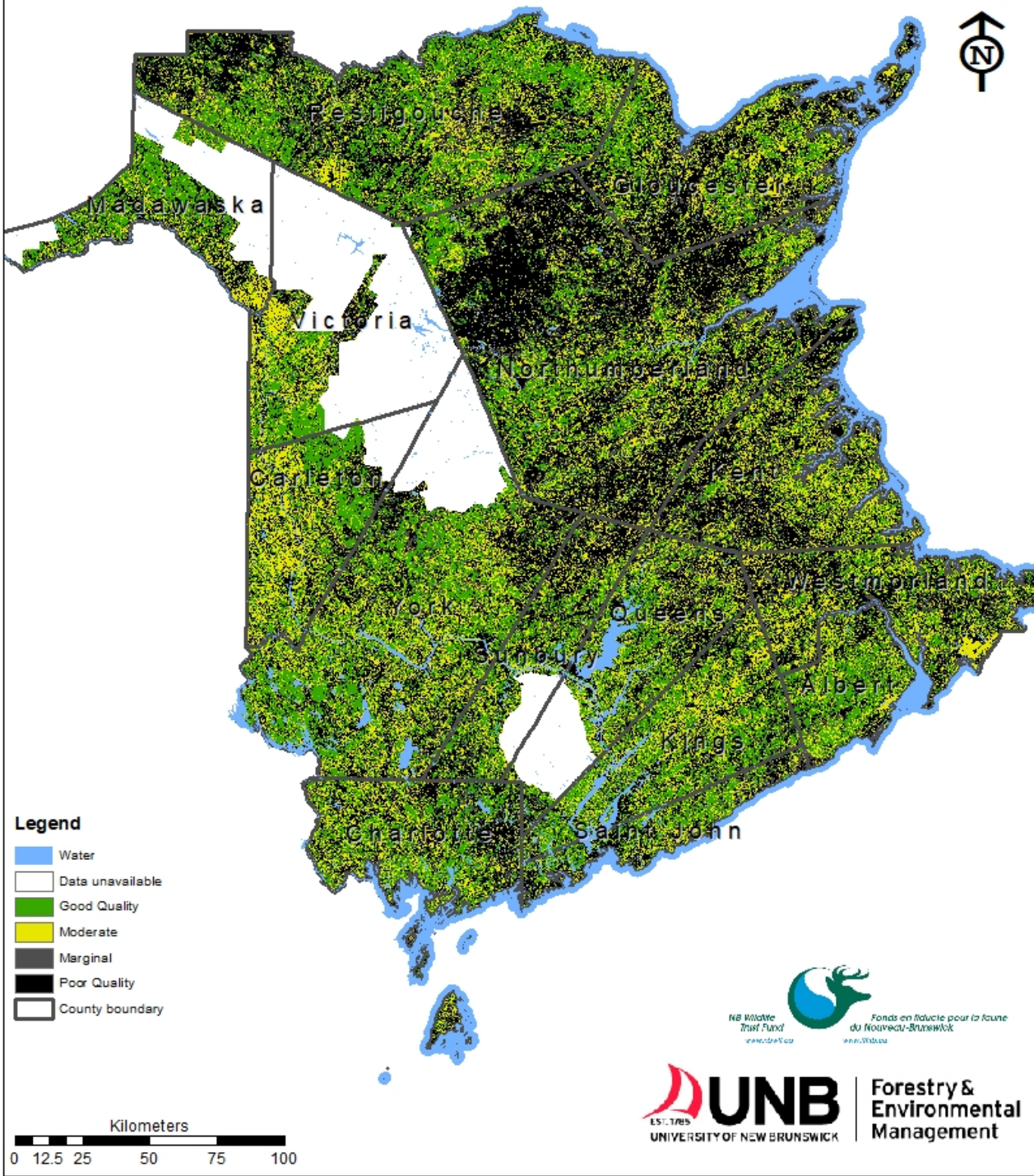
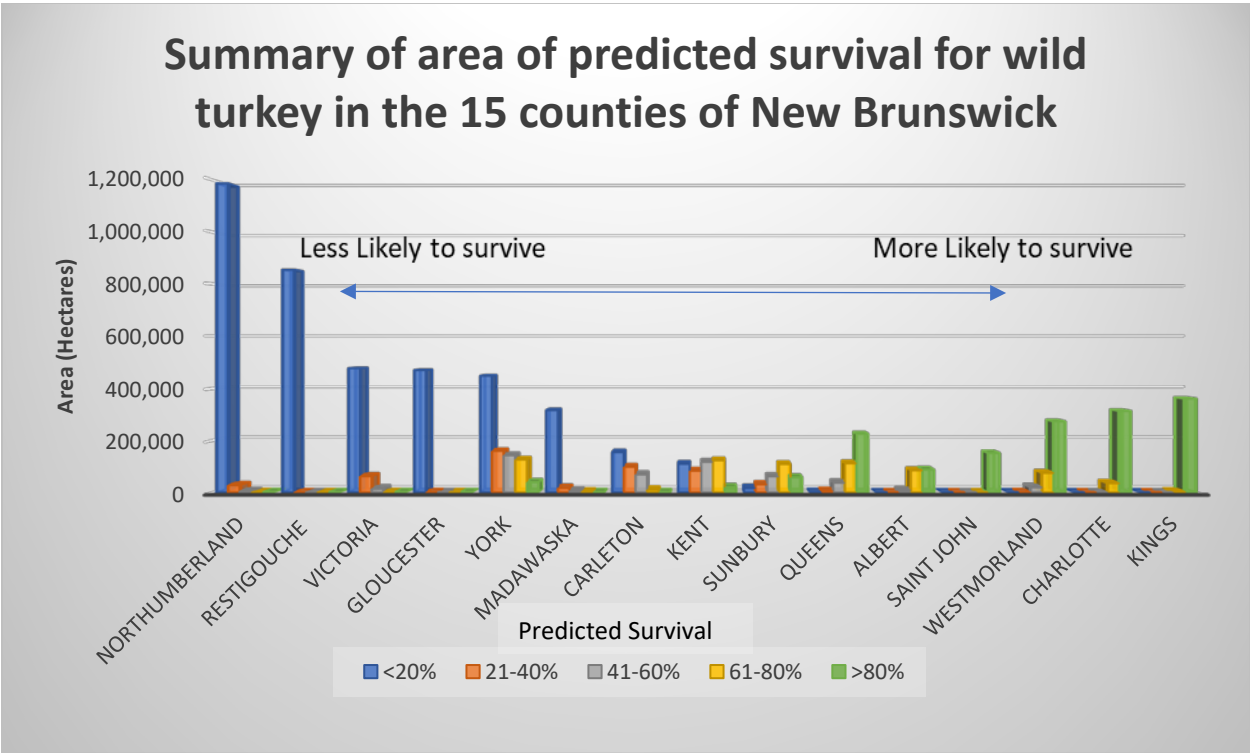Figure 7. Map of New Brunswick depicting suitability of habitat for wild turkey.

Figure 8. Summary of area in hectares of predicted survival for wild turkey in 15 counties in New Brunswick.
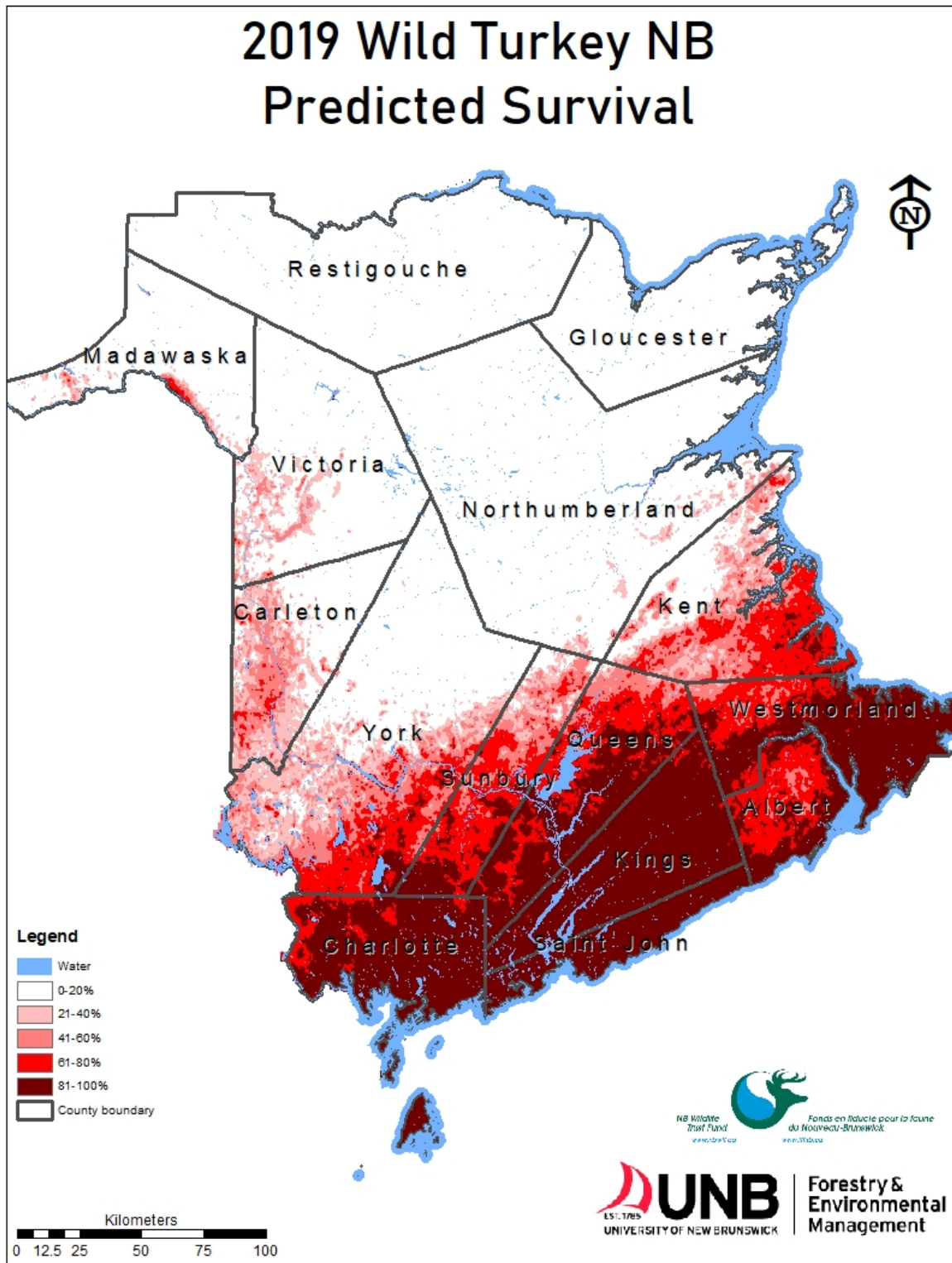
Figure 9. Map of New Brunswick depicting area where wild turkey will likely persist, based on winter snow depth as limiting factor expressed as a percent of survivability.

The goal of this project was threefold: 1) to establish the current distribution of wild turkey in New Brunswick, based on citizen science reports of observations; 2) to document naturalized establishment using brood surveys as a potential indicator of reproduction and: 3) where suitable habitat and favorable environmental conditions exist, to predict viability of the eastern wild turkey population.

There is great interest in wild turkeys in New Brunswick, as evident by the contributions of many observers to the Facebook and JotForm dataset. It is also clear that citizen science can be a valuable source of data to fill an information gaps quickly with likely very accurate results, given the correct parameters, and recognizing limitations. Based on citizen science contributions obtained from historic observations from *eBird* and *iNaturalist*, and more recently, Facebook and JotForm in this study, there is a confirmed population of wild turkeys in New Brunswick (from Madawaska County in the northwest to Charlotte County in the southwest). The origins of this population are undetermined; they could be naturally expanding their range from Maine, escaped, accidental, or purposeful unsanctioned releases. The citizen science observations are just that, observations of birds, at a point in time.

There is evidence that reproduction has occurred based on the results from the brood surveys. Broods, particularly if young can be an indicator of naturalized establishment. Broods seem evident in Charlotte County. Additional data from other areas of the province are necessary to confirm naturalized establishment in other counties.

The information obtained from brood surveys could be further analyzed to estimate overall flock size and local bird density (population estimate), the number of hens and number of breeding hens, the mean number of poults per breeding hen, and the mean number of poults for all hens (useful to estimate and forecast population trends) should these surveys become a part of wildlife management strategy. Tadeusz Splawinski (personal communication; June 2019) suggests that if this type of survey is conducted annually, it would be possible to

correlate poult production with spring meteorological conditions and habitat type (proximity to farmland, forest age, composition, and structure).

Under current environmental conditions, winter snow depth will limit the natural expansion and survivability of wild turkey populations in as much as 50% of the province. During severe winters when above-average snow depths exist, many wild turkeys will succumb to emaciation even when supplementary food sources are unavailable (Porter et al. 1980; Kane et al. 2007) and would concentrate populations, allowing for increased mortality rates due to predation. We lack provincial-scale information on future snow depth associated with global warming but milder winters could be expected to benefit wild turkey. Also, birdfeeders may be offsetting winter mortality rates because easily obtainable food would limit the need to travel and risk depredation, and limit starvation. Given that existing winter conditions in the southern parts of New Brunswick, and that the future conditions for central New Brunswick, are both favourable to winter survival, it seems likely that wild turkey will persist in New Brunswick.

Recommendations:

1) Brood surveys are used in other jurisdictions to assist in making population estimates or breeding success of hens. In future, brood surveys in the province should be more standardized with respect to length and location of route, time of day, time spent observing, number of times route is travelled when completed by a volunteer.

2) Snow depth of >30 cm of soft powder is certainly different than >30 cm of hard pack snow with a crust. Turkeys could easily walk on the crusty snow compared to powdery snow, in search of food. More work needs to be done on the actual properties of snow, depth of snow, and survivability of wild turkeys at the northern limit of their range to completely understand this aspect of limiting factors on range. Furthermore, a comprehensive study to assess anticipated climate change effects on New Brunswick snow levels may be of interest.

3) This study did not address actual wild turkey survival. Based on the predicted survivability map, wild turkeys observed in Restigouche County are far more unlikely to survive than birds observed in Charlotte County. More information is needed to understand actual wild turkey survival in New Brunswick.

4) This study did not generate appropriate data to estimate population size and viability, as it was not the purpose of this study. To determine population size, there would need to be mark-recapture studies, demographic work on age class trends, and determining survival rates of wild turkeys.

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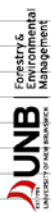
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Appendix 2 | 2019 Wild Turkey Brood Survey Form

		Observer Name:								
					Number of Turkeys Seen[3]				**Seen**	
Observation[1] #	**Date[2]**	**Location**	**Postal Code**	**Hens**	**Poults**	**Males**	**Unknown**	**Before[4]**		
Ex. 1	28-Jul	1667, Route 101 Nasonworth	E3C 2E2	1	5	0	0	N		
Ex. 2	12-Aug	2km past Irving truck stop, Hwy 2, Oromocto		0	0	3	0	N		
Ex. 3	15-Aug	Junction of Rte 101 and 7, Welsford		2	0	0	2	N		
Ex. 4	18-Aug	1667, Route 101 Nasonworth	E3C 2E2	1	4	0	0	Y		
1										
2										
3										
4										
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18										
19										
20										

Survey Form Instructions:
1) Record each observation on a single line. Do not leave any spaces blank. (see examples..If there were no males, enter zero).
2) Record only wild turkeys seen in August (enter day, then month).
3) Record the number of all wild turkeys seen: include hens, poults, males (jakes and gobblers), and those you could not identify as hens, poults or males.
4) Seen Before: If you believe you have recorded seeing these turkeys before enter"Y" for Yes, if not, enter "N" for No.

Appendix 3

Year 2019 Day/Month	Total Number WT reported on date	Number of Reports received on date	Minimum Number of WT in flock on date	Maximum Number of WT in flock on date	Average number of WT in Flock on date
Daily	165	5	7	70	33.0
1-Jan	25	1	25	25	25.0
14-Jan	6	1	6	6	6.0
26-Jan	12	1	12	12	12.0
1-Feb	14	1	14	14	14.0
3-Feb	5	1	5	5	5.0
8-Feb	16	2	8	8	8.0
13-Feb	56	2	6	50	28.0
15-Feb	3	1	3	3	3.0
17-Feb	6	1	6	6	6.0
19-Feb	1	1	1	1	1.0
22-Feb	30	1	30	30	30.0
23-Feb	3	1	3	3	3.0
1-Mar	50	3	11	20	16.7
2-Mar	15	1	15	15	15.0
3-Mar	62	3	15	32	20.7
5-Mar	63	5	2	31	12.6
6-Mar	46	1	46	46	46.0
7-Mar	20	1	20	20	20.0
8-Mar	13	1	13	13	13.0
9-Mar	32	2	12	20	16.0
10-Mar	19	2	5	14	9.5
11-Mar	22	2	9	13	11.0
12-Mar	10	1	10	10	10.0
13-Mar	53	5	3	23	10.6
15-Mar	4	1	4	4	4.0
16-Mar	57	4	2	28	14.3
17-Mar	42	2	17	25	21.0
19-Mar	13	2	2	11	6.5
21-Mar	24	2	9	15	12.0
22-Mar	5	1	5	5	5.0
23-Mar	8	2	2	6	4.0
24-Mar	2	1	2	2	2.0
25-Mar	3	1	3	3	3.0
27-Mar	18	2	6	12	9.0

28-Mar	1	1	1	1	1.0
29-Mar	40	6	1	24	6.7
30-Mar	43	6	2	31	7.2
31-Mar	8	2	2	6	4.0
1-Apr	40	4	2	27	10.0
2-Apr	36	3	1	32	12.0
3-Apr	75	8	1	20	9.4
4-Apr	52	11	1	7	4.7
5-Apr	42	7	1	8	6.0
6-Apr	45	8	1	12	5.6
7-Apr	21	3	2	10	7.0
8-Apr	23	5	1	12	4.6
9-Apr	69	8	1	25	8.6
10-Apr	26	7	1	7	3.7
11-Apr	179	11	1	65	16.3
12-Apr	85	14	1	20	6.1
13-Apr	134	26	1	20	5.2
14-Apr	287	44	1	22	6.5
15-Apr	67	10	1	20	6.7
16-Apr	41	9	1	12	4.6
17-Apr	66	16	1	9	4.1
18-Apr	48	7	1	15	6.9
19-Apr	80	16	1	25	5.0
20-Apr	46	16	1	20	2.9
21-Apr	19	7	1	11	2.7
22-Apr	39	4	1	30	9.8
23-Apr	36	8	1	11	4.5
24-Apr	11	6	1	3	1.8
25-Apr	45	8	1	15	5.6
26-Apr	22	7	1	8	3.1
27-Apr	20	6	1	12	3.3
28-Apr	30	12	1	8	2.5
30-Apr	25	6	1	15	4.2
1-May	9	6	1	3	1.5
2-May	14	4	1	7	3.5
3-May	8	3	1	4	2.7
4-May	21	8	1	7	2.6
5-May	4	3	1	2	1.3
6-May	18	6	1	10	3.0
7-May	2	2	1	1	1.0

8-May	9	5	1	4	1.8
9-May	10	6	1	4	1.7
10-May	1	1	1	1	1.0
11-May	12	4	1	5	3.0
12-May	21	5	2	9	4.2
13-May	9	4	1	5	2.3
14-May	24	7	1	11	3.4
15-May	25	6	1	13	4.2
16-May	5	2	1	4	2.5
17-May	6	2	1	5	3.0
18-May	20	4	1	8	5.0
19-May	17	2	2	15	8.5
20-May	4	3	1	2	1.3
23-May	5	2	1	4	2.5
26-May	12	3	1	6	4.0
30-May	1	1	1	1	1.0
1-Jun	1	1	1	1	1.0
2-Jun	1	1	1	1	1.0
4-Jun	1	1	1	1	1.0
Grand Total	**3100**	**476**	**1**	**70**	**6.5**