Occupancy of Rusty Blackbirds (*Euphagus carolinus*) in the Adirondack Region of New York State

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Abstract

Rusty Blackbird *Euphagus carolinus* populations have suffered a steep decline in the past few decades, but the reasons for this decline remain unclear. Until recently little information was known about the species' ecology due to its secretive nature and the remoteness of its breeding habitats in the boreal forest, but the recent development of a working group of biologists to study the species is rapidly improving our knowledge of the species. A number of reasons may play a role in the species' decline, including habitat loss and degradation, atmospheric deposition of pollutants, acidification of wetlands, and shrinking of wetlands as a result of climate change. Occupancy modeling is a tool to measure the presence or absence of a species at a given site as a function of detection probabilities to determine where a species is most likely to occur. Occupancy modeling can also help us to understand the natural history and population dynamics of Rusty Blackbirds in a short time period to meet the urgent need for information on this sparsely studied species, and be used over the long-term to identify trends in abundance and understand how threats to this species are related to population declines. The Adirondack Park Region in New York State is the southern edge of the range of many boreal species, including the Rusty Blackbird, but there is little information on this species in the Adirondacks. To meet the need for information on this species in the Adirondack Park I surveyed 75 points in wetlands throughout the park during the early breeding season of 2010, and used program PRESENCE to identify the best-fit model for predicting occupancy in the Park's wetlands. I found that both habitat-scale and landscape scale factors are important predictors of Rusty Blackbird occupancy, and that the park's largest wetlands have the greatest probability of Rusty Blackbird occupancy.

Introduction

Literature Review

In recent years a concern has developed among scientists over the apparent decline of Rusty Blackbird populations. It was first brought to the attention of the scientific community in 1999 when an analysis of long-term data found that there has been a consistent decline in the Rusty Blackbird population over the last 5 decades (Greenberg and Droege 1999). Population estimates of Rusty Blackbirds are available from long-term avian monitoring projects such as the North American Breeding Bird Survey (BBS), the Christmas Bird Counts (CBC) and the Quebec checklists program (EPOQ). The BBS provides data at 110 point count locations within the southern edge of the boreal zone, which covers a very small fraction the species' breeding range. This data set shows a 92.8% decline between 1966 and 2008. The data obtained from the CBC database provides a rough estimate of wintering populations across the southern U.S and indicates an average decline of 5.1% per year, or an 88% cumulative decline in the population between 1966-2007. The EPOQ offers the best baseline data within the Rusty's breeding range and shows a 92.1% decline since 1966. While these data sets provide clear evidence that the Rusty Blackbird is declining, there is still a lack of information from much of the species' range, making the size of the population difficult to determine. The most recent population estimates range widely from 158,000 (Rich et al. 2004, Savignac 2006) to 2,000,000 individuals (Wells 2007).

Recent research using isotope analysis has allowed researchers to identify two geographically distinct populations of Rusty Blackbirds among the Atlantic and Mississippi flyways, and has found that there are steeper declines in the smaller Atlantic population due to extirpations that have been observed in New England and the Maritime Provinces (Hobson et al. 2010, Greenberg et al. 2011). Statewide breeding bird atlas projects show a marked decline at the southern edges of the boreal zone. The New York State breeding bird atlas (Figure 1), conducted in 1980-1985 and again in 2000-2005, found a decline of 23% in the number of blocks that had breeding Rusty Blackbirds between the two atlases (McGowan and Corwin 2008). The Vermont breeding bird atlas, conducted in the same time periods as New York State, found breeding Rusty Blackbirds in only 11 of the 26 blocks that had records of Rusty Blackbirds in the first atlas (Avery 1995).

The apparent declines in Rusty Blackbird populations prompted the formation of the Rusty Blackbird Technical Working Group in 2005, coordinated by the Smithsonian's Institute for Migratory Bird Populations. The main purpose of this group is to determine the reasons for the sudden decline in Rusty Blackbird populations. The working group serves as a forum for researchers to collaborate on Rusty Blackbird research, and has given rise to new research on both breeding and wintering grounds. Prior to the formation of this group the majority of research data that existed for Rusty Blackbirds was drawn from ecological accounts from the early twentieth century. Until recently very little information was known about breeding ecology, habitat selection, or population dynamics. Researchers from the working group have conducted studies on a wide range of topics, including breeding ecology (Powell 2010, Greenberg and Matsuoka 2010), mercury accumulation (Edmonds et al. 2010), and radio isotope analysis to connect wintering populations to their breeding grounds (Hobson et al. 2010).

The Rusty Blackbird breeds in wetlands in northern New England, the boreal region of Canada, and Alaska, and winters in bottomland forests throughout the southeastern U.S. Rusty Blackbirds nest in low conifers or shrubs such as balsam, spruce, and alder, in close proximity to open water (Matsuoka 2010a). Rusty Blackbirds have a single brood, with egg-laying beginning in mid-May to mid-June. They have an incubation period of 14 days, and young leave the nest at

13 days (NYSDEC 2000). Their diet is more specialized than other Iceterid species, relying on aquatic invertebrates such as insects and snails as a primary food source, but will diversify their diet during migration and winter to include seeds and small fruits (Avery 1995). Their mean home range of 37.9 Hectares is larger than other Icterid species due to their need to seek out shallow water for foraging sites (Powell 2010).

A number of factors have been suspected as reasons for the decline in Rusty Blackbird populations. Increased exploitation and development of resources in the boreal forest has caused a great deal of fragmentation and habitat loss in recent decades, and may account for the decline of many boreal bird species (Greenberg and Matsuoka 2010). Habitat degradation is a threat to Rusty Blackbirds in all parts of its range, adding stress to both breeding and wintering populations. Since European settlement 75-80% of the bottomland hardwood forests that provide crucial wintering habitat for Rusty Blackbirds were converted to agriculture, and losses continue to occur due to logging and urban development (Greenberg and Matsuoka 2010). The boreal forest of Canada is one of the earth's largest intact ecosystems, but to date only 12% of it is protected and 30% of it is slated for logging, energy, and resource extraction in the near future (Boreal Songbird Initiative 2007). Development in the boreal forest threatens to have a negative impact on Rusty Blackbird populations by reducing available habitat, increasing competition from species such as Common Grackles (*Quiscalus quiscula*) and Red-winged Blackbirds (*Agelaius phoeniceus*), and increasing nest predation (Greenberg and Matsuoka 2010).

Numerous studies have documented the negative effect that fragmentation has on the reproductive success of songbirds due to increased predation (Burke and Nol 2000, Small and Hunter 2008). Rusty Blackbird nest success was found in one study to be significantly lower in regenerating clearcuts than in mature forest, and the failure to produce young in 11 of 25 nests studied was attributed to predation (Powell 2008). In Alaska Gray Jays (*Perisoreus canadensis*) are the most common nest predator of Rusty Blackbirds (Matsuoka 2008), but in New England Gray Jays (*Perisoreus canadensis*), Blue Jays (*Cyanocitta cristata*), Common Ravens (*Corvus corax*), American Crows (*Corvus brachyrhynchos*), and Red Squirrels (*Sciurus vulgaris*) are all potential nest predators, with Blue Jays and American Crows being more abundant in fragmented regions (Robinson et al. 1995).

Atmospheric deposition of pollutants is suspected to also play a role in the Rusty Blackbird's decline. Atmospheric pollutants can lead to acidification of wetlands and negatively impact aquatic invertebrate populations. The loss of these calcium sources during breeding season could inhibit eggshell and bone formation, resulting in reduced nesting success (Greenberg and Droege 1999). Declines in other boreal species that rely on aquatic invertebrates for food have been documented in recent decades, suggesting that there may be a link between the decline in Rusty Blackbirds and other specialized species (Greenberg and Matsuoka 2010). Acid rain is also a source of mercury, which when converted to methyl mercury has been shown to decrease reproductive success in predatory aquatic birds (Edmonds et al. 2010).

Another suspected reason for the decline in Rusty Blackbird populations is the effects of climate change on their environment. Wetland breeding birds are particularly vulnerable to climate change because of predicted changes in precipitation patterns, especially in wetlands that rely on snowmelt to sustain water levels (North American Bird Conservation Initiative 2010). Such effects have already been documented in the Adirondacks, where snowpack has been decreasing over the past few decades (Jenkins 2010). In response to rising temperatures many species of birds have already shifted their range of central abundance to the north, with landbird species having shifted an average of fifty miles north (NABCI 2010). Such a shift of Rusty

Blackbird populations would likely result in the extirpation of the species from the Adirondack and New England portions if its range.

To identify which of these environmental changes has the greatest impact on Rusty Blackbirds we must understand more about the species' habitat, and the factors within that habitat which have the greatest correlation with the species' distribution. Recent developments in the field of occupancy modeling have improved the precision by which wildlife managers can use occupancy modeling to monitor trends in populations over time and to further determine which factors of a species' habitat are correlated with occupancy (MacKenzie et al. 2006). Occupancy modeling measures the proportion of an area that is occupied and determines the probability that a species is present at a certain site. The ideal measure for population monitoring is to calculate abundance, but doing so requires a great deal of field effort and is often impractical for rare or elusive species. Occupancy modeling requires much less effort, as it can be done in a single season with repeated visits to sites, while providing a comparable measure of a population. Detection versus non-detection surveys were first used as an alternative to measuring abundance in the 1970's to uncover the relationship between species diversity and island size (MacKenzie et al. 2006). Occupancy modeling was further developed from these types of surveys in the 1990's as a tool to determine the relationship of occupancy to habitat characteristics by calculating the likelihood that a species is present based on a set of parameters. Occupancy modeling further evolved when a paper published by MacKenzie et al. in 2002 introduced new methods for modeling occupancy that account for imperfect detection, greatly improving the precision of occupancy modeling.

Failure to account for changes in detectability, defined as the probability that a species is detected when present, can lead to biased estimates of occupancy when detectability is <1

(MacKenzie et al. 2006). It is especially important to consider when studying species with low detection probabilities such as Rusty Blackbirds, which have a low probability of being detected ranging from 16-19% on point counts in previous studies (Powell 2008, Glennon 2010). Failure to account for detectability can lead to underestimation of a species' presence, and is a main weakness of statewide Breeding Bird Atlas projects. The New York Breeding Bird Atlas provides information as to where Rusty Blackbirds were detected, but offers no insight into where the species may have been present but not detected, likely underestimating the species' presence. The use of occupancy modeling in my study to account for imperfect detectability will provide a more accurate model of where the species is present in the Adirondacks.

Occupancy modeling requires the use of numerous formulas, a process that can be extremely lengthy by hand but was recently made easier by the creation of program PRESENCE (Hines 2006). PRESENCE was developed to estimate detectability and occupancy simultaneously based on survey-specific parameters. Modeling occupancy and detection probabilities as a function of covariates enables a large range of *a priori* models to be investigated in order to determine the best-fitting model for predicting occupancy (MacKenzie et al. 2006). Akaike's Information Criteria uses likelihood to assess a value to each model that can be used to determine which models have the greatest support (Burnham and Anderson 2002). The best-fitting model can then be used by wildlife managers to predict occupancy in a given area based on the habitat parameters of that area.

Occupancy modeling has been used by members of the working group in Alaska and New England to establish a baseline of parameters that are related to Rusty Blackbird occupancy. These studies found that small bodies of open water, wetland area, stunted conifers (<5m tall) and adjacent coniferous upland were significant indicators of Rusty Blackbird occupancy at the habitat scale (Powell 2008). These variables are important to habitat because open water provides foraging sites, stunted conifers are often used for nesting, and a coniferous upland provides a buffer to the wetland that may play a role in reducing nest predation. Models conducted at the landscape scale found that the best indicators of occupancy were the percentage of shrub forest within 1km, freshwater surface area, and emergent vegetation wetland area (Powell 2008, Matsuoka et al. 2010a). These findings provide insight into the fact that Rusty Blackbirds may require a wide range of wetland habitats in their breeding range.

Based on all the above research the ideal Rusty Blackbird landscape would include small conifers for nesting, patches of shallow water with abundant prey, and a buffer to reduce nest predation (Powell et al. 2010), but further research is needed to better understand how and why these factors are correlated with occupancy. Luke Powell and the University of Maine designed a protocol for long-term monitoring of Rusty Blackbirds using point-count surveys during the breeding season that uses point-counts with a playback recording to efficiently measure occupancy in the southeast portion of the species' breeding range where the steepest declines have occurred. The protocol is intended to establish a baseline of occupancy in the region and better determine which parameters are associated with occupancy in order to correlate these parameters to changes in habitat over the long term (Powell 2009). This protocol emphasized the need for a baseline of data in the Adirondack region, and served as the inspiration for my own study to model occupancy in the Adirondacks.

My original intent was to use the plan's protocol to identify nesting pairs and monitor nest success, and in turn the results of my research could be combined with that of researchers conducting similar studies in other regions. However, in my pilot year I realized that Powell's monitoring protocol in an area as remote as the Adirondacks was not an efficient survey method due to the inaccessibility of suitable wetland habitats by roads. I also determined that the remoteness of Rusty Blackbird locations would make a nesting study impractical in a single season due to effort and time restraints, so I shifted my focus to designing a protocol that aims to establish a more precise estimate of occupancy in the Adirondacks and a better focus of the parameters associated with occupancy. The purpose of my research was to identify which wetlands within the park still maintain Rusty Blackbird populations, and identify the habitat characteristics and landscape features of these wetlands that correspond with occupancy. Understanding which variables have the highest degree of correlation with Rusty Blackbird occupancy will give wildlife managers in the Adirondacks and beyond the information that they need to plan for the future conservation of the species.

Hypothesis

I hypothesized that at the habitat scale parameters that provide nesting or foraging habitat would be positively correlated with occupancy based on previous findings by Powell (2008) and Matsuoka (2008). I further hypothesized that wetland size, determined by the percentage of wetland in a 5-10km landscape, would be positively correlated with occupancy, and that the park’s largest wetlands would have the highest likelihood of Rusty Blackbird occupancy.

Methods

Study Area

I located study sites within the Adirondack Park, a 6 million acre mosaic of public and private lands that contains tens of thousands of acres of lowland boreal habitat. Historical records of Rusty Blackbird occurrence in New York State indicate that the species occurs within these lowland boreal habitats (Peterson 2008). I chose most of the study sites based on data from the NY State Breeding Bird Atlas, which provided data on which 5kmx5km blocks within the Adirondacks have records of breeding Rusty Blackbirds. Based on previous studies indicating that open water, conifer swamps, and shrub swamps are key indicators of occupancy (Powell et al. 2010, and Matsuoka et al. 2010), I used aerial photos and site visits to identify where within these blocks the species was most likely to have occurred. Of these sites, I selected the ones that could be accessed by foot or boat within a few hours as survey sites to minimize effort. I also selected a few sites based on previous records of occurrence from surveys conducted by the Wildlife Conservation Society (Glennon 2010). I identified a total of 17 accessible wetlands as study sites that I thought would have the highest likelihood of Rusty Blackbird occurrence (Table 1).

Survey Design

I based the survey protocol on the point count methods described in the Rusty Blackbird Monitoring Plan (Powell 2008) and in the Wildlife Conservation Society's boreal report (Glennon 2009). Myself and one field assistant conducted surveys at 75 points within the 15 wetland complexes, with points placed a minimum of 250m apart. The number of points per wetland varied from 1-7 based on the amount of suitable habitat, and were placed on a road, trail, or waterway at locations where local habitat characteristics such as the presence of open water and/or shrubs or conifers for nesting seemed appropriate habitat for the species. We conducted counts independently, and at each point we listened for 3 minutes, played a 30 second recording of a Rusty Blackbird vocalization (recorded in NY by Peter Kellogg, stored at the Cornell Lab of Ornithology), and listened for an additional 3.5 minutes, for a total point count time of 7 minutes. We recorded any individuals that were heard or seen during the 7 minute period within a 100m radius of the point to maintain site independence.

At the conclusion of the survey we recorded the GPS location, site variables (Table 2) and weather conditions. The list of site variables we recorded were based on variables that were related to occupancy in previous studies by Powell (2009) and Matsuoka (2008). We estimated vegetation cover for all species with >20% cover within 100m of the point based in visual observation from the point count location. We conducted surveys between May 13th and June 15th of 2010, within the period of maximum detectability when the species is establishing territories prior to the nesting season based on known egg-laying and fledging dates for NY State (NYSDEC 2000). Surveys were conducted only between 700h and 1100h based on prior research that indicates that Rusty Blackbird detectability decreases after 1100h (Matsuoka 2008 and Powell 2008). We visited each site twice during the survey period in order to estimate detection probability.

At the conclusion of the field season landscape variables (Table 3) were determined based on a number of studies that show the influence of local versus landscape scale habitat characteristics in shaping bird community structure (Bennett et al. 2004, Haslem and Bennett 2008, Schlesinger et al. 2008). In previous studies wetland area was calculated based on National Wetlands Inventory data, but the NWI dataset in the Adirondacks was incomplete in 2010, making such an analysis unfeasible. As an alternative we used data from the LANDFIRE project (Landscape Fire and Resource Management Planning Tools Project, 2007, www.landfire.gov) to determine the amount of boreal habitat (boreal acidic peatland) within 500m, 5k, and 10k of each point using ArcMap (V9.2). For a more detailed analysis we also used a dataset that was compiled by Jerry Jenkins (2004) using data from Adirondack Park Agency and NWI data that delineated several categories of boreal habitat in the Adirondack Park to determine the amount of boreal habitat types within 500m and 5K of each point, also using ArcMap.

Data Analysis

I modeled Rusty Blackbird occupancy as a function of site-specific and sampling covariates using single-season analysis in the program PRESENCE (Hines 2006). Detectability was modeled as a function of the parameters time, Julian date, wind speed, and temperature. I tested each detection covariate while keeping occupancy constant in order to determine the best predictor for detection probability. Upon determining that temperature was the best detection variable, I modeled occupancy with temperature as the detection covariate in all models. I ran 2 sets of occupancy models, one which evaluated the influence of local habitat scale variables and one which evaluated the influence of landscape scale variables on Rusty Blackbird occupancy. Models were assessed for overdispersion with parametric bootstraps and ranked according to QAIC (Burnham and Anderson 2002, MacKenzie et al. 2005

I then used the model averaging function in PRESENCE to calculate the likelihood of occupancy per wetland site based on site scale and landscape models to determine which sites have the most suitable habitat for Rusty Blackbirds when all models are considered.

Results

Rusty Blackbirds were detected on 8 out of 148 surveys at 6 of the 74 points (naïve occupancy= 0.11), and is illustrated in figure 3. A total of 15 individuals were recorded, including a pair with two fledglings at Spring Pond Bog. I limited all my models to single predictor variables on both detection and occupancy due to the small number of positive detections. The best-fit model for detectability was the covariate TEMPERATURE (Table 4). Models WIND, TIME, DATE, and SKY also received some support (ΔQAIC values <2). I used the best-fit model for detectability as the base model for site scale and landscape scale models. The best-fitting models had an estimated mean occupancy of 0.13 ± 0.05 SE and a mean detectability of 0.54 ± 0.18 SE.

The best site-scale model was the null model, but most models received some support with ΔQAIC values ≤2 (Table 5). The second best model (ΔQAIC=0.85) was the variable BALSAM as a negative predictor, though confidence intervals of occupancy were wide (>0.25). Models CEDAR, MUD, PINE, CON<5m, and ALDER received some support (ΔQAIC=1.15-1.98) as positively correlated with occupancy. Models HEATH and SPAHGNUM received some support (ΔQAIC=1.64 and 2 respectively) as negatively correlated with occupancy. Models SPRUCE , TAMARACK, and SEDGE were discarded due a failure of the models to converge on a solution.

The best landscape-scale model was the null model, but all models received some support with ΔQAIC values ≤2 (Table 6). The second best model with strong support (ΔQAIC=0.59) was PEAT10K as a positive predictor of occupancy. The model OPENBOG500m had moderate support as a negative predictor of occupancy, while models CONSW500, CONSW5K, BOREAL5K, OPENBOG5K, and CONSC500 all received some support as positive predictors of occupancy. Model CONSC5K ranked lowest (ΔQAIC=2) as a negative predictor.

The sites with the highest likelihood of occupancy when the site scale model results were averaged included sites in Massawepie Mire, Bloomingdale Bog, and Shingle Shanty Preserve (Table 7). Sites with the highest likelihood of occupancy using landscape scale models were located in Bloomingdale Bog and Massawepie Mire (Table 8).

Discussion

Occupancy Modeling

I found predicted occupancy of Rusty Blackbirds in the Adirondacks to be 0.13±0.05. This is similar to what was found in a previous study in the Adirondacks (0.15 by Glennon 2010), but is noticeably lower than similar breeding season studies in New England (0.37±.12 by Powell 2008) and Alaska (0.51±.21 by Matsuoka et al. 2008). Detectability of 0.54±.18 was higher than in previous point count-based studies of Rusty Blackbirds, as would be expected from using the methods outlined in the Rusty Blackbird Monitoring Plan, which were designed to maximize detectability to minimize survey effort through the use of playback recordings during the early breeding season. I anticipated that improving detectability would find Rusty Blackbirds to be present in wetlands where they were not previously recorded, but that was not the case. In contrast, my findings confirm previous findings that the Adirondack population is sparsely distributed, and that the species has lower occupancy rates than more northerly regions of the species' range.

Occupancy at the habitat scale was mostly correlated with features that could provide nesting or foraging habitat. Alder and Cedar were positively correlated with occupancy and could provide potential nest sites, though the negative correlation of Balsam with occupancy contradicts my hypothesis (Powell 2008). Exposed mud was positively correlated with occupancy in this and other studies (Powell 2008 and Matsuoka et al 2010), and provides crucial foraging habitat for the species. The positive association of upland pines with occupancy aligns with a previous study that found adjacent upland conifers to have a positive correlation with Rusty Blackbird occupancy (Powell 2008). Adjacent upland habitats may be important as a buffer to nesting habitat, reducing the impacts of predation and competition from other Icterid species (Powell et al. 2010). The negative correlation of Sphagnum and Heath species with occupancy was expected since these species are not important to nesting or foraging for this species.

At the landscape scale the amount of boreal acidic peatland within 10km was a strong indicator of occupancy, which supports my hypothesis that larger wetland complexes would have higher occupancy rates. My hypothesis was based on a previous study of boreal birds that was conducted in the Adirondacks by Michale Glennon between 2005-2010 that identified the importance of landscape scale factors and found that the percentage of boreal acidic peatland at the 500km and 10km scales are the best indicators of occupancy for boreal bird species (Glennon 2010). The same study also found that the park's large wetland complexes have the highest likelihood of occupancy for boreal bird species. Percentages of conifer swamp and conifer scrub were positive indicators at both the 500m and 5k scales, which is in line with Powell's (2008) findings at the 1km scale of similar habitats. The amount of open bog was a strong negative indicator of occupancy within 500m, which would be expected since it provides neither nesting nor foraging habitat, though at the 5km model it became a positive indicator of occupancy. In general all wetland types used in this analysis had a positive correlation to Rusty Blackbird occupancy above the 500m scale, indicating that wetland size may play a more important role than wetland composition in the species' distribution.

Management Implications

Boreal habitat in the Adirondacks occurs mainly in small patches in the central and northwestern areas of the park with a few extensive wetland complexes that serve as the boreal core. These large wetland complexes have the highest diversity of boreal species, and previous studies suggest that these large wetland areas may be crucial habitat for source populations of boreal species in the Adirondacks (Glennon 2010, Jenkins and Keal 2004). The findings in my study that large wetland complexes such as Spring Pond Bog, Shingle Shanty Preserve, Bloomingdale Bog, and Massawepie Mire have the highest likelihood of Rusty Blackbird occupancy emphasizes the importance of these wetlands to Rusty Blackbird populations. My study deepens our understanding of which habitat and landscape variables are important to Rusty Blackbird occupancy in the Adirondacks, but further research in this area would help to better understand why these particular wetlands are important to this species. A study of survival and metapopulation dynamics of Rusty Blackbirds and other boreal bird species would help identify source populations within in the park and identify which wetlands should have the highest conservation priority. Such a study would also help identify which factors are limiting survival, and whether these factors are related to localized habitat changes, landscape scale changes, or environmental sources such as acid rain. It is interesting to note that at the landscape scale Bloomingdale Bog has the highest likelihood of Rusty Blackbird occupancy, but the species has not been recorded breeding here in the past decade. This suggests that there are factors surrounding the extirpation of Rusty Blackbirds from sites such as Bloomingdale Bog that could not be identified by my study.

The Adirondacks are a unique patchwork of public and private lands which creates some interesting challenges to preserving contiguous wetlands in the park. Forty-three percent of the park is owned by the state and preserved as forever wild, but fifty-seven percent of the park is private land, much of which is open to development. Wetlands on private lands are protected under the National Wetlands Act, and small buffers around these wetlands are protected by the APA, but the adjacent uplands are open to exploitation and fragmentation by rural development. Adirondack land classifications afford some protection to these uplands by limiting the density of rural development, but such restrictions still leave these lands vulnerable to fragmentation. The areas surrounding Spring Pond Bog and Massawepie Mire in St. Lawrence County are mostly classified as resource management lands, which are vulnerable to fragmentation from logging and rural development, and loss of buffers around these wetlands could negatively impact these Rusty Blackbird populations. Bloomingdale Bog in Franklin and Essex Counties is an extensive wetland complex with ample Rusty Blackbird habitat, but is closer to urban and suburban development than the other large wetland complexes. Bloomingdale Bog is uniquely surrounded by land with a variety of classifications ranging from wild forest to moderate intensity use (Figure 4). Failure to manage this bog as a contiguous unit has led to fragmentation of the adjacent upland areas and changes in hydrology due to its maintenance for recreational use. Rusty Blackbird, Spruce Grouse, and Olive-sided Flycatcher have declined or disappeared from Bloomingdale Bog in the past two decades as changes to the landscape have occurred (Glennon 2010). Further studies of survivorship and the role of predation in habitats that are affected by use and development may help determine whether these factors have played a role in the extirpation of Rusty Blackbirds and other species from these habitats.

The dependency of Rusty Blackbirds on aquatic invertebrates for food puts them at a high risk as decreasing snowmelt and precipitation causes wetlands to shrink in size as is predicted in climate change models (Jenkins 2010). The isolation of the Adirondacks from other boreal forests due to lowland valleys surrounding the park makes boreal species particularly susceptible to extirpation if predicted changes from a warming climate do occur. The nearest populations of Rusty Blackbirds are hundreds of kilometers away across the St. Lawrence River valley to central Quebec or across the Champlain Valley to northeastern Vermont. Preserving areas of the Adirondack Park that provide source populations for species at the southernmost edge of their range is crucial to maintaining species diversity within the park (Jenkins and Keal 2004, Jenkins 2010). Deepening our understanding of metapopulations within the park and their connectivity to other boreal regions will help us to understand and minimize the impacts that climate change may have on Rusty Blackbirds and other boreal bird species. Further research is needed to determine whether Rusty Blackbirds and other boreal bird species move between these boreal regions or if these populations are independent of one another. If the Adirondack population is independent of neighboring regions then identifying and preserving source populations within the region will be essential to prevent the extirpation of Rusty Blackbirds from New York State.

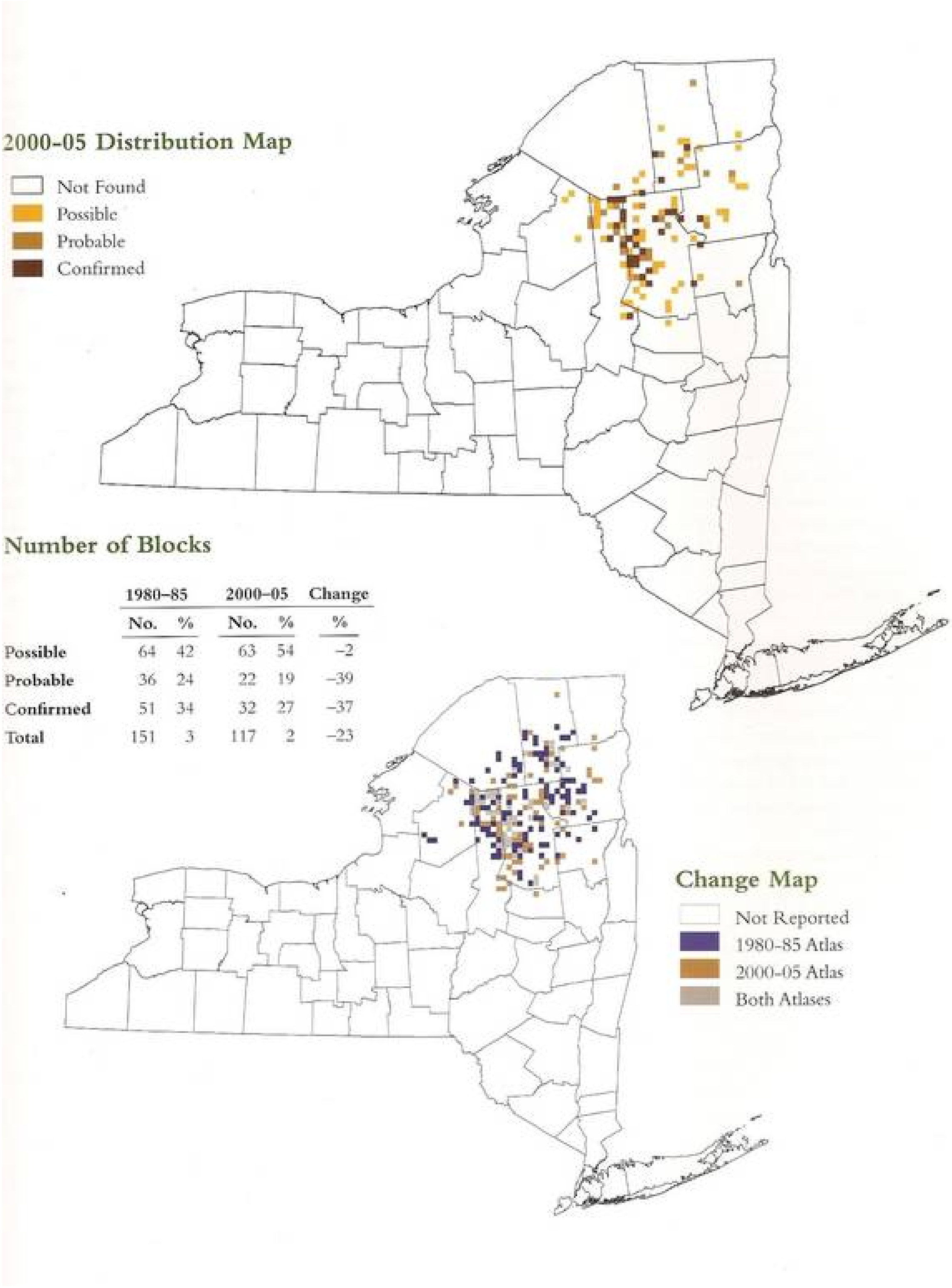
Based on my study I believe Spring Pond Bog to be the best location for future study based on the confirmation of a breeding pair and the presence of at least two pairs within the wetland complex. Given the low detection probability of the species and the habitat and landscape structure of wetlands within Spring Pond Bog it is likely that more extensive searches of this wetland would result in more detections of Rusty Blackbirds. As the second largest boreal wetland in the Adirondacks this location would be an excellent place to study metapopulation dynamics of Rusty Blackbirds and other boreal bird species, to determine whether fledglings from this site disperse to other wetlands in the park. The use of radiotelemetry with breeding boreal birds and fledglings in Spring Pond Bog combined with increased survey efforts in nearby wetlands would help us understand how boreal birds move between wetlands in the park and better inform wildlife managers to set goals for the conservation of Rusty Blackbirds and other declining boreal species.

Conclusion

My study deepened our understanding of the habitat and landscape variables that can be used as predictors for Rusty Blackbird occupancy, and emphasized the importance of large wetlands to Rusty Blackbird populations. My study confirmed that the Rusty Blackbird population in the Adirondacks is widely dispersed among remote areas of the park, which presents a challenge to further study of the species in this region. It is my recommendation that further research of Rusty Blackbirds within the Adirondacks should be combined with research efforts targeting a wider range of boreal species. Research pertaining to natural history of the species would be more practical in areas of the species' range with higher occupancy and better accessibility than the Adirondacks, though some studies may be worth the effort if combined with studies in regions with higher occupancy. Due to the time and expense of reaching the wetlands where Rusty Blackbirds still occur, further studies of the species in the Adirondacks should be inclusive of other boreal bird species, to make such effort worthwhile and deepen our understanding of other boreal species that have declined within the park. It is my hope that my study not only draws support for the preservation of the park's largest wetlands and the Rusty Blackbirds that inhabit them, but that when combined with other studies of the Rusty Blackbird Technical Working Group it will help create a clearer picture of the reasons for the Rusty Blackbird's decline.

Figures and Tables

Figure 1. Map of Rusty Blackbird records in New York State during the 2000-2005 Breeding Bird Atlas and changes in the species' distribution since the 1980-1985 Atlas (McGowan and Corwin 2008).



Number of Blocks

	1980–85		2000–05		Change
	No.	%	No.	%	%
Possible	64	42	63	54	–2
Probable	36	24	22	19	–39
Confirmed	51	34	32	27	–37
Total	151	3	117	2	–23

Figure 2. Map of boreal habitat in the Adirondack Region of New York state denoting locations of Rusty Blackbird point counts conducted in May-June 2010.

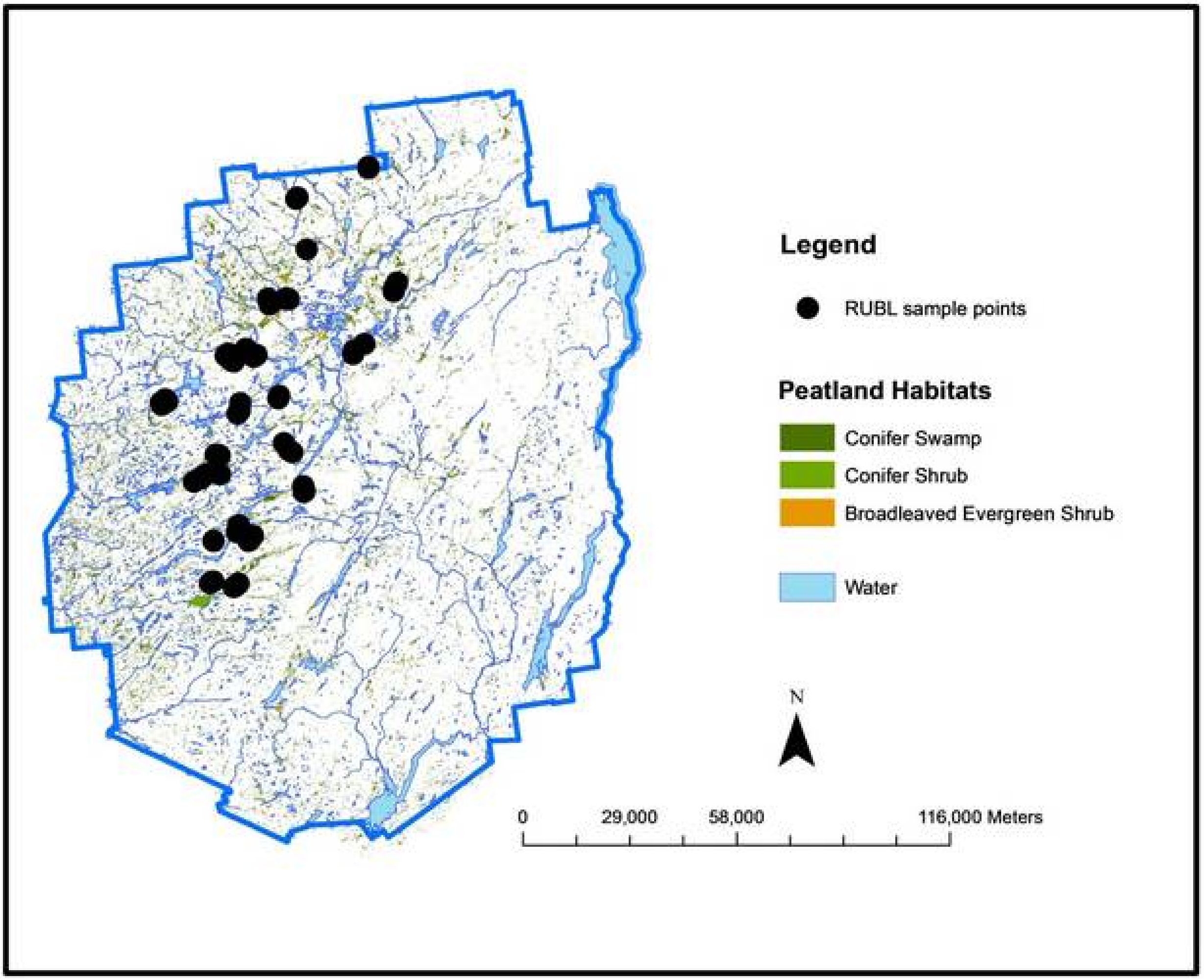


Figure 3. Map of boreal habitat in the Adirondack Region of New York State denoting the survey points with positive detection of Rusty Blackbirds in May-June 2010.

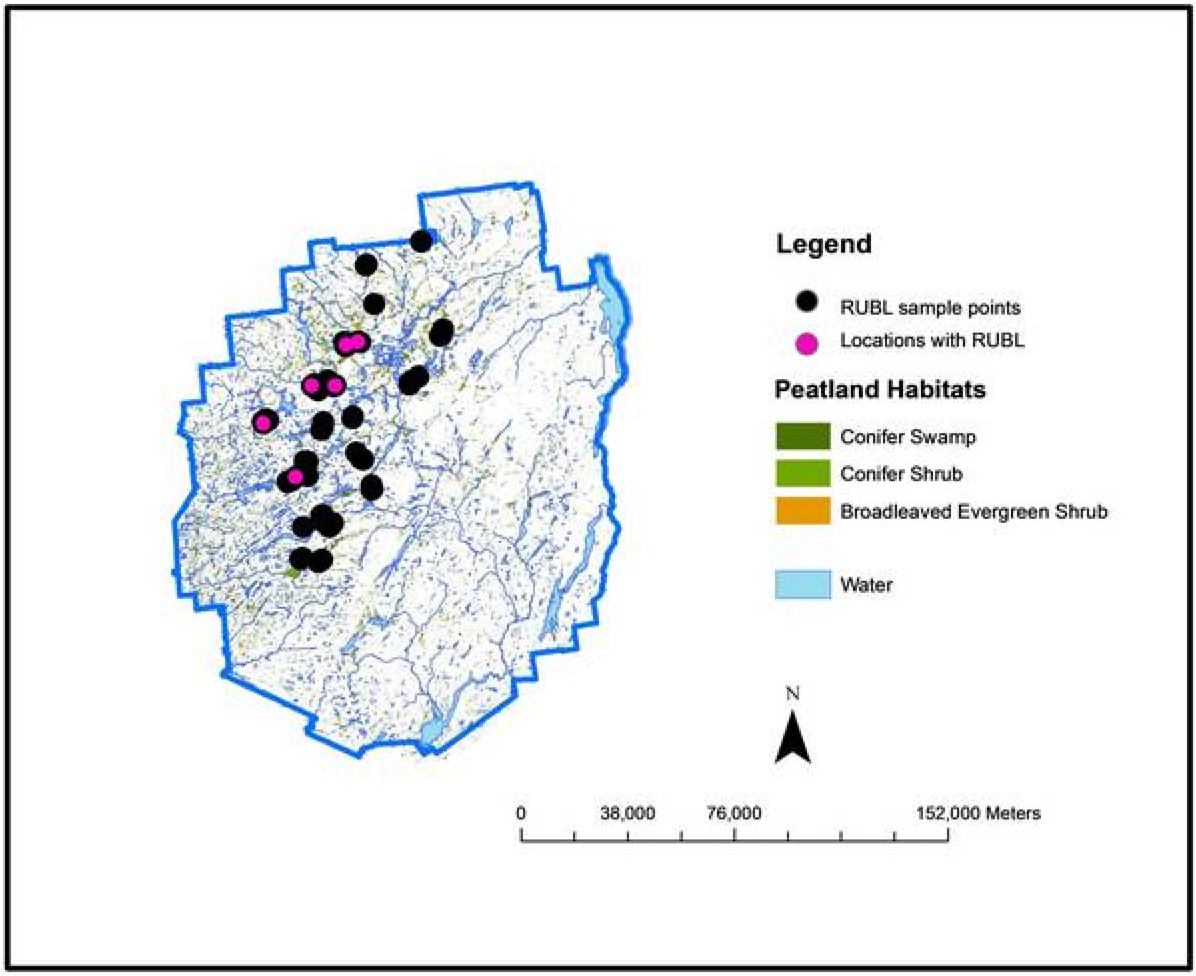


Figure 4. Map of Adirondack Park Agency land classifications in and around Bloomingdale Bog (depicted by red circle), Franklin County, NY (NYSDEC 2004).

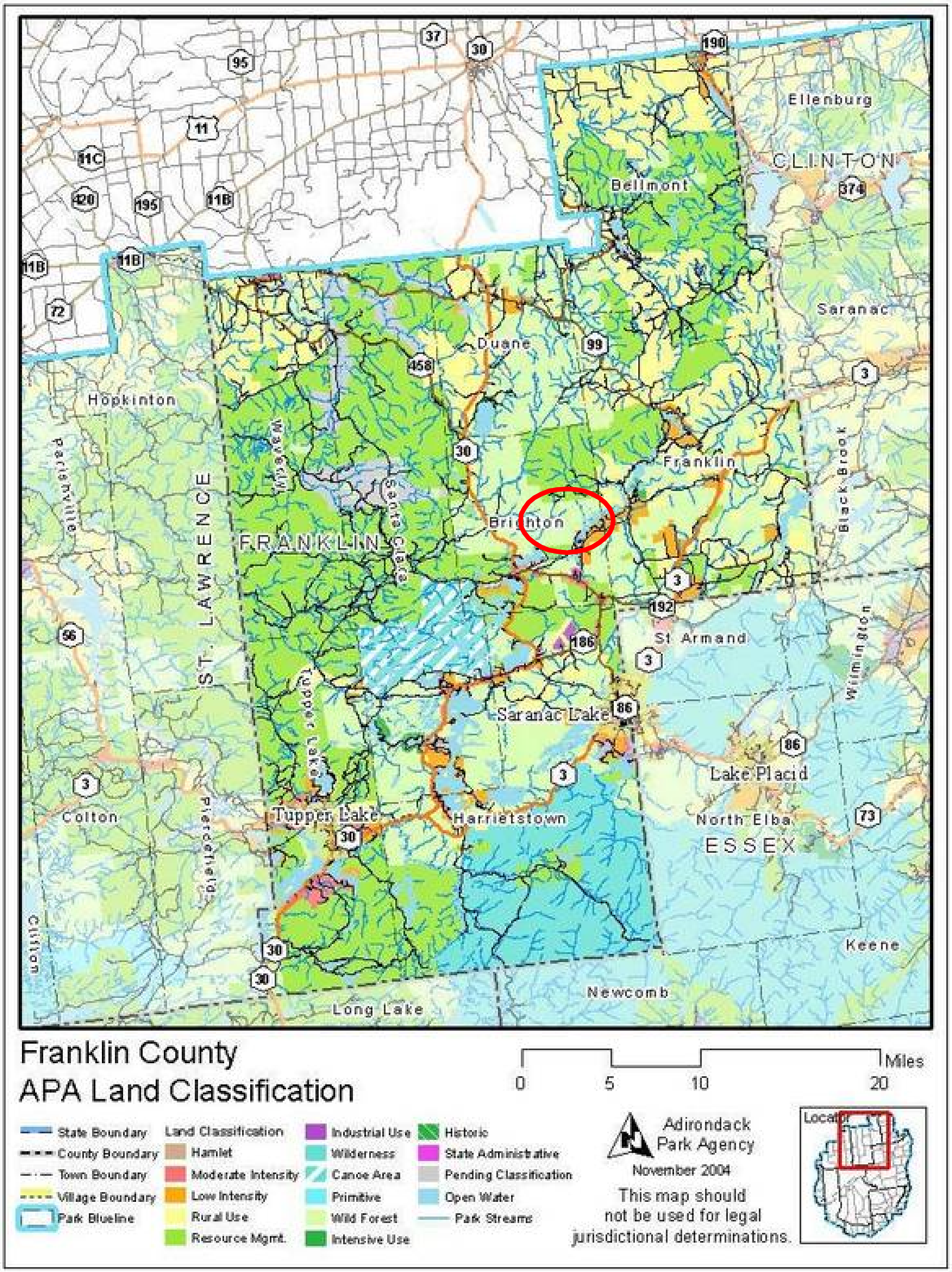


Table 1. List and description of wetlands surveyed for Rusty Blackbirds in the Adirondack Region of New York State in 2010. Sites in bold indicate wetlands where Rusty Blackbirds were detected.

Site	Site Description	County	Number of Points Surveyed
BDB	Bloomingdale Bog	Franklin/Essex	6
BMRD	Blue Mountain Road	Franklin	4
BRF	Bog River Flow via Hitchins Bog Trail	St. Lawrence	5
BRFP	Bog River Flow waterway	St. Lawrence	2
DEAD	Dead Creek	St. Lawrence	5
FERD	Ferd's Bog	Hamilton	1
LONG	Long Pond	St. Lawrence	3
MASW	Massawepie Mire	St. Lawrence	6
MRP	Moose River Plains	Hamilton	6
MSAR	Middle Saranac Lake	Franklin	4
RAQS	Raquette Lake, southern outlet	Hamilton	5
RLS	Raquette Lake, Brown's Tract Inlet	Hamilton	5
SOPO	South Pond	St. Lawrence	3
SPB	Rock Pond, Spring Pond Bog	Franklin	5
SPBF	Spring Pond Bog	Franklin	5
SSRBS	Shingle Shanty Preserve	St. Lawrence	6
WANK	Wanakena, Cranberry Lake	St. Lawrence	4

Table 2. List and explanation of site scale parameters used to estimate Rusty Blackbird occupancy in the Adirondack Region of NY State in May-June 2010.

Parameter	**Description**
Tamarack	*Larix laricina* cover >20% within 100m
Balsam	*Abies balsamea* cover >20% within 100m
Spruce	*Picea* sp. cover >20% within 100m
Cedar	*Thuja* sp. cover >20% within 100m
Pine	*Pinus* sp. cover >20% within 100m
Alder	*Alnus* sp. cover >20% within 100m
Heath	*Kalmia polifolia*, *Chamaedaphne calyculata*, *Ledum groenlandicum* cover >20% within 100m
Sedge	*Carex* sp. cover >20% within 100m
Conifer<5m	Stunted conifers <5m
Sphagnum	*Sphagnum* sp.
Exposed Mud	Exposed mud within 100m

Table 3. List and explanation of landscape scale parameters used to model Rusty Blackbird occupancy in the Adirondack Region of NY State in May-June 2010.

Parameter	**Description**
Peat 10k	Amount of boreal acidic peatland within 10K
ConSw500m	Amount of Conifer Swamp habitat within 500m
ConSw5K	Amount of Conifer Swamp habitat within 5K
OpenBog500m	Amount of open bog (peatland with shrubs<1m) habitat within 500m
OpenBog5K	Amount of open bog (peatland with shrubs<1m) habitat within 5K
ShrubSw500m	Amount of shrub swamp (Alnus sp.) within 500m
ShrubSw5K	Amount of shrub swamp (Alnus sp.)within 5K

Table 4. Model selection results, Akaike's Information Criteria (AIC), model weights (w_i) and parameters estimated (K) for detectability of Rusty Blackbirds in the Adirondack Region of NY State based on data collected in May-June 2010.

Model	**QAIC**	**ΔQAIC**	w_i	***K***
psi(.), p(temp)	58.72	0.00	1.00	3
psi (.), p(.)	58.83	0.11	0.24	2
psi(.), p(date)	59.42	0.70	0.18	3
psi(.), p(sky)	60.18	1.46	0.12	3
psi(.), p(time)	60.40	1.68	0.11	3
psi(.), p (wind)	60.83	2.11	0.89	3

Table 5. Model selection results, Akaike's Information Criteria (AIC), model weights (w_i) and parameters estimated (K) using site scale parameters to estimate occupancy of Rusty Blackbirds in the Adirondack Region of NY State based on data collected in May-June 2010.

Model	**QAIC**	**ΔQAIC**	w_i	**K**
psi(.),p(temp)	25.82	0	0.12	3
psi(balsam),p(temp)	26.67	0.85	0.08	4
psi(cedar),p(temp)	26.97	1.15	0.07	4
psi(expmud),p(temp)	27.31	1.49	0.06	4
psi(pine),p(temp)	27.42	1.60	0.05	4
psi(heath),p(temp)	27.46	1.64	0.05	4
psi(con<5),p(temp)	27.72	1.90	0.05	4
psi(alder),p(temp)	27.8	1.98	0.04	4
psi(sphag),p(temp)	27.82	2.00	0.04	4

Table 6. Model selection results, Akaike's Information Criteria (AIC), model weights (w_i) and parameters estimated (K) using landscape scale parameters to estimate occupancy of Rusty Blackbirds in the Adirondack Region of NY State based on data collected in May-June 2010.

Model	**QAIC**	**ΔQAIC**	w_i	K
psi(.),p(temp)	27.09	0	0.18	3
psi(Peat10K),p(temp)	27.68	0.59	0.14	4
psi(OpenBog500),p(temp)	28.46	1.37	0.09	4
psi(ConSw500),p(temp)	28.61	1.52	0.09	4
psi(ConSwamp5K),p(temp)	28.69	1.60	0.08	4
psi(Boreal5K),p(temp)	28.84	1.75	0.08	4
psi(OpenBog5K),p(temp)	29.03	1.94	0.07	4
psi(ConScrub500),p(temp)	29.05	1.96	0.07	4
psi(ConScrub5K),p(temp)	29.09	2.00	0.07	4

Table 7. Estimations of Rusty Blackbird occupancy at wetland sites in the Adirondack Region of NY State using site scale covariate models to predict occupancy based on data collected in May-June 2010.

Site	**Psi**	**SE**	**Lower CI**	**Upper CI**
MASW3	0.22	0.03	0.16	0.29
BDB6	0.22	0.03	0.16	0.28
MASW5	0.22	0.03	0.16	0.28
SSRBS3	0.22	0.02	0.17	0.26
MRP1	0.21	0.03	0.16	0.27
BDB2	0.21	0.03	0.15	0.27
MASW4	0.21	0.03	0.15	0.27
RAQS2	0.21	0.02	0.16	0.25
RAQS3	0.21	0.02	0.16	0.25
BDB3	0.20	0.03	0.14	0.26
LONG1	0.20	0.03	0.15	0.26

Table 8. Estimations of Rusty Blackbird occupancy at wetland sites in the Adirondack Region of NY State using landscape scale covariate models to predict occupancy based on data collected in May-June 2010.

Site	Psi	SE	Lower CI	Upper CI
BDB6	0.29	0.06	0.17	0.41
BDB5	0.28	0.06	0.16	0.40
BDB4	0.27	0.06	0.16	0.39
MASW3	0.27	0.05	0.17	0.37
BDB2	0.27	0.06	0.16	0.38
BDB3	0.26	0.06	0.15	0.37
MASW5	0.25	0.05	0.16	0.35
MASW4	0.25	0.05	0.16	0.35
LONG1	0.25	0.05	0.16	0.34
SPB2	0.25	0.03	0.19	0.31
SPB3	0.24	0.03	0.19	0.30

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