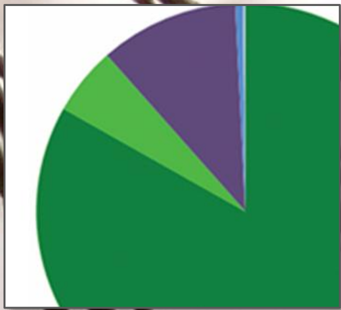

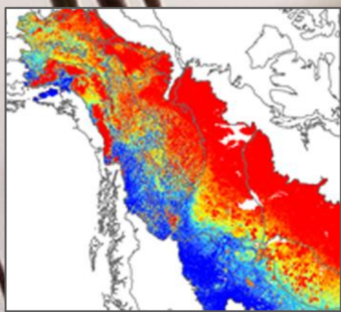

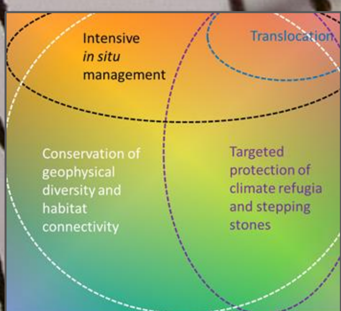


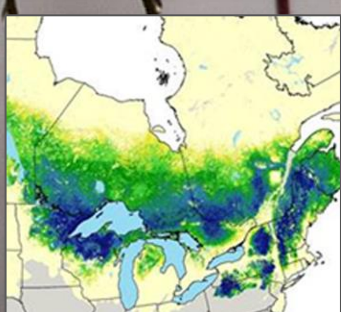

Boreal Avian Modelling Project
Projet de modélisation aviaire boréal

# Boreal Avian Modelling Project

## Annual Report
## April 2016 - March 2017

# The Boreal Avian Modelling Project

The Boreal Avian Modelling (BAM) Project was founded in 2005 to address **critical knowledge gaps** challenging the management and conservation of boreal birds in Canada. BAM develops, distributes, and applies statistical models of **avian populations** and the **impacts of human activity** on boreal bird species. Our work draws upon a powerful database created through a large initial investment in **assembling** and **harmonizing** data from **individual research and monitoring efforts** conducted in the Canadian and US boreal & hemi-boreal forest.

The BAM Project Team is made up of academic researchers, government scientists, project staff, and graduate students. BAM collaborates with federal and provincial governments, academics, industry, and non-governmental organizations with interests in the development and application of science for bird conservation and management. Our research products are applied to many aspects of boreal bird management and conservation, including migratory bird monitoring, population estimation, determination of habitat requirements, population assessment and recovery planning for species at risk, environmental assessment, identification of priority wildlife areas, protected areas design, and land-use planning.

## Our Objectives

1. **ASSEMBLE**, harmonize, and archive avian point-count survey **data.**
2. **DEVELOP** or refine **statistical methods** to analyze these data, to:
    3. **PROVIDE reliable information** on boreal bird distributions, abundances, trends, and habitat associations;
    4. **FORECAST** population consequences of **human activity** and **climate change;**
    5. **CONTRIBUTE** to **conservation**, **management**, and **monitoring** of boreal avifauna and their habitats.
6. **BUILD SUPPORT** for avian conservation in academia, industry, governments, non-governmental organizations, and the public.
7. **FACILITATE** further research efforts by generating testable hypotheses about key mechanisms driving boreal bird populations.
8. **ENCOURAGE** public **awareness** and support **education.**

Learn more at borealbirds.ca

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Photo: White-throated Sparrow, Stan Tupo

## Project Team & Technical Committee

| | |
|---|---|
| Erin Bayne, U.Alberta | Steering Committee |
| Steve Cumming, U.Laval | Steering Committee |
| Fiona Schmiegelow, U.Alberta | Steering Committee |
| Samantha Song, ECCC | Steering Committee |
| Nicole Barker, U.Alberta | Coordinating Scientist |
| Trish Fontaine, U.Alberta | Database Manager |
| Péter Sólymos, U.Alberta | Statistical Ecologist |
| Diana Stralberg, U.Alberta | Project Ecologist |
| Mélina Houle, U.Laval | GIS Technician |
| Francisco Dénes, U.Alberta | Post-doctoral Fellow |
| Lionel Leston, U.Alberta | Post-doctoral Fellow |
| Alberto Suarez-Esteban, U.Alberta | Post-doctoral Fellow |
| Tara Stehelin, U.Alberta | PhD Candidate |
| Samuel Haché, ECCC | Contributing Scientist |
| Lisa Mahon, ECCC | Contributing Scientist |
| Steve Matsuoka, USGS | Contributing Scientist |
| Judith Toms, ECCC | Contributing Scientist |
| Steve Van Wilgenburg, ECCC | Contributing Scientist |
| Alana Westwood, Independent | Contributing Scientist |
| Marcel Darveau, DUC / U.Laval | Technical Committee |
| André Desrochers, U.Laval | Technical Committee |
| Pierre Drapeau, UQAM | Technical Committee |
| Charles Francis, ECCC | Technical Committee |
| Colleen Handel, USGS | Technical Committee |
| Keith Hobson, UWO | Technical Committee |
| Craig Machtans, ECCC | Technical Committee |
| Julienne Morissette, DUC | Technical Committee |
| Gerald Niemi, U.Minnesota | Technical Committee |
| Rob Rempel, OMNR / Lakehead U. | Technical Committee |
| Stuart Slattery, DUC | Technical Committee |
| Phil Taylor, BSC / Acadia U. | Technical Committee |
| Lisa Venier, CFS | Technical Committee |
| Pierre Vernier, U.Alberta / BEACONs | Technical Committee |
| Marc-André Villard, UQAR | Technical Committee |

Photo: Jeff Ball

# Highlights from 2016-17

**How does BAM operate?** We pursue work within three parallel but inter-connected domains: research & monitoring, application & collaboration, and data development. We conduct research, create, apply, & share new statistical approaches; develop, distribute, & apply data products; and communicate our findings in papers, reports, presentations, & webinars. Here we've summarized our main achievements from April 2016 to March 2017.

## Research & Monitoring

### Detecting & Attributing Population Changes

- Our pan-boreal analysis of impacts of human industrial activities on birds found significant negative effects on bird densities, highlighting the importance of careful planning for these activities to support long-term conservation of boreal birds. → pg 7
- An exploratory analysis suggests that breeding ground factors explain more inter-annual variation in breeding abundance than do wintering ground factors, for 37 long-distance migrants. → pg 7
- While our local scale models of energy sector impacts on bird populations in the Alberta oil sands showed poor ability to predict actual population numbers, they showed a reasonable ability to rank regions based on predicted bird abundances. → pg 8
- In our effort to synthesize our work exploring human impacts on birds in the Alberta oil sands, we've added a 'zone of impact' method to the existing 'dose-response' and 'control-impact' methods. → pg 9

### Forest Management

- We demonstrated some of the ways 25-years of data from the Calling Lake Fragmentation Project can be used to explore impacts of forestry on boreal birds. → pg 10
- We've initiated efforts to offer a data-driven answer to "how does breeding bird density vary among forest stands of different ages, heights, and tree species compositions?" → pg 10

### Climate Change

- We created new climate refugia maps for 53 species; these are being used in the Northwest Boreal Landscape Conservation Cooperative's conservation assessments. → pg 12
- We developed a framework for evaluating climate change vulnerability of boreal birds and potential conservation actions to be taken. → pg14

### Advancing Methods

- We developed a method of estimating short-term population trends based on changes in habitat supply using density models built from environmental and point-count data. → pg 15
- Species detectability is predictable based on species traits and the singing behaviour of closely related species, justifying the use of detectability estimates from similar species in data deficient situations. → pg 16
- We updated our methods to correct for detection probabilities, leading to updated estimates of singing rates and effective detection radii for 141 species. → pg 18
- Our method to integrate data from automated recording units (ARUs) and human-based point counts is ready to be applied. → pg 16

### Avian Distributions, Abundances, & Habitat Needs

- Our analytical framework model describing Canada Warbler density across the North American boreal region is complete and being written up for publication. → pg 19
- Behavioural observations of Common Nighthawks suggest that generating density models may not be possible for this species; we are currently exploring other ways of quantifying important habitat for the species. → pg 21

### Informing Surveys & Monitoring

- When quantifying the habitat representation within our point-count database, we found undersampling of sparse, open forested habitats, wetlands, and recently disturbed habitats. → pg 22

# Application & Collaboration

### Informing Conservation & Management Actions

- Our newest team member will focus on science to support critical identification for Canada Warblers, Olive-sided Flycatchers, and Common Nighthawks. A revised workplan is nearly finished. → pg 24
- Our joint-hosted Conservation of Boreal Birds (COBB) workshop generated interest for greater communication and collaboration among participants. → pg 29
- We completed our efforts to explore priority areas within the boreal region in collaboration with Environment and Climate Change Canada (ECCC) and are preparing the results for publication. → pg 26
- BAM team members have supported a project to identify guidelines and locations for habitat management that will support Canada Warblers in Bird Conservation Region (BCR) 14. → pg 27
- We received funding from the Sustainable Forestry Initiative (SFI) and NSERC and started hiring and scheduling for these collaborative projects exploring beneficial forest management practices for boreal birds. → pg 28

### Action Through Collaboration

- Initial exploration in collaboration with ECCC's Boreal Monitoring Strategy suggests that the BAM dataset offers relatively low capacity for estimating long-term trends of boreal birds, due to the short time series of data offered by most studies. → pg 29
- BAM contributed, either directly or through supplying data products, to over 20 different collaborative efforts over the past year, involving NGOs, governments, and academic partners with regional, national, continental scopes. → pg 32

# Data Development

### Data Products for Distribution

- Products available, publicly through Data Basin or by request, include: national density maps for 103 songbird species and 17 waterfowl species or species groups, climate-change projections for 103 species, maps of climate refugia, maps of species' probabilities of occurrence, and a number of tabular datasets. → pg 35

### BAM Databases

- Our Avian Database contains almost 8 million bird observations from nearly 1 million point-count surveys, submitted from 150+ projects, covering more than 260,000 locations. → pg 37
- We're preparing BAM's Avian Database for integration of automated recording unit (ARU) data and data from eBird. → pg 38
- We identified a three-step process for making the BAM Avian Database public in an aggregated format, and will be reaching out to data partners in the near future to secure approval where applicable. → pg 38
- We created a Wiki-style webpage to summarize all spatial datasets we have used in models. It is currently meant for internal purposes, but we intend to make it publicly available after passing interval review. → pg 39

# Communications

### Web Presence

- We identified key areas for improvement on our website and data product distribution portal, and will implement the changes in 2017-18. → pg 41
- We discovered and fixed an error on our website that lost messages sent via the Contact Use form for much of 2016. We're very sorry for the inconvenience this caused. → pg 41

### Outreach & Publications

- BAM efforts resulted in 5 papers in peer-reviewed journals, over 25 talks, poster, or workshop presentations, 1 webinar, and 2 reports posted to the BAM website. → pg 34

# Project Management

### Team Structure

- Francisco Dénes joined the BAM team as a post-doctoral fellow conducting science to inform critical habitat identification for species at risk. → pg 46

# Research & Monitoring

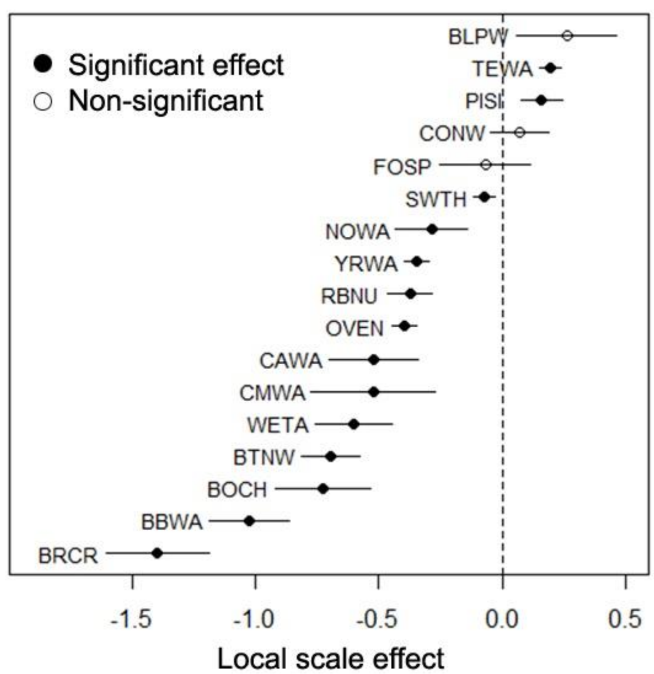
## Detecting & Attributing Population Changes

This past year, we drafted a manuscript outlining our analyses of human impact at national extent, and we explored some analyses to identify breeding and non-breeding drivers of boreal-breeding bird populations. We also continued our work exploring impacts of energy sector development, and contrasting population estimates derived from different modelling approaches.

### Effects of anthropogenic disturbances on boreal birds at national extent

In 2016-17, we continued our efforts to quantify impacts of human disturbance on bird populations at a national extent. Our results suggest the importance of careful planning of industrial activities to support the long-term conservation of boreal birds and the ecological functions they perform. We presented this work at the North American Congress for Conservation Biology in August 2016. A manuscript is being reviewed by co-authors, with expected submission to Conservation Biology or a similar journal in Spring 2017. [Contact: Alberto Suarez-Esteban]

**Effects of disturbances at local and neighbourhood scales.** We identified surveys affected by permanent (e.g., roads, seismic lines, well pads, mining) and transitional (forestry operations) disturbances. At the local scale (~3 ha), point count surveys with up to 30% of disturbed area were mostly affected by permanent disturbances, while the remaining disturbed surveys were mostly affected by transitional disturbances. At the neighborhood scale (~75 ha), point count surveys with up to 15% of disturbed area were mostly affected by permanent disturbances, while the remaining disturbed surveys were mostly affected by transitional disturbances.




We modelled species' counts using generalized linear mixed models (GLMMs) with Poisson distribution and a log link. Covariates and random effects accounted for variability in mean density associated climate, large-scale habitat selection, spatial autocorrelation, and temporal patterns. BAM offsets corrected for species detectability and methodological differences among surveys (Sólymos et al. 2013).

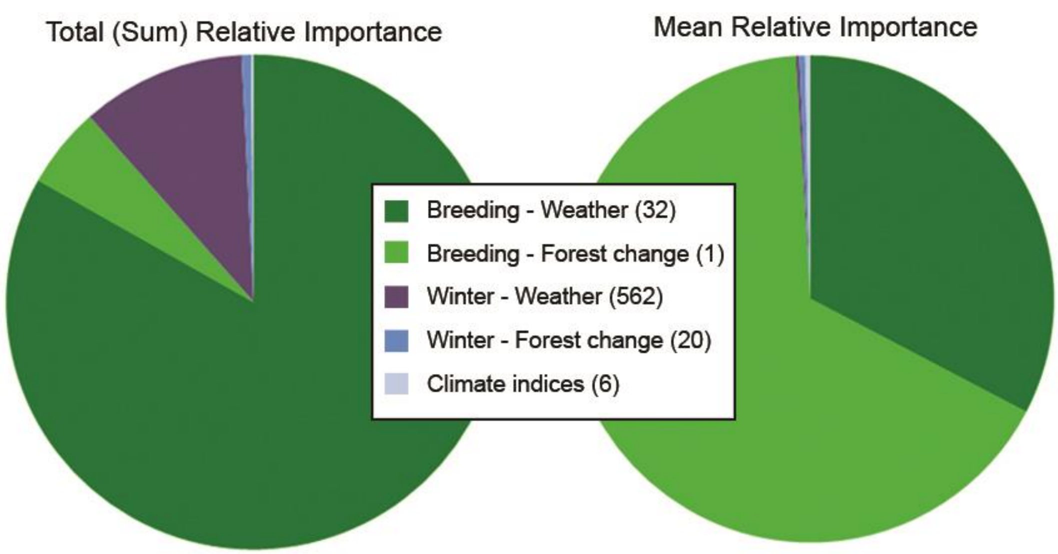
Preliminary results suggest a significant negative effect (filled circles) of local disturbances for 12 of 17 songbird species, with density reductions ranging from 6% to 75%, and a significant negative effect of neighborhood disturbances for 10 of 17 species, with density reductions ranging from 14% to 70%.

## Identifying drivers of inter-annual variability in breeding bird abundance

The conservation of migratory bird populations is complicated by the need to assess factors influencing their populations on the breeding grounds, their wintering locations, and along their migration routes. Unfortunately, we lack detailed information on how specific populations are connected for many species, and amassing pre-existing and forthcoming information on migratory connectivity for dozens of species could impede timely conservation. We are exploring possibilities for identifying breeding and non-breeding ground drivers of the breeding population as captured in the BAM Avian Database.

Overall, our preliminary results suggest that breeding ground factors explained more variation in abundance of 37 long-distance migrant species, but a wintering ground signal was also observed. We're currently revising existing analyses to restrict spurious correlations and to account for spatial structuring in the data. We aim to complete a draft manuscript in 2017-18. [Contact: Diana Stralberg]

**Importance of breeding ground factors.** Using BAM data, we employed a machine learning approach to rapidly identify hypotheses for climatic and land-cover factors acting on the wintering and breeding grounds that could drive population change for each of 37 long-distance migrant species.




Combining results across species, the first major finding was that breeding ground factors (weather and forest change) had the greatest influence on inter-annual fluctuations in species' breeding populations. Here, relative importance is a measure of how much of variation in breeding bird abundance is explained by each of these types of drivers. Breeding ground variables were most important based on total relative abundance.

However, if we adjust the relative importance for the number of variables contributing to the effect, we see that the single most predictive variable is forest change on the breeding ground.

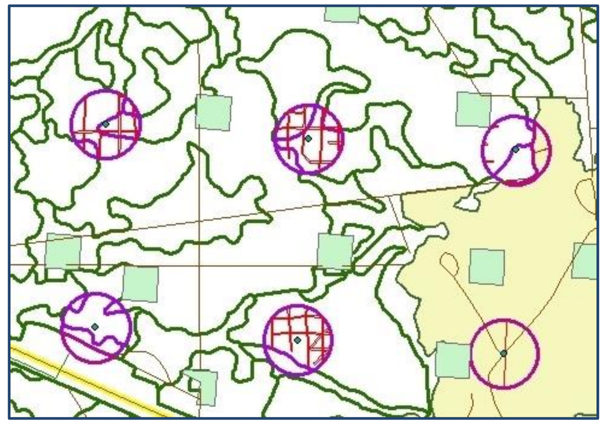
## Direct and indirect sector effects in Alberta

As part of the Alberta models built in collaboration with the Alberta Biodiversity Monitoring Institute (ABMI) through the JOSM program (page 20), we are assessing impacts of different sectors of human development on birds. Survey data from 2015 were added to the dataset and model methods were slightly updated. We anticipate drafting a manuscript in 2017-18. [Contact: Péter Sólymos]

## Evaluating cumulative effects of human activities on birds in the Alberta Oil Sands

BAM and collaborators have used several different models to examine the effects of human activity on bird populations in the oil sands region including analyses at local spatial scales (individual point counts as replicates) where cumulative effects are measured using dose-response methods (Sólymos et al. 2014, 2015) or control-impact methods (Bayne et al. 2016). We are now trying to compare and synthesize results from the various methods. In 2015-16, we contrasted predicted population size based on cumulative effects as calculated using Sólymos' (2015) method (page 20) and Bayne et al.'s (2016) method (page 8). In 2017-18, we are applying a third method to generate predictions (zone-of-impact, based on point count distance from human footprints), which will be compared to results from the other methods. [Contact: Lionel Leston]

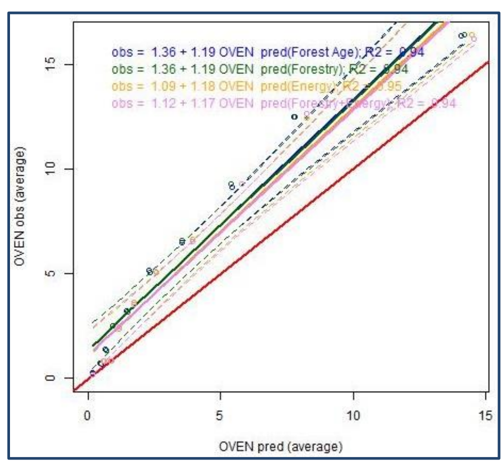
**Three methods of evaluating cumulative impacts**. For each 100-m point-count survey (purple circles) within this landscape of unharvested boreal forest stands (green outlines), cutblocks (yellow patches), roads (yellow), seismic lines (brown), and well-pads (green squares), we quantified human impact in three different ways. Area or proportional amount of each footprint within each point count enables calculation of dose-response effects of human footprint. Classifying each point count as within or having a particular type of human footprint enables calculation of control-impact effects. Distances from the centre of each point count to nearest cutblock, seismic line, road, pipeline and well-pad enable calculation of zone-of-impact effects of human footprint.



We have built models using all three methods at local spatial scales for Ovenbirds and are currently comparing the results among the three methods for both additive and cumulative effects models.

## Predicting population-level effects from local scale models of energy sector impacts

In 2015-2016, we assessed the ability of our local-scale impact models (Bayne et al. 2016) to accurately predict landscape abundance of species. In 2016-2017 we presented results from this manuscript at the North American Ornithology Conference and submitted a manuscript to Environmental Monitoring and Assessment, which was not accepted. We will be revising the manuscript for submission to Ecological Indicators at the end of May, 2017. [Contact: Lionel Leston]




We used habitat and human footprint models from separate point count studies (local scale ~ 7 ha) to predict abundance of 64 boreal bird species within 63-ha landscapes. Although prediction ($R^2$) was generally better for regionally abundant species and habitat specialists during internal validation, our local scale models were better at ranking landscapes according to species' predicted abundance or presence/absence than predicting actual abundance per landscape. Some species were overestimated or underestimated; overestimation was generally reduced and sometimes eliminated by removing potential outliers with unusually high predicted abundance counted due to correction factors in those few landscapes. Combining landscapes into groups according to predicted abundance of a species and predicting average landscape abundance resulted in higher $R^2$ (>0.50 for most species) than predicting abundance in individual landscapes. For example, at right: predicted and observed average number of Ovenbirds per landscape.

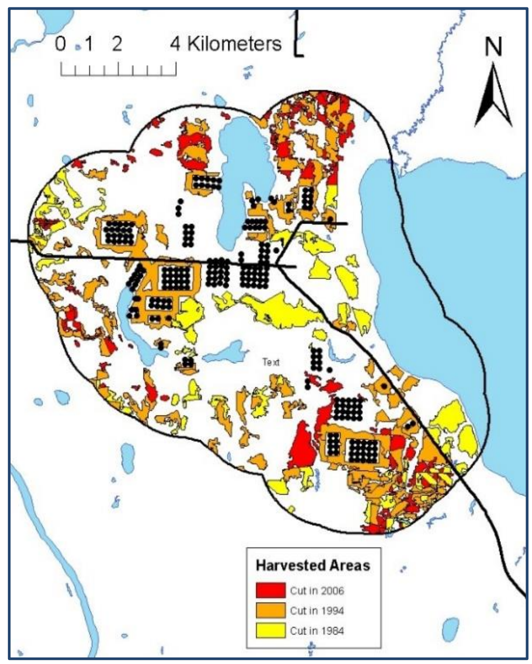
# Forest Management

In the past year, we quantified avian response to forest fragmentation using a long-term experimental dataset, and we are evaluating a tool to enhance avian conservation during forest management in the interior of British Columbia.

## Long-term data and forest management scenarios to explore avian response to forest structure and management

Long-term effects of changes in extent, structure, and configuration of Alberta's boreal forest resulting from forestry and development are unknown because most studies are short-term and observational. In collaboration with Alberta-Pacific Forest Industries (Al-Pac), we are using 24 years of experimental forestry data from the Calling Lake Fragmentation Project (Schmiegelow et al. 1997) to quantify effects of forestry and forest regeneration on boreal birds. In 2016-17, we explored multi-season occupancy models and other approaches for exploring impacts on boreal birds.

In 2017-18, we will build habitat models that can be linked to output from forest management planning software. These scenario analyses will attempt to estimate impacts on boreal bird populations resulting from various management options Al-Pac could employ, including a strategy that emphasizes caribou conservation. We anticipate having preliminary results within the 2017-18 fiscal year. [Contact: Lionel Leston]



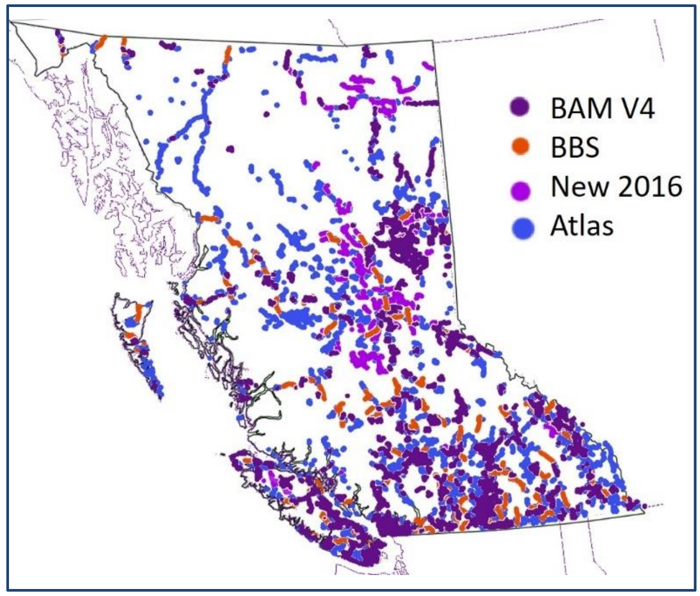

**Colonization in control and cut sites**. We used multi-season occupancy models to explore changes in Black-throated Green Warbler abundance in intact (control) sites versus cutblock sites. We found that initial site occupancy by the species was higher in control sites than in new or older cutblocks, and that colonization of new sites was more likely in control points than in cutblocks. However, the probability of colonization of a cutblock increased as the cutblock aged.

## Conservation value of forest stand types in British Columbia

Forest products companies are required to avoid destroying birds or nests during their logging operations. Forest companies in British Columbia have created a risk matrix tool to minimize impacts on populations. In 2016-17, BAM was recruited to evaluate their risk matrix using the BAM dataset and methods to estimate bird density. To date, we have collected more point count data, quality-checked the covariate data to be used in modelling, and identified where additional point counts would be beneficial. We will complete analyses and describe results in a report and/or manuscript during 2017-18. [Contact: Nicole Barker]

**Testing a risk matrix**. The risk matrix assigns each forest stand a rank representing its expected nest density based on Biogeoclimatic Zone, tree species group, forest age, and forest height. These ranks were determined based on general ecological principles, such as the understanding that birds will prefer more complex forests, represented as an interaction between forest age and height. To evaluate the matrix, we will model total bird density as a function of the same four attributes and contrast matrix ranks to our predicted density. We also intend to create species abundance models for target species to create maps of density for all forest stands, which could complement the matrix by identifying stands likely to contain species of conservation concern.

As of March 2017, we have data from ~36,000 point-count surveys across British Columbia. Almost half of the 3360 unique combinations of forest stand attributes were sampled by at least one point count.

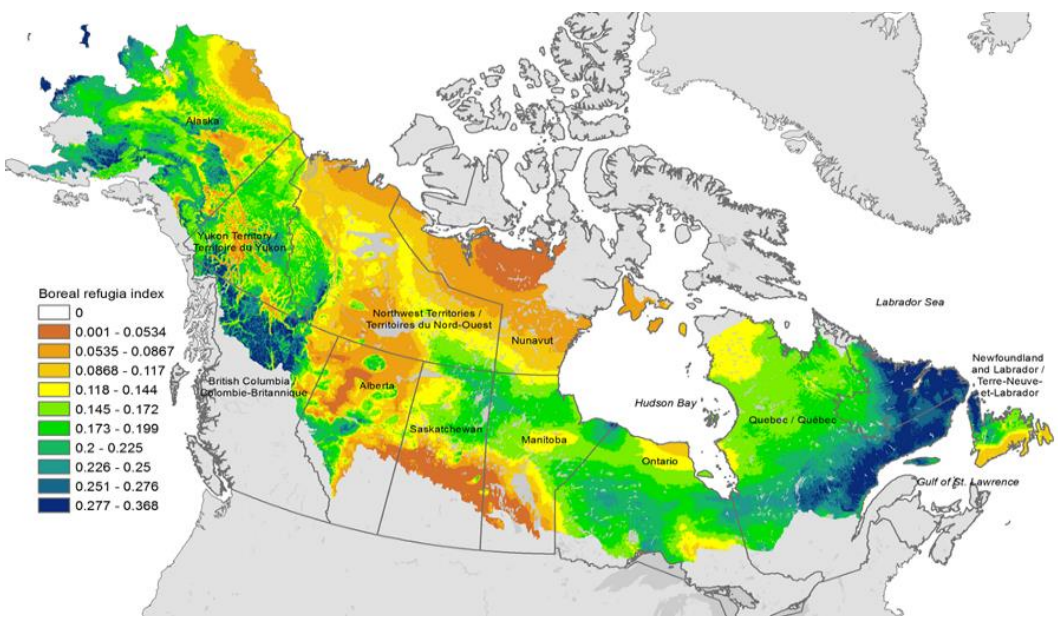


# Climate Change

This past year we continued work to identify climate-change refugia for use in conservation assessments. We also revisited work projecting avian response to interactions between fire and climate change in Alberta and Alaska. We continued work to understand possible timing mismatch between boreal songbirds and their insect prey, and we initiated a review of climate change impacts on boreal birds.

## Identifying climate-change refugia for boreal songbirds

Through 2016-17, BAM worked with Boreal Ecosystems Analysis for Conservation Networks (BEACONs; www.beaconsproject.ca) and the AdaptWest (adaptwest.databasin.org) project to introduce climate-change refugia for boreal birds into the prioritization approach. These refugia are new in that they are based on how quickly species must shift their distribution ranges to remain within constant climatic conditions. These refugia for six focal species are being used as one factor in conservation assessments for the Northwest Boreal Landscape Conservation Cooperative (NWB LCC). In related work, we developed new climate refugia maps for 53 species and created a combined refugia map, which is included our climate change review paper (page 14). [Contact: Diana Stralberg]

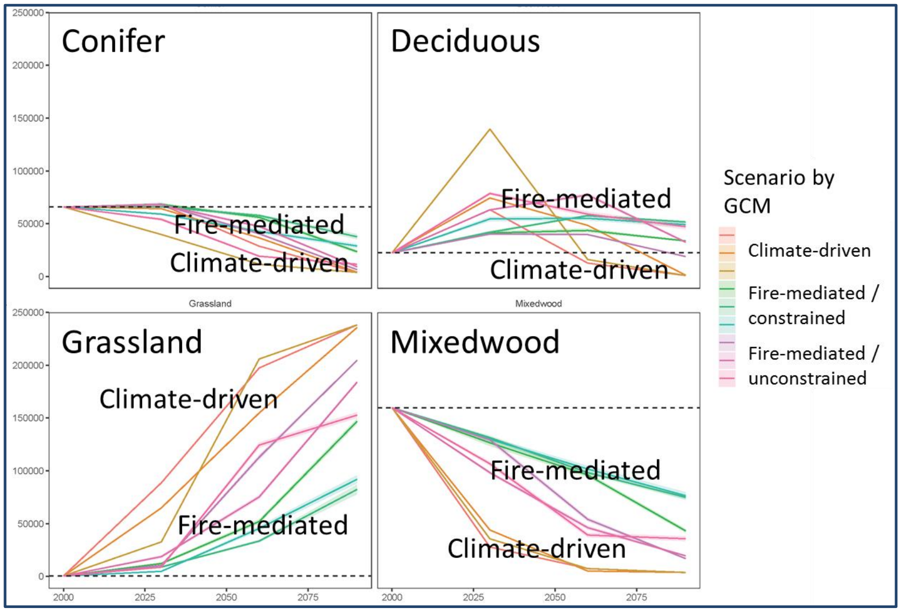



**Multi-species end-of-century velocity-based refugia map**. We averaged single-species indices to derive this combined map. Areas of highest combined future refugia potential (dark blue) include western mountain regions and eastern coastal regions with a maritime influence. These areas represent the most efficient options for protecting current boreal forest species and communities. Areas of low refugia potential (orange) reflect areas of rapid change (i.e., high biotic velocity) that are likely to harbor novel communities in the future, due to variation in how quickly species can respond to climate change. As such, they provide important opportunities for monitoring and possible conservation intervention. Robust conservation strategies should include both high- and low-velocity regions.

## Understanding bird response to climate change by simulating future landscapes

As part of D. Stralberg's PhD thesis, we used simulation tools to identify realistic rates and spatial patterns of future vegetation change in northern Alberta, and quantify the difference between climate-driven and "fire-mediated" vegetation change potential. In 2016-17, follow-up work involved regional stratification of model parameters and an update to more recent climate models. This work will be described in a manuscript forthcoming in 2017-18. [Contact: Diana Stralberg]

**Simulating fire regimes using the Burn-P3 tool.** Simulation results showed that current fire regimes, under future climate conditions, are enough to result in approximately a 50% loss in boreal conifer and mixedwood forest in Alberta by 2100, based on fire-mediated vegetation conversions. Additional increases in the number and duration of fires ("unconstrained" fire regime) would further accelerate vegetation change, approaching the extreme loss of conifer and mixedwood forest suggested by climate-driven niche model projections.




## Species vulnerabilities to climate-mediated landscape change across Bird Conservation Region (BCR) 4

In 2015-2016, the University of Alaska Fairbanks completed simulations of future landscapes for the region using Boreal ALFRESCO (ALaska FRame-based EcoSystem Code). These simulations show an increase in fire activity across the region which will reduce overall forest age and cause a shift in forest dominance by spruce to dominance by deciduous trees. In 2016-17, we will develop density models for the region that can be linked with the future simulated landscapes to project bird response to climate-mediate landscape change [Contact: Steve Matsuoka].

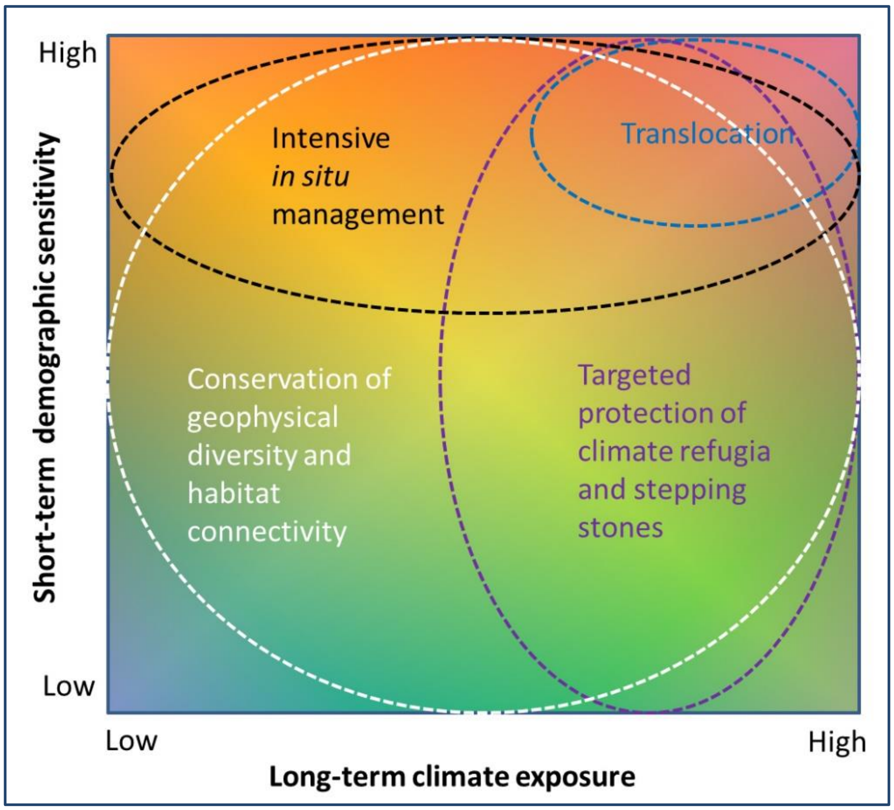
**Specific objectives**. 1) Identify important geographic areas and habitats currently supporting high breeding densities; 2) Identify geographic areas with large projected increases and decreases in density, as well as stable climate-change refugia; 3) Provide a synthetic vulnerability assessment of characteristics of habitats, geographic areas, and species within this region that may render them most vulnerable to effects of climate change; 4) Examine species vulnerability to landscape change relative to the public lands estate across the region, and demonstrate how agency responsibilities for species conservation will change through time.

## Timing mismatch between the breeding seasons and insect prey of two aerial insectivores


One predicted negative impact of climate change on birds is the mismatch in timing between insect abundance and the breeding season. In this project, Tara Stehelin (BAM PhD Student with Fiona Schmiegelow) is looking at the peak abundance of preferred insects in relation to the peak energetic demands of Olive-sided Flycatchers and Western Wood-pewees feeding insects to young. In 2016-17, insects from the 2016 field season were sorted and identified to Order, then weighed. In 2017-18, previously-created predator-prey models will be updated with the data collected from four seasons. [Contact: Tara Stehelin]

## Review of climate-change impacts on boreal birds

BAM is contributing several papers to the Conservation of Boreal Birds special issue of Avian Conservation and Ecology (page 29). One of these is a review paper summarizing climate-change implications for the conservation of boreal birds, entitled "Conservation planning of boreal birds in a changing climate: A framework for action." The paper builds heavily on BAM's previous modelling and climate-change projection work, as well as ongoing climate refugia identification. A complete draft is expected early in 2017-18. [Contact: Diana Stralberg]




**A framework for discussing climate change vulnerability of boreal birds**. Recommended climate change actions depend on a combination of short-term demographic vulnerability and long-term climate vulnerability. Although populations of most boreal bird species are currently stable, many are particularly vulnerable to climate change, based on expected future reductions in habitat. We developed a framework for action based on the intersection of these factors.

# Advancing Methods

We refined our method of estimating trend based on habitat supply at national extent, we updated our imperfect detection correction method, and we revamped our analyses of detectability in relation to life history traits. We also continued efforts to integrate data collected using automated recording units (ARUs) and humans, both on-roads and off.

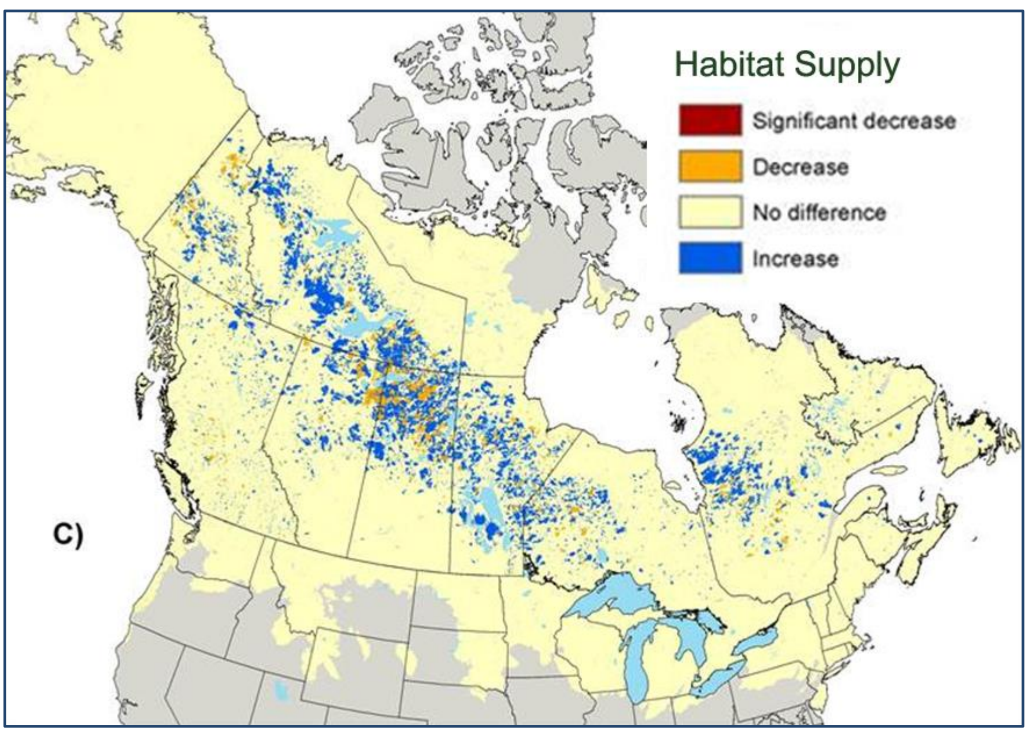
## Estimating short-term population trends based on habitat supply

Estimating population trends in the boreal region is difficult due to limited and spatially-biased data. Over the past several years, we have explored methods to calculate trends by combining off- and on-road data from the BAM dataset with the on-road data of the Breeding Bird Survey (BBS) data. During 2016-17, we presented some ideas and preliminary results at a webinar (page 43) and discussed the topic with members of the Environment and Climate change Canada (ECCC) Landbird Technical Committee.

Our current 'year effect' and 'residual trend' methods are described in our manuscript about our North American Canada Warbler density models (page 19). While we will continue to explore methods of estimating trends, it is not a priority project in 2017-18. [Contact: Péter Sólymos]

**Population trends and changes in habitat supply.** We estimate trends from our national Canada Warbler model as the expected density based on variation in the amount of habitat. The "year effect" indicates percent annual trend, how much the population changed on average each year, from 2002 to 2012, after accounting for all other variables in the models. We calculated this trend for Canada Warblers nationally and within provinces and BCRs where Canada Warblers were observed.

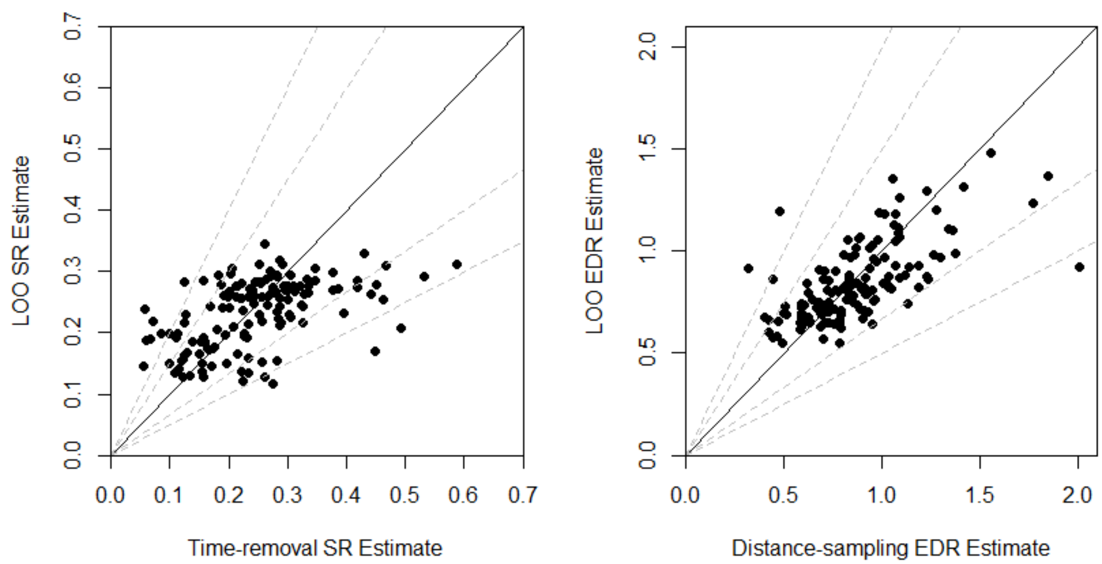
We found little evidence that changes in habitat supply should have influenced Canada Warbler population size between 2002 and 2012.



## Understanding detectability to improve and validate our models and methods

BAM periodically revisits our methods to correct for detection probabilities, which rely on assumptions regarding species detectability. In 2015-16, we revisited some work we started in 2012-13 that examined how species' detectability was influenced by life history traits under selection pressure. During 2016-17, we changed the focus and analyses of the paper to evaluate how well we can estimate how easily detectable a species might be based on known data from other species in the absence of field observations. A draft manuscript has been circulated to co-authors for contributions; we expect to submit in 2017-18. [Contact: Péter Sólymos]

**Approximating species detectability in absence of field data**. Our QPAD method generates singing rate and effective detection radius (EDR) estimates for each species with associated uncertainties (Sólymos et al. 2013, Sólymos 2016). We assessed how well these could be approximated based on phylogenetic relationships and species traits such as song pitch, body mass, migratory status, and habitat associations. Using a phylogenetic mixed model and leave-one-out (LOO) cross-validation framework, we found that EDR was well explained by covariates, especially habitat association (open vs. forested habitats) and body size, but displayed no unaccounted phylogenetic signal. Singing rate (SR) was related to song pitch and migratory strategy, and had a strong phylogenetic signal not accounted for by covariates.

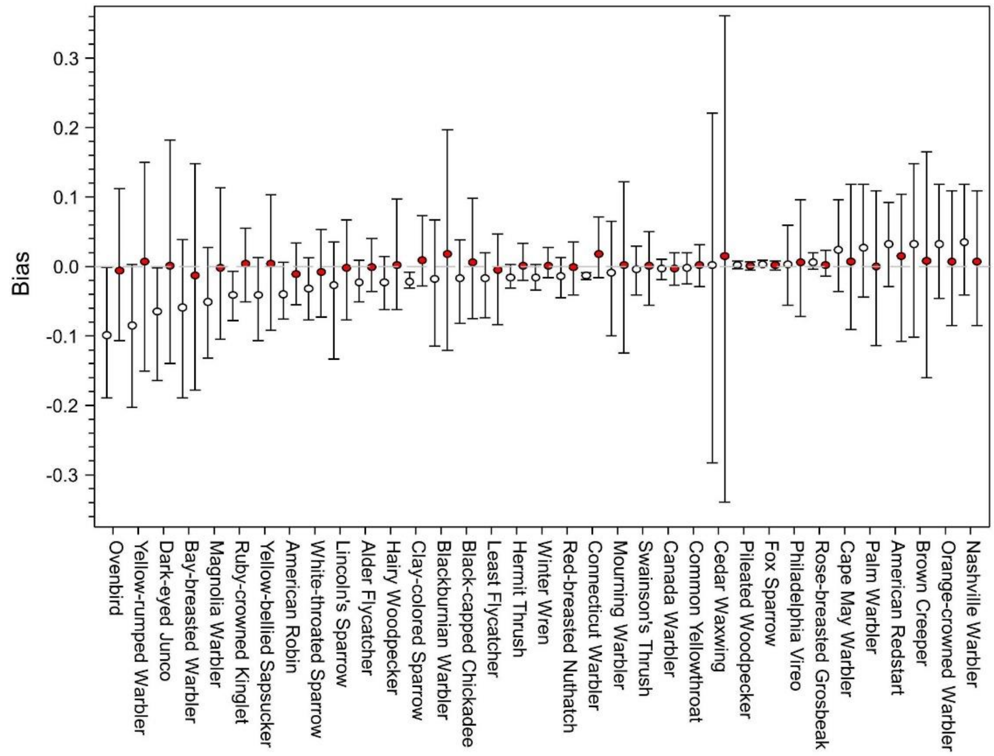



These findings indicate that detectability is predictable based on physical constraints posed by sound attenuation and singing behaviour of closely related species. This would justify using estimates of similar species in data deficient situations.

## Integrating data from automated recording units (ARUs) and traditional point-count surveys

Acoustic recordings are increasingly used to quantify occupancy and abundance in avian monitoring and research. These new data create a new challenge for integration with human-based point count data. In 2016-17, BAM contributed to two manuscripts describing experiments comparing these two data types. One of these manuscripts has been accepted for publication in Avian Conservation and Ecology (ACE-ECO) and the other has been revised and resubmitted to the same journal. [Contact: Steve Van Wilgenburg]

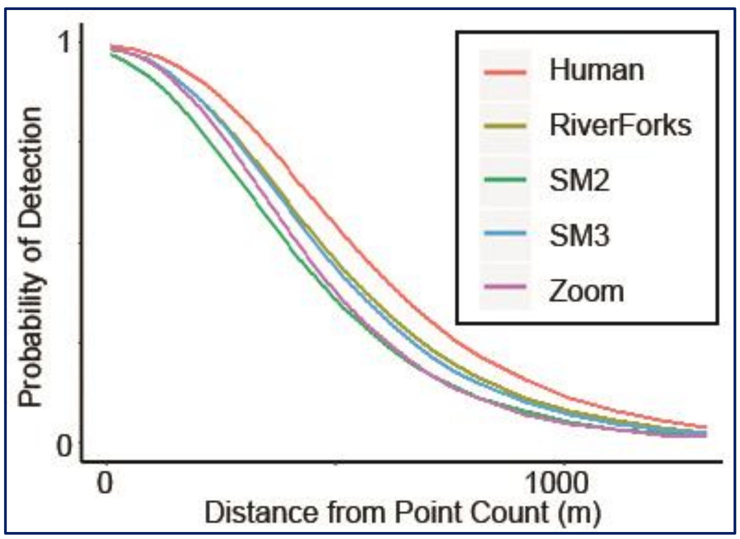
**Paired sampling to integrate ARU and human point count data**. We describe how paired sampling can be used in conjunction with GLMs or GLMMs to estimate correction factors (δ) to remove biases between autonomous recording units (ARU) and traditional point counts.




We used data from 363 point count stations in 105 unique boreal study sites, in which we simultaneously conducted human based point counts and recorded the bird community with ARUs.

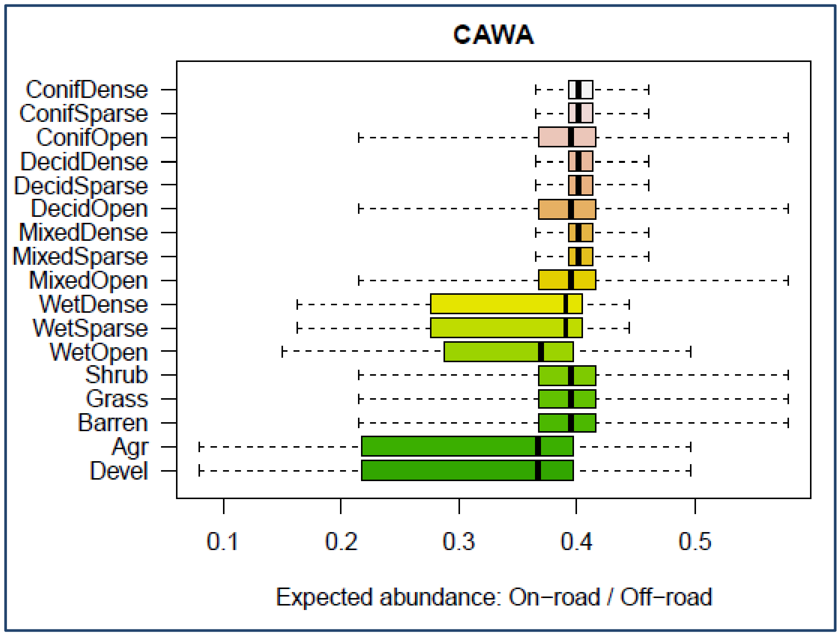
Here we show bias in estimated densities (birds/ha) for 35 species of boreal forest birds from point count data derived from autonomous recording units (ARUs) compared to densities derived from human point counts conducted at the same time and location. Densities from human point counts were derived by adjusting counts for biases in availability (p) and perceptibility (q) using the QPAD approach (Sólymos et al. 2013). Densities from ARU surveys were derived by applying QPAD offsets from human observer data (open circles), versus adjusting the offsets to account for the scaling constant δ (closed red circles) estimated from GLMM models that included survey type as a fixed effect factor. Bias was estimated from fitting models to 70% of the study sites and validated against the withheld external validation sites (30%) over 50 repeated random sub-samples of the data. The results suggest that our method removes systematic biases in counts between ARUs and human observers. Our method is easily implemented and will facilitate the integration of ARU and human observer point count data, facilitating expanded monitoring efforts and meta-analyses with historic point count data.

**Sound transmission experiments to compare ARUs and people.** Daniel Yip (PhD student with the University of Alberta-Bioacoustics Unit), with contributions from BAM team members, compared detection distances between human observers in the field and four commercially-available recording devices using a broadcast-recording experiment to simulate vocalizations of various avian species at different distances and amplitudes. He found that humans can detect sounds at greater distances than ARUs although it depends on species song characteristics. Results from the experiment were used to calculate correction factors for standardizing detection distances of ARUs relative to each other and human observers.




## Integrating roadside and off-road point count data to model boreal bird populations

Combining on- and off-road surveys improves sample sizes, the spatial and temporal coverage, and the number of species that models can be built for. However, we know that roadside surveys are biased compared to off-road surveys (Yip et al. 2017). We've explored several approaches over the past few years; in 2016-17, we settled on a combination of design- and model-based approaches for integrating on- and off-road data in our national (page 19) and regional density models. [Contact: Erin Bayne]




**Correcting for roadside bias**. The design-based element means that we filter out 'worst offenders' where our data analyses and simulations suggested roadside bias is expected to be maximal. We exclude surveys made along wide roads (i.e. highways). Model-based approaches include the estimation of modifying variables related to the presence of a road, or the proportion of linear features within 150 m radius circular buffers around point count locations. We also consider interactions between land cover type (open/closed canopy, forest composition) and the effects of road. These methods allow us to account for the roadside related bias in our density models. Corrected densities are then used for prediction purposes. Without proper attribution of the effects of linear features (e.g. numeric vs. behavioural responses, direct habitat loss vs. indirect edge effects), it is still challenging to consider linear features (roads, seismic lines, pipelines, transmission lines) in predictions and forecasting of population density.

In our Alberta-specific density model, we found that Canada Warbler abundance at roadside sites was 79% that of off-road sites (Ball et al. 2016).

## Developing and refining other methods

- We finalized our methods to map density and estimate population size for the North American boreal region, using Canada Warbler as a case study (page 19)
- We updated the method and posted online the documentation for the QPAD method (Sólymos 2016) along with estimates of singing rate and effective detection radii for 141 species. These are part of the updated QPAD R extension package available at https://github.com/psolymos/QPAD.

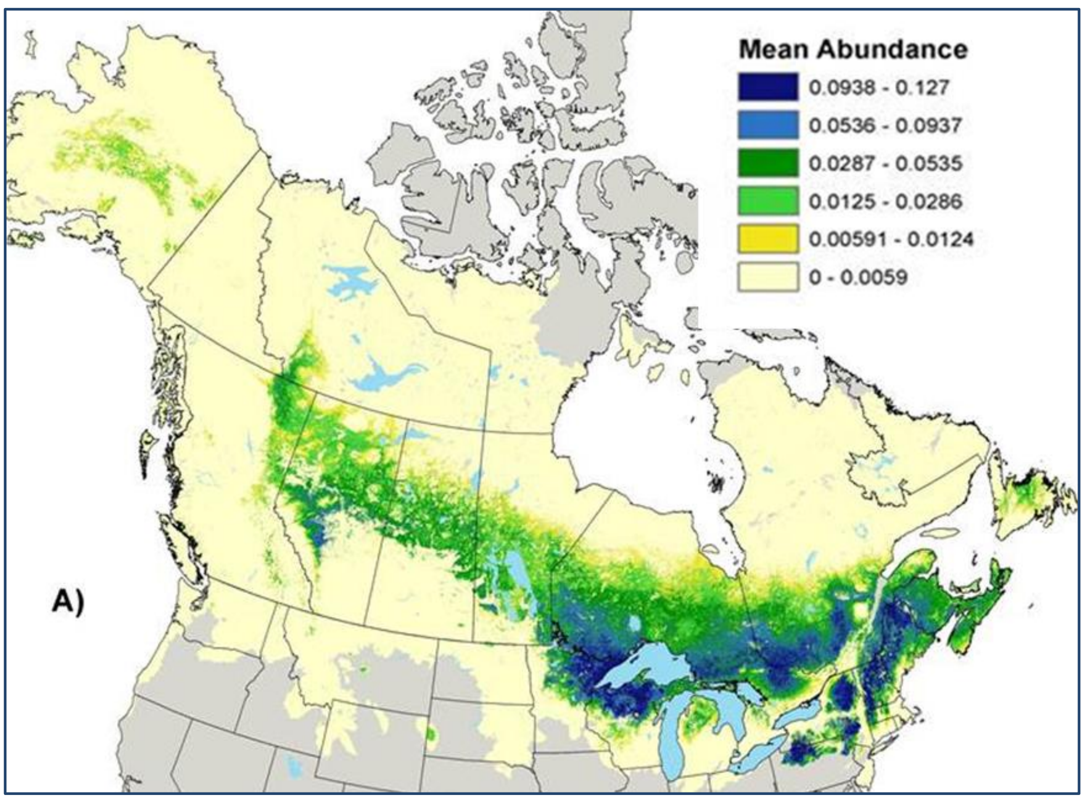
# Avian Distributions, Abundances, & Habitat Needs

We finalized our national Canada Warbler density model, and we're working on regional models for Western Wood-pewee and Olive-sided Flycatchers. We're also contributing to work understanding Common Nighthawk habitat use, for application to critical habitat models.

## National distribution, abundance, and habitat associations of Canada Warblers

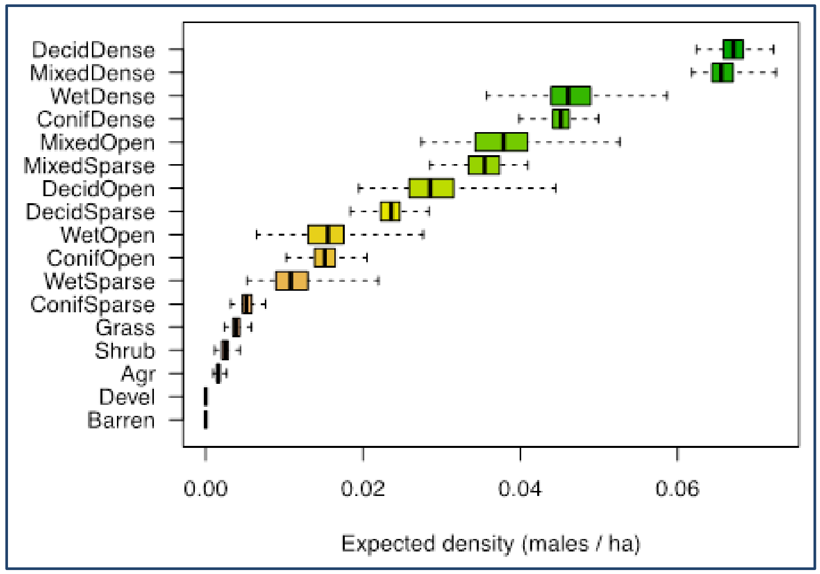
This past year, we finalized our national density model for Canada Warblers. This project, initiated in 2013-14 was intended to build national density maps, to identify biophysical attributes that support high densities of Canada Warblers, and to generate population size estimates. After several rounds of revision and improvements to the methods, we finalized our Canada Warbler model in 2016-2017. Changes for this year's model included: use of more point count data, addition of spatio-temporal biophysical attributes, and prediction to a larger spatial extent.

Our models indicate higher densities of Canada Warblers in older deciduous forests with canopy height between 15-20 m. The estimated 2012 breeding population size was 15.4 million individuals. These models will contribute to BAM's support of critical habitat identification for Canada Warblers (page 24). A manuscript describing this work will be submitted in 2017-18. We plan to apply this analytical method to all species with sufficient data in the BAM database, to produce updated density maps, population estimates, and habitat associations. [Contact: Samuel Haché]




**Canada Warbler density - finalized.** As in previous years, point-count data were modelled as a function of land cover, disturbance, topography, climate, and spatio-temporal variables to generate national models explaining the variation in abundance of Canada Warblers across Canada.

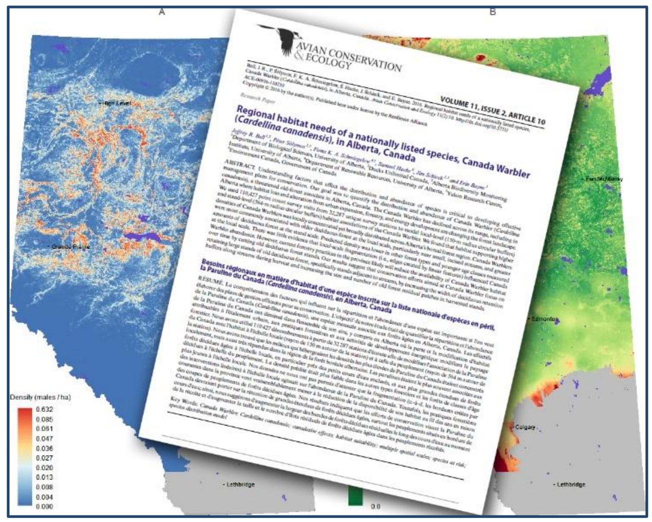
As one outcome, we mapped expected Canada Warbler density (males/km$^2$) across Canada, Alaska, and the northern portion of the United States.




Analyses suggest higher densities of Canada Warblers in dense deciduous and mixedwood stands and to a lesser extent in dense wetland and conifer stands. The model suggested higher densities as time since fire increased, and in stands with a canopy height between 15 and 20 m. We found a negative effect of on-road surveys compared to off-road surveys.

## Regional models describe habitat associations of Canada Warblers

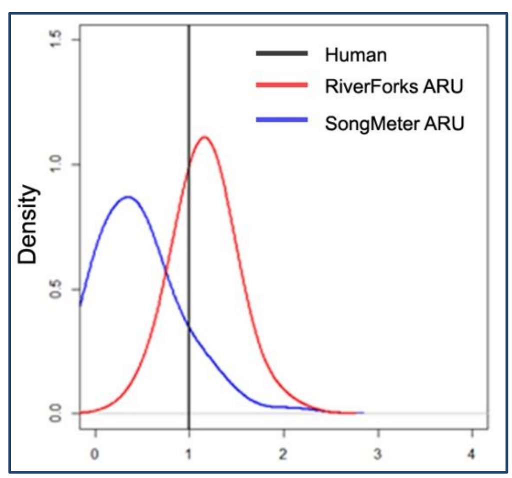
Our paper describing the regional habitat needs of Canada Warbler in Alberta was accepted and published in the journal ACE-ECO, with Jeff Ball (DUC) as lead author.




Canada Warblers were found in greater densities in older deciduous forests, particularly near small, incised streams. While no effect of local-scale fragmentation was found, the authors note that forestry practices in Alberta will reduce availability of Canada Warbler habitat by targeting older, deciduous forests.

## Updated models for Alberta are in progress

Each year, as part of the Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring (JOSM), BAM data and methods are used to update the JOSM bird models and subsequent information presented on the ABMI website. The 2016-17 models integrate human-based point count data with data from ARUs. The methodology was described by Ball et al. (2016). Results are available online at (species.abmi.ca). [Contact: Péter Sólymos]




**Latest Alberta models integrate ARU data.** Data integration consisted of filtering observations by date and time window defined by historical observations (late May, early June, early morning hours) and model-based estimation of the difference between effective detection radii for the different methods. This approach to data integration worked for most species, but effects were hard to estimate for some of the rare species with few ARU detections. For these species, development of correction factors, or a combination of corrections and model-based estimates will be warranted until recording technologies start dominating the data sets.

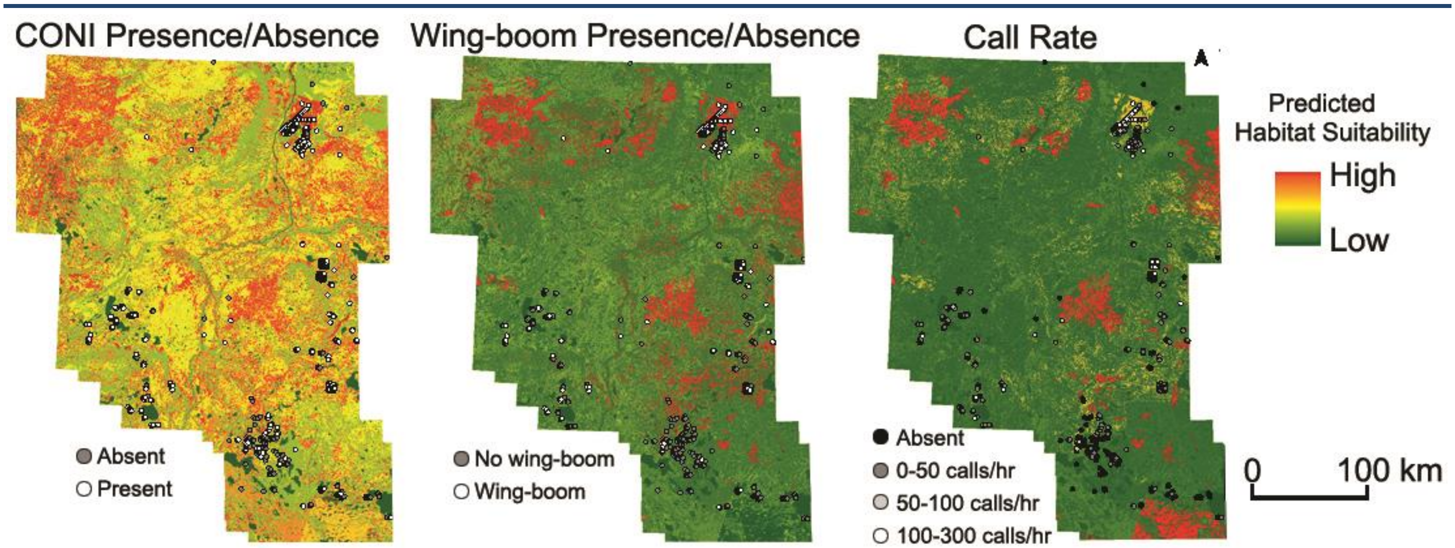
## Regional models for Western Wood-Pewee and Olive-sided Flycatcher

Western Wood-Pewee and Olive-sided Flycatcher populations have declined nationally over the past 40 years. Tara Stehelin (BAM PhD student with Fiona Schmiegelow, University of Alberta) is investigating climate and habitat factors affecting the abundance and distribution of these species in the northwestern boreal region of Canada. Habitat models are being built to ultimately identify areas of conservation priority within identified potential refugia from climate change (page 12). In 2016-17, Tara extracted the relevant subset of avian data, and explored various modelling approaches. In 2017-18, regional habitat models will be created. [Contact: Tara Stehelin]

## Acoustic signals as indicators of habitat use by Common Nighthawks

Elly Knight (PhD student with the University of Alberta-Bioacoustics Unit), with collaborations from BAM team members, is investigating whether variation in Common Nighthawk acoustic signals can be used as proxies for habitat components. The results of her research have implications for models built to inform critical habitat identification for the species. In 2017-18, Elly and her team will return to the McClelland Lake area in northeastern Alberta to complete behavioural data collection and deploy miniature GPS-microphones on Common Nighthawks. She will also describe her efforts to associate specific acoustic signals to different behaviours. [Contact: Elly Knight]

**Links between habitat use and acoustic behaviour**. Elly is using a combination of behavioural study, new technology, and ARUs to study Common Nighthawk acoustic behaviour at multiple scales. She has found that Common Nighthawk call rate and wing-boom rate both vary with behavioural activity, and that the wing-boom signal is centered over the nest site. She has also demonstrated that the results of Common Nighthawk habitat suitability models will vary depending on which acoustic signal is used as the response variable.



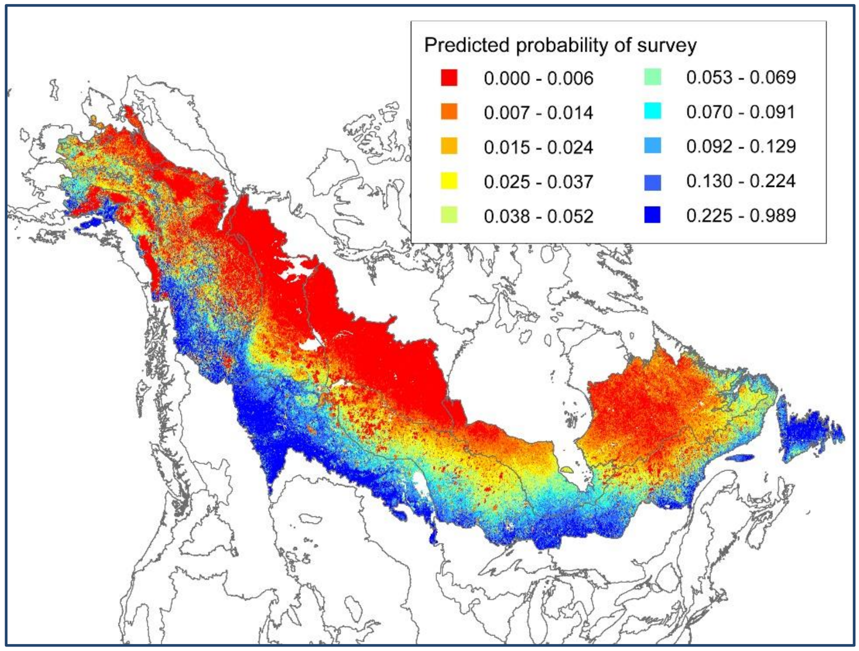
# Informing Surveys & Monitoring

In 2016-17, we began looking at how well the boreal region is sampled by the BAM dataset.

## How well does the BAM Avian Database sample the boreal region?

In 2016-17, we completed a preliminary analysis comparing the biophysical attributes of surveyed vs. unsurveyed locations to assess the representativeness of BAM data locations within the BAM study area. We will continue this and related analyses throughout 2017-18. [Contact: Diana Stralberg]

**Habitat selection by surveying biologists.** We used a logistic regression / resource selection function (RSF) framework to model the "selection" of BCR-specific survey conditions by those conducting point counts. Although results varied by BCR, odds ratios indicated that under-surveyed habitats included sparse, open conifer and deciduous habitats, and wetland habitats. Recently disturbed areas were also under-represented, as were climates characterized by long winters and high temperature seasonality. Using a combined boreal-wide model, we mapped the probability that a given location had been surveyed based on its biophysical attributes.



## Anticipated Research

BAM recently developed a 2.5 year workplan covering November 2016 to March 2019. Some of the anticipated research includes the following:

- Explore methods of modelling maximum density (i.e., carrying capacity) rather than mean density or habitat suitability, as part of our science to inform critical habitat identification.
- Compare historical range shifts to those predicted by climate-based models built using historical climate data, to detect and possibly attribute population changes to climatic effects.
- Identify thresholds in species' or communities' responses to land-use change.
- Build avian models that will link with landscape simulation tools such as Tardis or SpaDES; use these to evaluate impacts of alternative forest management plans.
- Relate avian abundance to tree structural profiles using LiDAR data, in effort to understand whether bird species respond to tree species or tree structure.
- Evaluate impacts of various forest retention practices on birds using data collected from strategically resurveyed locations.
- Evaluate existing range maps for boreal-breeding birds compared to observational records; explore methods of delineating range maps from density maps.
- Contrast the utility of smaller abundance datasets versus larger occurrence datasets to gain insight into where BAM's modelling efforts should focus.
- Initiation of efforts to validate BAM models with external data.

# Application & Collaboration

## Informing Conservation & Management Activities

Much of BAM's work can be applied to conservation and management, but a subset of it is explicitly designed to do so. In this section, we describe the work we lead, often in collaboration with other organizations, to directly inform conservation and management of boreal birds. This year, that includes our work to support critical habitat identification for three Species at Risk, a collaborative workshop and associated special issue, our work supporting identification of Zones of Interest for boreal songbirds, identification of habitat management guidelines and opportunities for Canada Warblers in BCR14, and status reports for Western Wood-pewee and Olive-sided Flycatcher.

### Informing critical habitat identification to aid species at risk

Defining critical habitat is required to inform recovery strategies for species at risk. ECCC's recently developed recovery strategies for Canada Warbler (Environment Canada 2016a), Olive-sided Flycatcher (Environment Canada 2016b), and Common Nighthawk (Environment Canada 2016c) did not identify critical habitat. Instead, they identified a Schedule of Studies to be completed that would provide the information necessary to identify critical habitat. BAM has been involved in this process since 2013-2014, contributing models, expertise, and data.

In 2016-17, BAM hired a new post-doctoral fellow, Francisco Dénes, to lead BAM's scientific efforts to inform critical habitat identification for these three species. On February 23rd-24th, 2017, several BAM team members met with Kathy St-Laurent (ECCC-Canadian Wildlife Service [CWS]) and Andrew Boyne (ECCC-CWS) on the University of Alberta's campus to review work to date and decide on the steps forward.

Also in 2016-17, Francisco Dénes was added to ECCC's Science Advisory Committee for these three species, joining BAM Team Members Erin Bayne and Samuel Haché. In March 2017, Péter Sólymos and Samuel Haché presented the finalized Canada Warbler models (page 19) to the Advisory Committee. [Contact: Francisco Dénes]

Meeting objectives: 1) update BAM's new post-doctoral fellow with the work to date; 2) discuss the policy motivation, conceptual underpinnings, and analytical approaches associated with critical habitat identification; 3) discuss obstacles associated with each species and with different scales (regional vs. national models); and 4) prioritize activities.

Discussion from the meeting highlighted: 1) the need to develop a conceptual model/operational framework to guide critical habitat identification to support species conservation; 2) the importance of distinguishing suitable habitat from used habitat; 3) the need to integrate anthropogenic and natural disturbances in critical habitat models; and 4) the difficulty posed by attempting to achieve population and distribution objectives by protecting breeding habitat in the likely circumstance where habitat loss in non-breeding habitats is a major factor driving population declines.

### Facilitating conservation of boreal birds by integrating science, policy, and action

By the fall of 2015, BAM had learned of several independent research and conservation initiatives focused on boreal birds. To improve communication and collaboration among the various interested parties, we co-led with Marcel Darveau (Ducks Unlimited Canada [DUC]) the first North American, boreal-wide collaborative Conservation of Boreal Birds (COBB) workshop at the North American Congress for Conservation Biology in July 2016 (WS20 on scbnacongress.org). Participants discussed the state of knowledge for boreal bird conservation, with the twin goals of establishing linkages and collaborations and developing review papers that will be contributed to a special issue of the journal Avian Conservation and Ecology in in 2017-18 (see pages 14 and 26 of this report). [Contact: Nicole Barker]


**Breakout session discussions.** The workshop included a breakout session focused on improving collaboration and communication among boreal bird conservationists and managers. All groups highlighted the need for a formalized structure to facilitate collaboration and communication, but also to support long-term planning, implementation, and follow-up on goals. Proposed ideas included a pan-Boreal Joint Venture structure, a Boreal Landscape Conservation Cooperative, or an expansion of the Boreal Partners in Flight. As for next steps, the group hoped that the special issue in ACE-ECO will begin to address the current communication gap between initiatives that was identified at the meeting.

**A synthesis to catalyze action.** The special issue's goal is to present an overview of the current state of boreal bird conservation in North America. Specifically, our collection of 6-8 review papers will: showcase the various boreal bird conservation initiatives; review relevant government policy, legal directives, and voluntary incentives mandating conservation of boreal birds; summarize the observational datasets available to support this work; and compare conservation planning and other analytical tools in use. It will also review current challenges to avian conservation and management: the human activity; climate change; and inter-annual population fluctuations.

In the range of subjects of scope of individual manuscripts, we solicited input from governmental and non-governmental sources, including ECCC, DUC, National Audubon Society and Audubon Alaska, Parks Canada, Wildlife Conservation Society Canada, Nature Conservancy of Canada, various academic institutions, and others. BAM team members are leading or contributing to papers including the Editorial and discussion, a climate change review, a population fluctuations review, a data review, anthropogenic disturbance review, and a systematic conservation planning review.

## Identifying Zones of Interest for priority forest landbirds in boreal Canada

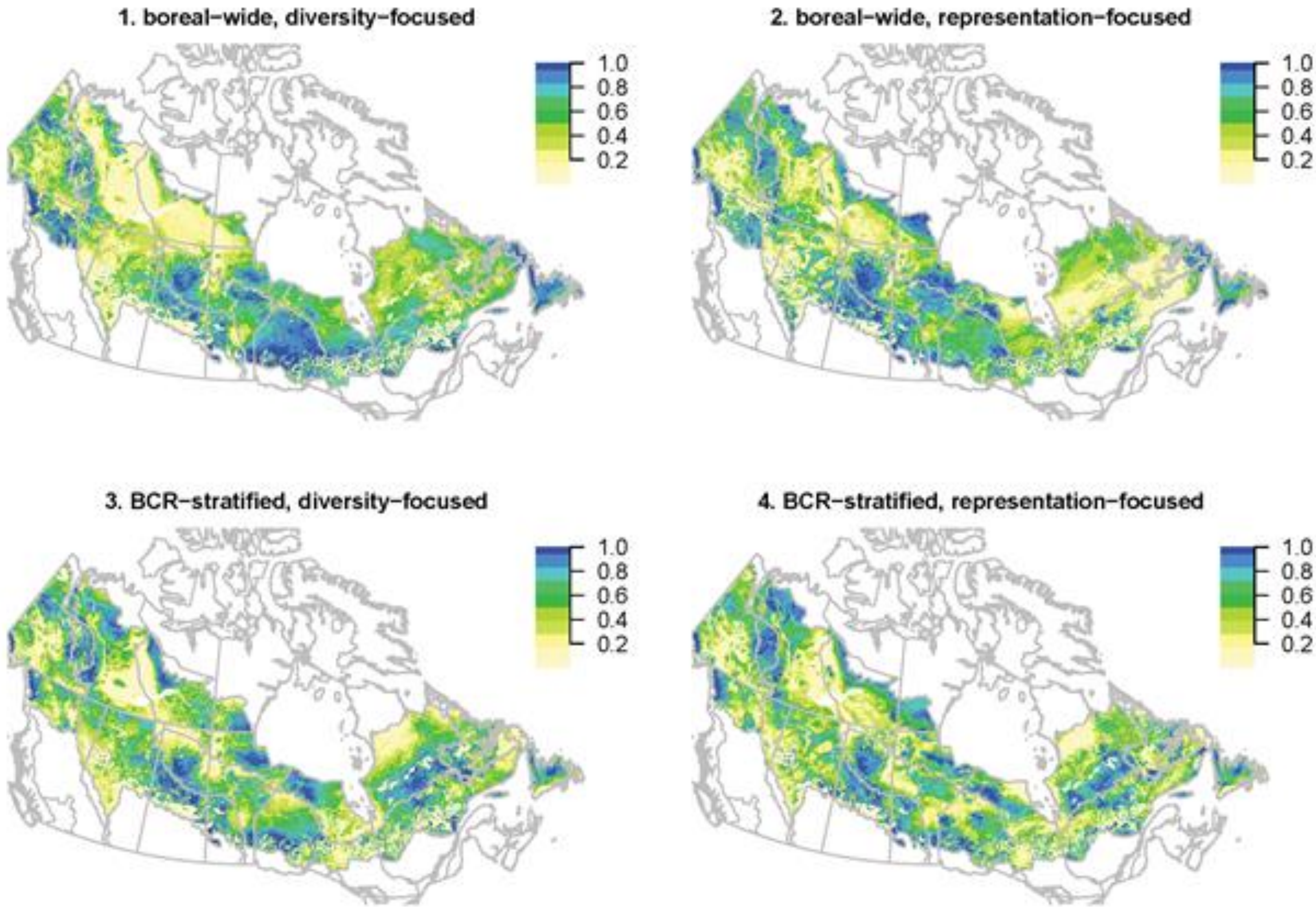
In recent years, CWS initiated a "Zones of Interest" project to identify priority areas for boreal landbird species, which represent a conservation planning gap in Canada. In late 2015-16, we built on previous work by Carlson (2015), aiming to refine inputs and assumptions, and to identify conservation priorities across a range of scenarios. In 2016-17, we revised our analyses and report based on feedback from earlier reviews. We are currently drafting a manuscript based on these results, which will be part of the COBB special issue (page 29). [Contact: Diana Stralberg]

For the boreal region of Canada (BCRs 4, 6, 7, and 8), we used the Zonation (Moilanen et al. 2009) conservation planning software to rank 4-km x 4-km grid cells according to their conservation value for 63 priority landbird species, resulting in a set of nested conservation "solutions" for a range of land percentage targets. Based on recommendations of the International Boreal Conservation Science Panel (Badiou et al. 2013), we used a 50% target as a starting point for evaluating scenario efficiency.

We developed 128 unique scenarios representing all possible combinations of the following six factors: 1) *Prioritization algorithm:* focus on individual species core areas vs. species richness; 2) *Stratification:* boreal-wide vs. BCR subregion-specific conservation priorities; 3) *Disturbance:* discounted by footprint proportion vs. not discounted; 4) *Climate change and uncertainty:* discounted by current and/or future uncertainty vs. not discounted (four alternatives); 5) *Species weights:* species weighted by conservation status vs. all equal; 6) *Species list:* all priority landbird species vs. forest-associated boreal species.

After constraining our study area to the boreal region and adjusting our focal species accordingly, we found that solutions were similar across species weightings and uncertainty assumptions. Consistent high value areas were found in western British Columbia, northern Saskatchewan, central Newfoundland, and undisturbed portions of southern Saskatchewan, Manitoba, Ontario, and Québec. The largest differences in Zonation rankings were driven by external factors such as disturbance and climate change, as well as *a priori* choices regarding ranking algorithm and study area stratification. This highlights the importance of establishing *a priori* assumptions and criteria to guide the interpretation of results and identification of conservation priorities and management strategies.

Here we showcase conservation priorities based on four core scenarios, with areas of higher disturbance and model uncertainty down-weighted and species' influence weighted by conservation status. BCR-stratified = BCR subregion-specific; species diversity focus based on additive benefit function; species representation focus based on core area zonation algorithm. Highest conservation values in dark blue; lowest values in light yellow.




Results from this study can cautiously be used to guide broad, continental-scale conservation priorities for boreal bird species. We suggest that more constrained scenarios, in terms of disturbance, climate change, and priority species, are generally more informative and appropriate than simpler, unconstrained scenarios.

### Supporting habitat management for Canada Warblers in BCR14

In its Full Life-Cycle Canada Warbler Conservation Plan, the Canada Warbler International Conservation Initiative (CWICI) recognized that breeding habitat requirements represented a major knowledge gap. This project was initiated by CWICI, with support from ECCC, the US Fish & Wildlife Service, and the services of High Branch Conservation Services Ltd. to fill that gap by developing habitat guidelines for those interested in conserving or managing Canada Warbler habitat. The major outcome of this work is a set of guidelines that describe the conditions and processes that benefit Canada Warblers and other native species that depend on similar habitats. This report will be accompanied by set of spatial priorities indicating opportunities to protect existing habitat or create new habitat for Canada Warblers. In 2016-17, BAM Contributing Scientist Alana Westwood drafted reports, and solicited feedback from BAM team members throughout the process. The reports will be finalized in 2017-18. [Contact: Alana Westwood]

**Habitat guidelines**. The report summarizes a comprehensive review of the literature to identify stand and landscape-level features associated with high bird densities. A range of strategies are presented, ranging from habitat manipulation to protection. In general, harvest-based strategies are likely to be most useful in areas of active forest management, especially large ownerships that include forested wetlands. Forest preservation may also be effective at sustaining Canada Warbler populations on large tracts that contain the requisite wet mixedwood/deciduous forest composition, vertical canopy structure, and ground complexity. Combined approaches can be applied to areas where harvesting is limited but conservation objectives call for some level of habitat manipulation.

**Spatial conservation priorities.** A multi-criterion evaluation method was approached by removing areas from an initial habitat suitability model that do not offer opportunities to protect or supply Canada Warbler Habitat. Connectivity and flow analysis was applied to account for sensitivity of the species to fragmentation and roads.

## Status reports for Western Wood-Pewee and Olive-sided Flycatcher

In 2016-17, BAM team members contributed to two status reports. The final copy of a status report for the Western Wood-Pewee in Alberta was submitted in November 2016. A draft of a COSEWIC status report for Olive-sided Flycatcher is being circulated for internal review within COSEWIC. It will be finalized in 2017-18. [Contacts: Alana Westwood and Tara Stehelin]

## Anticipated Opportunities

In 2016-17, BAM received a Conservation Grant from SFI (lead: Fiona Schmiegelow), and a Strategic Partnership Grant from NSERC (lead: Steve Cumming). The two efforts are complementary in that they both aim to improve the conservation value of forest management; both have a strong collaborative element. [Contact: Nicole Barker]

- We will host a **workshop** with participants from BAM, forest products companies, NGOs, federal governments, and provincial governments to develop a common understanding of tools and processes used in forest planning, capabilities and limits of avian modelling and simulation techniques, and research and data needs. Results from this workshop will be considered during development of subsequent forest management projects, including student and post-doctoral projects funded through the Strategic Partnership Grant. This will be funded by a Conservation Grant from SFI with partners including: American Bird Conservancy, Bird Studies Canada, CWS, Canfor, DUC, Louisiana - Pacific, Nature Canada, the Canadian Forest Service (CFS)-Pacific Forestry Centre, and West Fraser.
- The NSERC SPG will fund 4 PhD students and 2 post-doctoral fellowships. All recruited individuals will have the opportunity to join the BAM Team. The individuals will perform spatial simulation experiments to quantify the costs and benefits of different forest management strategies for birds. They will project the likely consequences of forest management that satisfies current timber supply expectations under beneficial management practices, and under alternatives that minimize or mitigate impacts. These spatial simulation experiments require forecasts of future forest condition; the spatial variation in composition and age structure that will result from interacting disturbances and climate change. Generating these "future forests" at national extent requires specialized spatial simulation models coupled with statistical models i.e. of fire vegetation and climate, and of future tree species distributions. We will rely on collaborations with Eliot McIntire at the Pacific Forestry Centre, who is developing spatial simulation tools, including novel vegetation dynamics models, specifically for such purposes. Additional confirmed partners include Junior Tremblay (ECCC-Science & Technology [S&T]) and Mark Drever (ECCC-CWS), who will provide scientific input and policy background as the projects develop.

# Collaborations for Conservation

Since its inception in 2004, BAM's goal has been to provide information to support conservation and management of boreal birds. We do this primarily through the many partnerships we've developed within the research and conservation community. In the sections above, we described research led primarily by BAM team members. In this section, we describe how BAM data products have been used in conservation initiatives led primarily by external groups.

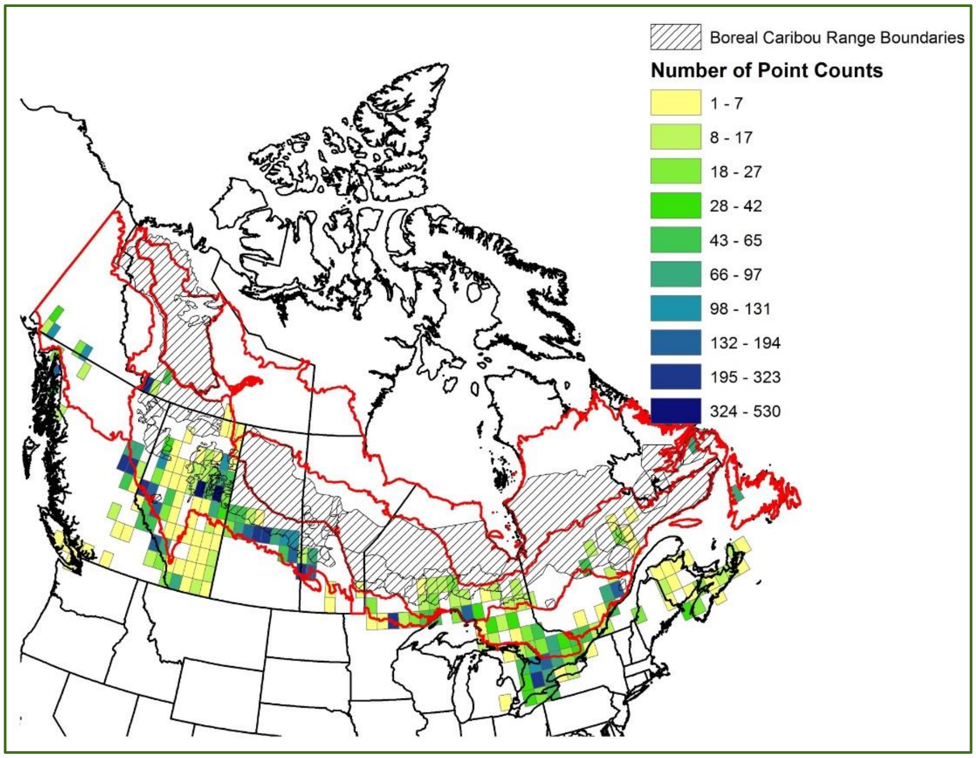
## ECCC's Boreal Monitoring Strategy

ECCC is developing a national framework for boreal monitoring that also: (1) prioritizes monitoring needs and associated risks; (2) identifies key parameters, trade-offs, and costs; (3) identifies key characteristics of efficient and reliable monitoring; and (4) identifies the design and sampling plan framework required for regional implementation. Key goals to the Boreal Monitoring Strategy are to provide accurate estimates of species status, trend and distribution. Thus future monitoring will be designed not only to track species trends but should also improve our knowledge of species ecological niches to inform other priorities such as environmental impact assessment. Several BAM Contributing Scientists are involved in the Boreal Monitoring Strategy. In 2016-17, we discussed possible ways that BAM can contribute and we summarized the ability of the BAM database to provide insight on trends; we foresee greater contributions in 2017-18. [Contact: Steve Van Wilgenburg]

**How a compiled dataset can inform future monitoring.** BAM data can be used to help inform sample size targets for boreal monitoring. The sample sizes needed to effectively monitor changes in species abundance through time are dependent in part on how much abundance varies in space (between site variance) and over time (inter-annual variance). While BAM data are non-representative (e.g. bias toward upland, mesic landcover types in some regions; see page 22), representative bootstrapping of the data could be used to estimate mean abundance and between-site variation to inform sample size estimation.

Finally, one goal of a boreal monitoring program is to improve our ability to predict abundance. The Boreal Monitoring Strategy will seek to improve sampling of spatial, habitat, and climate gradients not adequately sampled by BAM data. Thus, BAM may be able to contribute information from existing models (e.g. parameter estimates and their variance) to inform model-based sample designs or priority regions for further work.

**Potential capacity of BAM database for estimating long-term trends.** We tabulated the number of point count locations that have been sampled more than once. Each cell in the map indicates the number of point count stations that have been sampled in more than one year.




### Future landscape simulation to understand impacts of forestry, natural disturbance, and climate change

In 2015-16, BAM was recruited for a collaboration with Yan Boulanger (CFS-Laurentian Forestry Centre) and Junior Tremblay (ECCC-S&T) to estimate the impacts of climate change on boreal forest landscapes while considering forest harvest and natural disturbance (wildfire and spruce budworm outbreaks). The goal is to simulate future forest landscapes using the LANDIS landscape simulation tool and translate them into bird habitat to understand how many birds can be supported by the theoretical future landscapes.

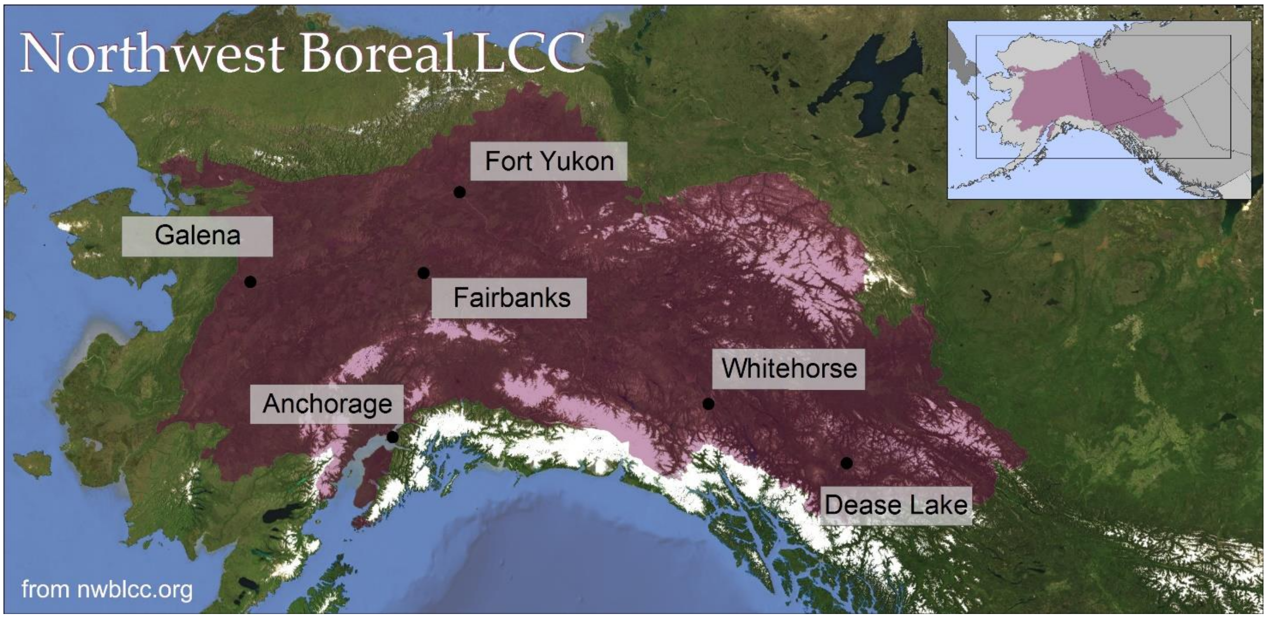
In 2016-17, LANDIS was parameterized for four regions in boreal Canada, and preliminary results have been generated using avian densities from an ABMI/BAM collaboration to project future bird habitat in the Al-Pac region. The next phase (2017-18) will focus on Québec, using regionally-specific density estimates to be derived from BAM data. [Contact: Diana Stralberg]

### Nature Conservancy of Canada's Boreal Plains Atlas

In 2015-16, BAM was approached by the Nature Conservancy of Canada for expert knowledge and data products to aid in their Nature Atlas for the Boreal Plains. The project goal is to identify areas of conservation priority within the Boreal Plains ecozone. In that same year, we contributed various data products to support the effort. In 2016-17, BAM contributed climate refugia layers (page 12) and otherwise contributed in an advisory capacity. Draft conservation assessment results are expected in Summer 2017, and will be publicly available sometime in 2018-19. [Contact: Diana Stralberg]

## Northwest Boreal Landscape Conservation Cooperative

BAM's collaboration with the BEACONs project advances boreal bird conservation through application of our products to on-the-ground conservation planning efforts in association with the Canadian Boreal Forest Agreement (CBFA) and the Northwest Boreal Landscape Conservation Cooperative (NWB LCC). Historically, BAM has provided models of current and projected future species density and climate refugia for use in design and evaluation of protected areas networks. In 2016-17, we worked with BEACONs to develop new methods to identify climate refugia for six boreal bird focal species as part of conservation assessments for the NWB LCC (page 12). [Contact: Diana Stralberg]



# BAM's Collaborative Activities at a Glance

Here we summarize all efforts involving contributions from BAM during 2016-17. Those described in more detail above are indicated with page references.

## BAM Collaborations

In 2015-16, we contributed to the following efforts directly or by supplying data products:

- BAM contributed expertise and data products to the **Nature Conservancy of Canada**'s Boreal Plains Atlas. [contact: Diana Stralberg]
- **CWS-Northern Region** (CWS-NR) is developing an automated approach to delineate species' northern range limits based on known breeding locations from all available data (e.g. BAM, BBS, eBird, etc). in 2016-17, BAM suggested several analytical approaches which are currently being explored by the collaborator. [contact: Samuel Haché]
- BAM team members contributed data and analyses to a **CWS-NR** effort to compare results from ARU and human-based point counts with the goal of expanding the geographic scope of the BBS survey. [contact: Samuel Haché]
- At the request of the **Boreal Songbird Initiative** BAM prepared a report summarizing climate-change impacts on boreal bird distribution and abundance, and related climate-smart conservation strategies. This work will be finalized in 2017-18. [contact: Diana Stralberg]
- BAM team members have joined one or more **Partners in Flight** (PIF) working groups and have helped draft Species Profiles for PIF's forthcoming website. [contact: Nicole Barker]
- Matthew Betts (**Oregon State University**) is using BAM data to explore bird communities in forest plantations. The research is expected to proceed in 2017-18, and BAM team members will be invited to participate in the research at that time. [contact: Nicole Barker]
- BAM and collaborator Lisa Venier (**CFS-Great Lakes Forestry Centre**) recommitted to pursuing research regarding bird responses to spruce budworm outbreaks in 2017-18. [contact: Nicole Barker]
- BAM was recruited to proposed work led by **Nature Canada** and the **Moose Cree First Nation** to contribute to conservation of the Canada Warbler and other species of conservation concern within the Moose Cree Homelands. [contact: Nicole Barker]
- BAM data products are being used for environmental assessment being done by **Joro Consultants** for the Manitoba Government. [contact: Diana Stralberg]
- **Bighorn Wildlife Technologies** requested advice from BAM regarding appropriate methods for point-count survey methods and data collection. [contact: Nicole Barker]
- **Al-Pac**, **DUC**, **Government of Quebec**, and **West Fraser** partnered on an application to fund the Common Attribute Schema for Forest Resource Inventory (CASFRI) product that will support BAM's forest simulation research. [contact: Steve Cumming]
- BAM maintained its collaboration with **ABMI**, **Alberta Environment and Parks**, **ECCC**, and the Bayne Lab at the **University of Alberta** via the JOSM work in Alberta (pages 8 and 20). [contact: Erin Bayne and Judith Toms]
- A new collaboration with **Al-Pac** was launched, supported by a Mitacs Accelerate for Lionel Leston, looking at impacts of forest fragmentation on birds and subsequent long-term effects of alternative forest management plans (page 10). [contact: Lionel Leston]

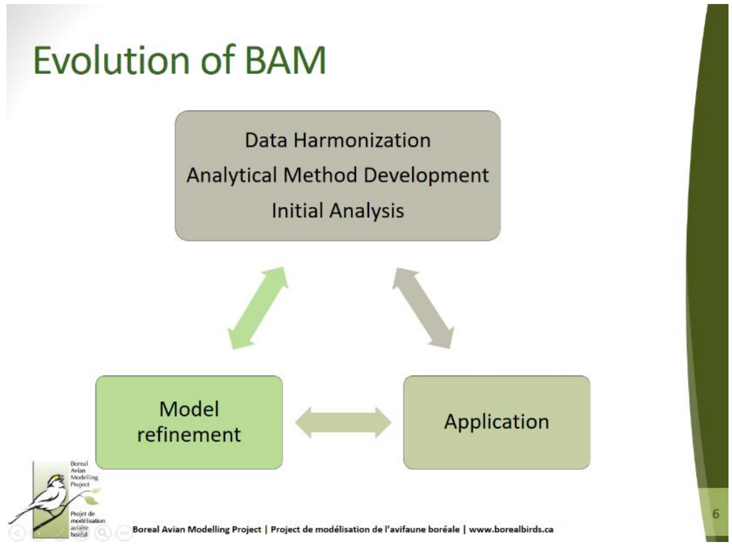
- BAM quality-checked datasets, acquired new point count data, and preliminary analyses to evaluate a Migratory Birds risk matrix in association with **Canfor** and **West Fraser**, supported by a Mitacs Accelerate for Nicole Barker (page 10). [contact: Nicole Barker]
- BAM's climate change contribution to the COBB special issue involves collaborators from **ECCC**, **Nature Conservancy of Canada**, and **Université du Québec à Rimouski** (page 14). [contact: Diana Stralberg]
- BAM continues to contribute data products to efforts by **BEACONs** and **AdaptWest** to support conservation assessments (page 12). [contact: Diana Stralberg]
- A chapter from Diana Stralberg's Ph.D. thesis was revisited. This work, involving fire and climate change simulations, involves individuals from the **University of Alberta, CWS, ABMI,** and **CFS-Northern Forestry Centre** (page 13). [contact: Diana Stralberg]
- BAM is initiating a collaboration with **University of Alaska Fairbanks** to explore impacts of climate change on bird populations in Alaska (page 13). [contact: Steve Matsuoka]
- BAM team members contributed to work by Daniel Yip (**University of Alberta-Bioacoustics Unit**) that will inform the integration of ARU-based and human-based point count data (page 16). [contact: Erin Bayne]
- BAM continues to support **ECCC's** efforts to identify critical habitat for Canada Warblers, Olive-sided Flycatchers, and Common Nighthawks (page 24). [contact: Elly Knight]
- We identified conservation priorities as part of **ECCC**'s Zones of Interest project (page 26). [contact: Diana Stralberg]
- The BAM team provided input on efforts coordinated by the **Canada Warbler International Conservation** in collaboration with BAM Contributing Scientist Alana Westwood and collaborators from **High Branch Conservation** Services and **Plymouth State University** to identify habitat management guidelines and spatial prioritization methods for Canada Warblers (page 27). [contact: Alana Westwood]
- The COBB workshop co-organized by BAM team members and Marcel Darveau (DUC) was attended by representatives from **ABMI**, **AdaptWest**, **Audubon Alaska**, BEACONs, BSI, DUC, ECCC-CWS, ECCC-Sci, **Michigan Technical University**, the **National Audubon Society**, the **National Council for Air and Stream Improvement**, the **Wildlife Conservation Society of Canada**, **Université du Québec en Abitibi-Témiscamingue**, **Université Laval**, the **University of Alberta**, and the **University of Maine** (page 29). [contact: Nicole Barker]
- BAM has and will continue to contribute both data products and scientific expertise to **CWS**'s Boreal Monitoring Strategy (page 29). [contact: Steve Van Wilgenburg]
- BAM contributed in an advisory capacity to a collaboration with Yan Boulanger (**CFS-Laurentian Forestry Centre**) and Junior Tremblay (**ECCC-S&T**) examining bird response to climate change, forestry, and natural disturbance. In 2017-18, this work will involve more direct collaboration, including data and analyses (page 30). [contact: Diana Stralberg]

## Meetings with External Groups

In 2016-27, we joined or hosted the following meetings with external groups to establish or further collaborations or to learn about related efforts to ensure complementarity or comparability.

- May 18 and June 15, 2016, and January 16, 2017: **ECCC** representative attended BAM webinars to discuss the Zones of Interest project (page 26).
- May 25, 2016: Kim Lisgo (**BEACONs**) attended a BAM meeting to provide an overview and update on inclusion of BAM data products in BEACONs ongoing conservation assessments (page 31).
- September 14, 2016: Dan Lambert (**High Branch Conservation Services**) and Len Reitsma (**Plymouth State University**) attended a BAM meeting to engage in discussion on Canada Warbler spatial prioritization approaches (page 27).

- October 12, 2016: Liber Ero recipient Richard Schuster (**Carleton University**) attended a BAM meeting to discuss potential synergy in our research programs.
- October 25-27, 2016: A BAM representative provided an update on BAM's workplan at the October 2016 meeting of the **ECCC Landbird Technical Committee.**




- Starting in November 2016: Several BAM team members regularly attend monthly **Partners in Flight** (PIF) calls.
- November 23, 2016 and February 13, 2017: Elly Knight (**University of Alberta-Bioacoustics Unit**) attended BAM webinars to discuss her Common Nighthawk research and how it relates to BAM's Common Nighthawk models (page 21).
- November 30, 2016 and January 23, 2017: Representatives from **CWS-NR** attended BAM webinars to discuss range delineation work (page 31).
- December 12, 2016: A BAM representative attended an **Alberta Forest Products Association** phone call to learn about their version of the migratory birds risk matrix (page 10).
- December 14, 2016 and January 9, 2017: BAM learned about **CWS**'s Boreal Monitoring Strategy and discussed our parallel efforts with BAM Contributing Scientists affiliated with CWS (page 29).
- February 2, 2017: A BAM representative called into all-day meeting to discuss **COFI**'s Migratory Birds work and provide an update on BAM's contributions (page 10).
- February 23-24, 2017: BAM and **ECCC-CWS** co-hosted an in-person meeting to discuss next steps for critical habitat research (page 24).
- February 27, 2017: Representatives from the **Government of Alberta** and **ECCC-S&T** attended a BAM meeting to discuss ideas for incorporating birds in forest management planning (page 28).


- March 13, 2017: Pierre Vernier (**BEACONs**) attended a BAM meeting to showcase the interactive mapping tool developed by BEACONs as part of the NWB LCC efforts (page 31).
- March 14, 2017: BAM team members attended a meeting of **ECCC's Science Advisory Committee** for Canada Warblers, Olive-sided Flycatchers, and Common Nighthawks (page 24).

# Data Development

## Data Products for Distribution

We did not add any new data products to our collection during 2016-17, but we reproduce this table to summarize what is currently available.

### Products available for distribution

BAM has created many data products that are available for various applications. Many of these are online, either on the BAM website or our Data Basin portal. More will be uploaded in future, as they become available and as resources permit. The following table is an inventory of what is currently available. Interested parties can contact the BAM Coordinating Scientist, Nicole Barker, at nbarker@ualberta.ca for more information or to request a product.

| Layer | Details | Location | Reference |
| --- | --- | --- | --- |
| Density version 1. Estimated breeding density by BCR, jurisdiction, and land cover class | Males / hectare of each species estimated from hierarchical models of species' density.<br>• Timeframe: 2005<br>• # species: 70<br>• Extent: varies by species | Table available by request to Coordinating Scientist. | BAM website (BAM 2012) |
| Density version 2. Spatially-explicit current species density | Males / hectare of each species, predicted from Boosted Regression Tree models.<br>• Timeframe: current<br>• # species: 103<br>• Extent: northern North America, excluding high Arctic | **Interactive** maps on Data Basin<br><br>**Download** ASCII grids from Data Basin | Stralberg et al. 2015. Ecological Applications (Stralberg et al. 2015b). |
| Species Density under Climate Change | Males / hectare of each species, predicted from Boosted Regression Tree models and climate models.<br>• Timeframe: 2011-2040; 2041-2070; & 2071-2100<br>• # species: 103<br>• Extent: northern North America, excluding high Arctic | **Interactive** maps on Data Basin<br><br>**Download** ASCII grids from Data Basin | Stralberg et al. 2015. Ecological Applications (Stralberg et al. 2015b). |
| Climate Change Refugia | Area of overlap between current and future suitable habitat for each species.<br>• Timeframe: 2011-2040; 2041-2070; & 2071-2100<br>• # species: 103 | Temporary FTP (by request to Coordinating Scientist) | Stralberg et al. 2015. Diversity & Distributions (Stralberg et al. 2015a). |

| | | | |
|---|---|---|---|
| | • Extent: northern North America, excluding high Arctic | | |
| **Species Distribution & Relative Habitat Suitability** | Predictions of habitat suitability from MaxEnt models of species' presence.<br>• Timeframe: current<br>• # species: 88<br>• Extent: North American boreal and hemiboreal | Static images on BAM website.<br><br>Rasters available via temporary FTP (by request to Coordinating Scientist) | Described on the BAM website |
| **Forest Age Associations** | The minimum forest age inhabited by each species.<br>• # species: 59 | Table available by request to Coordinating Scientist | Appendix of Stralberg et al. 2015. Diversity & Distributions (Stralberg et al. 2015a). |
| **Waterfowl Relative Densities** | Pairs / $km^2$ of each species/group, predicted from Boosted Regression Tree models.<br>• Timeframe: current<br>• # species: 17 species & 3 nesting guilds.<br>• Extent: Canada | Rasters available by request from DUC (contact Al Richard) | Barker et al 2014. ACE-ECO (Barker et al. 2014a)<br>And<br>Barker et al 2014. Ecosphere (Barker et al. 2014b). |

## Distributing data products

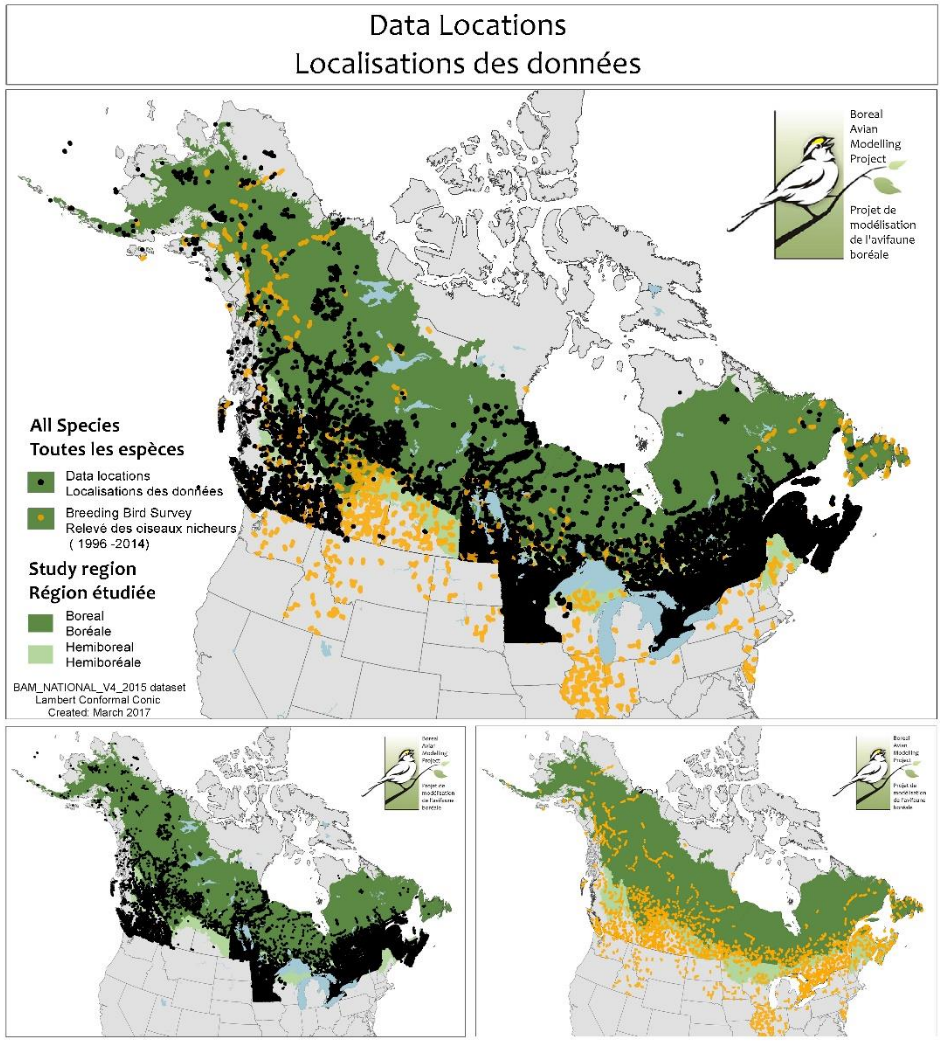
As part of our web review (page 41), we are revisiting the best mechanism for distributing our data products. We initiated this effort in 2016-17 and will finish the review and update the website in 2017-18.

# BAM Databases

This past year we focused on updating the BAM Avian Database and exploring ways to make portions of the dataset publicly available.

## The BAM Avian Database

In 2016-17, we updated our database by adding Breeding Bird Atlas data from British Columbia and Manitoba. We also added additional publicly-available data from British Columbia. The current contents of our database are summarized below.




| | BAM Avian Database | BAM's BBS Database |
|---|---|---|
| Version (Year Updated) | V4 (2017) | V4 (2017) |
| # Projects | 150 | Data inclusive of 2014, all Canadian and Alaskan BBS routes and some routes from northern USA. |
| # Sampling Locations | 201,062 | 65,609 |
| # Sampling Events | 328,603 | 670,453 |
| # Bird Observations | 3,057,409 | 4,901,199 |

### Integrating ARU data

BAM has contributed to several methodological studies to pave the way for integrating ARU data into the BAM dataset and BAM models (page 16). Through our collaboration with the University of Alberta's Bioacoustics Unit, we are exploring how to expand the structure of the BAM Avian Database to hold the additional information associated with ARU datasets. In 2017-18, we anticipate soliciting ARU data and to begin the process of standardizing ARU data to a common standard for inputting into the BAM Avian Database.

### Integrating eBird data

Although BAM has historically focused on count data, we recognize that using occurrence data can improve the spatial extent and amount of data. We anticipate using eBird data as part of our work to inform critical habitat identification and as a means of validating BAM density and range maps. In 2016-17, we downloaded eBird data for North, Central, and South America and began exploring the structure. In 2017-18, we will reformat the dataset so that it matches BAM's Avian Database structure and we will automate these processes to facilitate periodic updates from eBird.


### Building a public version of the BAM database

BAM was created as a mechanism to combine and standardize isolated datasets to build better models to inform conservation; data sharing was never the goal due to concerns for the rights of the data contributors (mostly related to scale of use). However, in the current age of big data, on-line citizen science (e.g., eBird), and mandatory data repositories, there is a new expectation of data availability. Furthermore, more researchers, managers, and planners have a need for regional and continental scale datasets to inform conservation and management. In 2016-17, we a developed plan to make the BAM database more widely accessible in a way that is consistent with existing data-sharing agreements. We also finalized our Data Policies and Request Procedures, which are posted on the BAM website (www.borealbirds.ca). We expect to pursue step two of our public data plan during 2017-18.

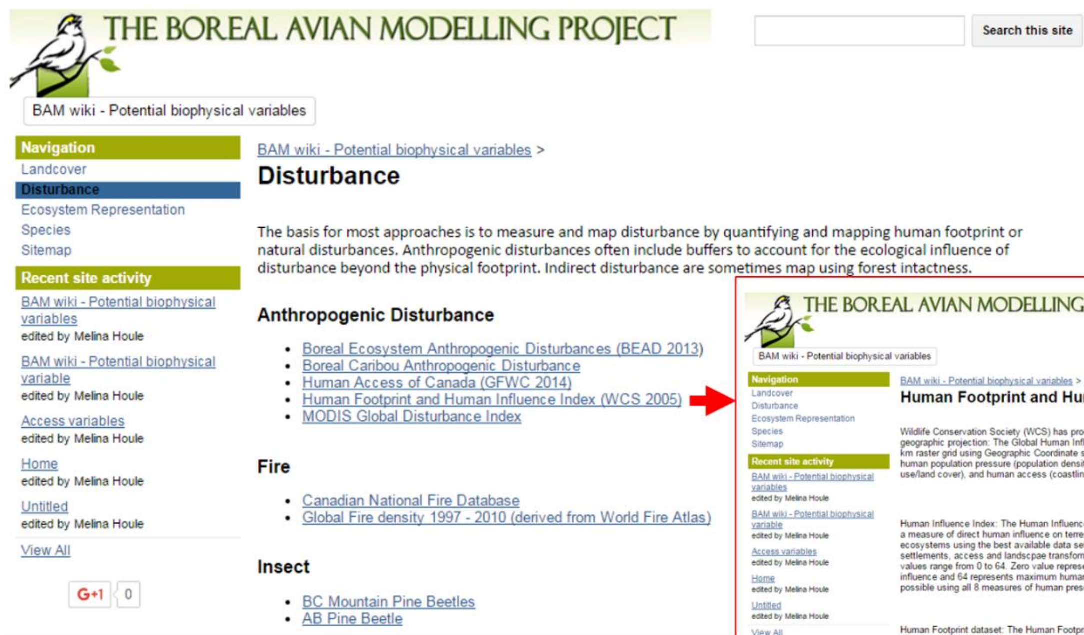
**A public BAM database.** Our current vision for making BAM data public follows a three-tiered approach. First, we will make available our species distribution and density layers. This step is in progress. Second, we will create and make available summaries of the dataset, for instance the count for each species observed each year, summarized to a 4-km grid. This series of products will contain much of the biological information available in the BAM Database while protecting Data Partners individual datasets. Partners will also have the option of withholding their data from these aggregates, either wholly or partially. Our third step is to make available the BAM Avian Database through a web portal similar to that used by the Avian Knowledge Network. Each dataset receives an individual permission level, and users can query and request data using a portal.

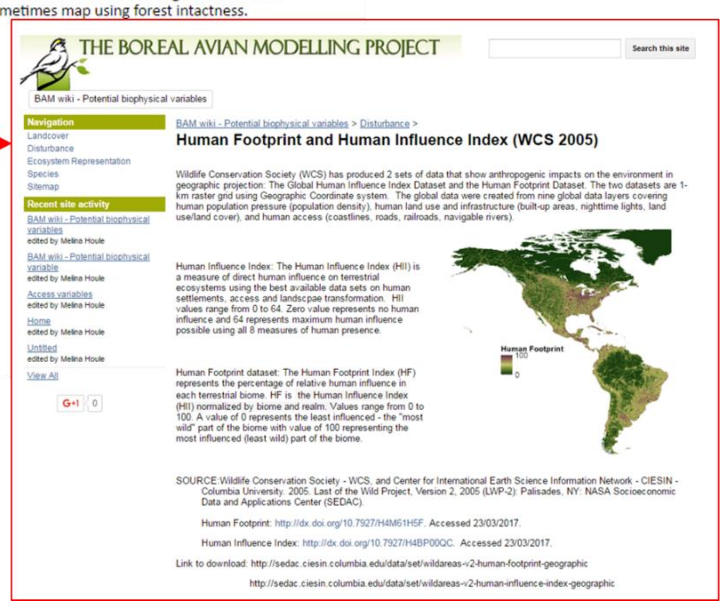
### Compiling spot-mapping data to quality-check our density models

Data from point counts are a reliable index of population density in the boreal forest, but results are imprecise. Spot-mapping data provide a more precise method of estimating population density. BAM, ECCC, and the Bayne Lab are collaborating to develop a database collating spot-mapping data from across the boreal forest. We're currently compiling two databases from spot-mapping data. The first is collecting all Canadian databases with a spot-mapping density; these densities will be used as "truth" for model predictions from our models built with point count data. The second database is a detailed GIS layer with spatial points of bird locations that will be used to build resource utilization functions examining edge use by birds in relation to forest and energy development. To date, over 25 surveys, primarily from ECCC and the University of Alberta, have been digitized and added to the database. The hope is that these data will provide a gold standard of density, which can be used, for instance, to validate BAM density models.

### The BAM Biophysical Database

Most BAM models use spatial layers depicting the conditions (e.g., landcover, climatic, etc) across the study area. In 2016-17, we initiated an effort to summarize the various products we've used in a single coherent, easy-to-read, and easily updated format. We will continue this effort in 2017-18.




**Biophysical data wiki.** We created a wiki (https://sites.google.com/site/bambiophysical/) as a test of whether the format will work for our purposes. We started by populating the wiki with layers we expect will be necessary for BAM's work to support the identification of critical habitat (page 24). The wiki contains a brief description of each potential covariate, the URL access for download and the spatial extent of the dataset, supported by a figure. The use of a wiki will allow BAM team members to access the most updated version of the biophysical products as well as the opportunity for collaborative editing.

# Communications

We describe our research and distribute our data products via our website and our DataBasin pages. This year we initiated a review of our web presence, with intention to improve distribution of information and products for those who use them.

## Web Presence

### A glitch on the Contact Us portal of borealbirds.ca

In November 2016, we were alerted to a glitch on our borealbirds website whereby we no longer received emails sent to us via the Contact Us form. It is possible that we missed emails sent between November 1, 2015 and November 30, 2016. If you tried to contact us during that time, please know that we did not receive your request, and we invite you to re-submit or contact us directly at BorealAvianModellingProject@ualberta.ca. We're very sorry for any inconvenience caused by this lapse.

### Reviewing and updating the BAM website to suit the user's needs

BAM uses a public website (borealbirds.ca) to disseminate key results and synthesized data products to managers and other end users. We use the BAM website to share information and distribute static data products such as map images or tables of data. We introduced DataBasin to distribute spatial products. In 2016-17, we initiated a review of BAM's web presence to ensure our website is achieving our goals. In 2017-18, we will complete this review and update the website, including an improved data distribution mechanism.

Current Website (March 2017)


Proposed Changes (Mockup)


We invite feedback or suggestions regarding our website, since we wish it to suit our user's needs. Please contact us at BorealAvianModellingProject@ualberta.ca with comments on how you use the current website and any suggestions you have for our revision.

# Outreach & Publications

We communicate BAM research via webinars, publications in peer-reviewed journals, presentations, and reports. From January 2016 through March 2017, BAM efforts resulted in 5 papers in peer-reviewed journals, over 25 talks, poster, or workshop presentations, 1 webinar, and 2 reports posted to the BAM website..

## Publications

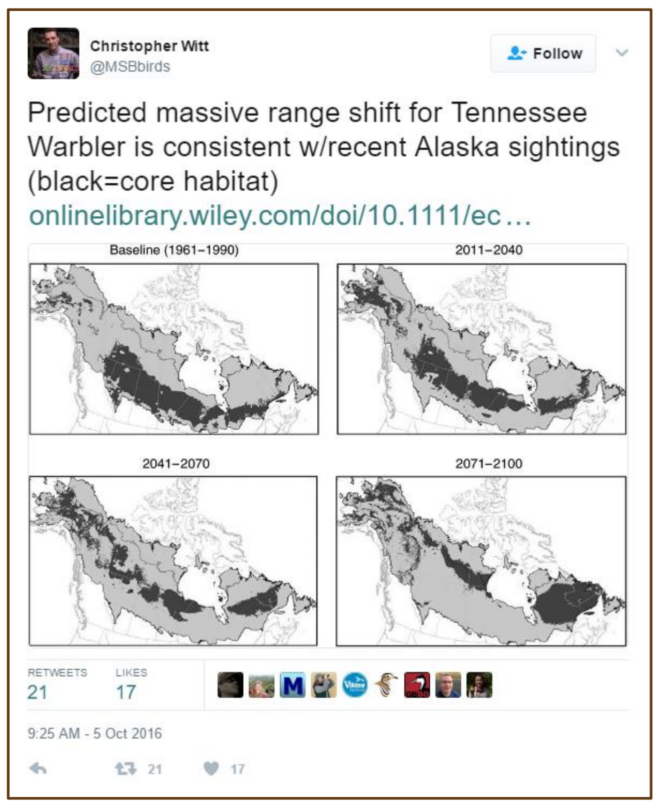
Ball, J. R., P. Sólymos, F. K. A. Schmiegelow, S. Hache, J. Schieck, and E. Bayne. 2016. Regional habitat needs of a nationally listed species, Canada Warbler (*Cardellina canadensis*), in Alberta, Canada. Avian Conservation and Ecology 11. doi: 10.5751/ACE-00916-110210.

Bayne, E. M., L. Leston, C. L. Mahon, P. Sólymos, C. S. Machtans, H. Lankau, J. R. Ball, S. L. Van Wilgenburg, S. G. Cumming, T. Fontaine, F. K. A. Schmiegelow, and S. J. Song. 2016. Boreal bird abundance estimates within different energy sector disturbances vary with point count radius. Condor 118:376–390. doi: 10.1650/CONDOR-15-126.1.

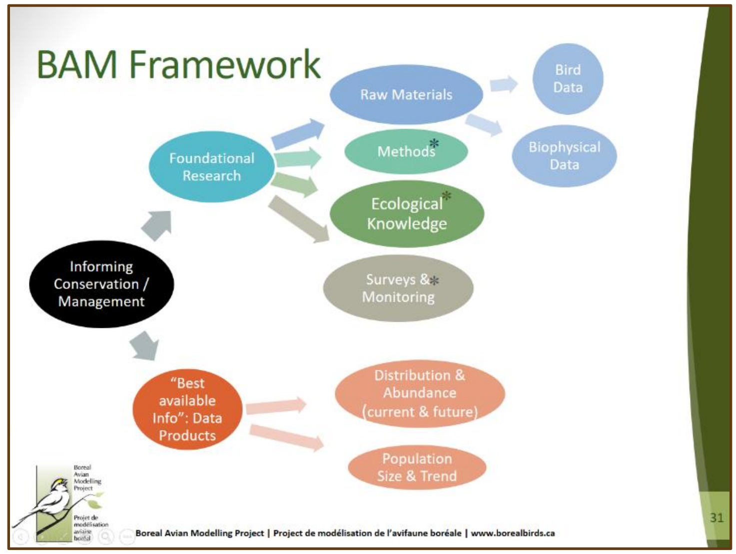
Mahon, C. L., G. Holloway, P. Sólymos, S. G. Cumming, E. M. Bayne, F. K. A. Schmiegelow, and S. J. Song. 2016. Community structure and niche characteristics of upland and lowland western boreal birds at multiple spatial scales. Forest Ecology and Management 361:99–116. doi: 10.1016/j.foreco.2015.11.007.

Stralberg, D., S. M. Matsuoka, C. M. Handel, F. K. A. Schmiegelow, A. Hamann, and E. M. Bayne. 2016. Biogeography of boreal passerine range dynamics in western North America: past, present, and future. Ecography. doi: 10.1111/ecog.02393.

Van Wilgenburg, S. L., P. Sólymos, K. J. Kardynal, and M. D. Frey. in press. Paired sampling as a pragmatic approach toward comparability between point counts conducted by humans versus acoustic recorders. Avian Conservation and Ecology.



## Presentations




Barker NKS. Boreal Avian Modelling Project: Past, present, and future. fRI Research Bird Conservation Workshop; 2016 Dec 8; Edmonton, AB, Canada. Viewable on YouTube.

Barker NKS, Drever MC, Stuart-Smith K, Trout LM. Ranking the bird values of forest stands in the interior of British Columbia. fRI Research Bird Conservation Workshop; 2016 Dec 8; Edmonton, AB, Canada.

Barker NKS, Roy C, Bidwell M, Cumming SG, Darveau, Marcel. Implications of large-scale habitat selection for conservation and management of waterfowl in North America. North American Congress for Conservation Biology; 2016 Jul 19; Madison, WI, USA.

Bayne EM. New technological approaches to understanding behavioral, population, and community level responses of birds to cumulative effects. fRI Research B ird Conservation Workshop; 2016 Dec 8; Edmonton, AB, Canada.

Bayne EM. Canada Warbler response to vegetation structure on recovering energy sector disturbances. PTAC - AUPRF - Ecological Issues Forum; 2016 Nov 24; Calgary, AB, Canada.

Bayne EM. Avian Response to Energy Sector Impacts at Different Scales: Do local-scale control-impact models tell us everything we need to know about cumulative effects? Oilsands Monitoring Program; 2016 Nov 23; Calgary, AB, Canada.

Bayne EM, Leston L, Mahon CL, Sólymos P, Machtans CS, Lankau H, et al. Boreal bird abundance estimates within different energy sector disturbances vary with point count radius. Poster presented at: Alberta Biodiversity Council Meeting; 2016 Feb; Calgary, AB, Canada.

Cumming SG, Barker NKS, Crewe T, Francis CM, Fontaine T, Haché S, et al. Uniting and augmenting avian data to inform conservation in the boreal. Conservation of Boreal Birds Workshop at the North American Congress for Conservation Biology; 2016 Jul 21; Madison, WI, USA.

Cumming SG, Stralberg D, Barker NKS, Vernier PR, Schmiegelow FKA, Darveau, Marcel. Evaluating biophysical surrogates of biodiversity in protected areas network design: songbirds and waterfowl in the Canadian boreal forest. North American Congress for Conservation Biology; 2016 Jul 18; Madison, WI, USA.

Leston L, Bayne EM. Mixture and occupancy models of birds recorded by autonomous recording units in boreal wetland landscapes. Oral presentation presented at: Meeting of the Alberta Chapter of the Wildlife Society; 2016 Mar 4; Drumheller, AB, Canada.

Leston L, Bayne EM, Mahon CL, Sólymos P, Ball JR, Schieck J, Schmiegelow FKA, Song S. How well do local-scale habitat models from forestry and energy sector control-impact studies predict boreal bird abundance at larger spatial extents? Oral presentation presented at: North American Ornithological Conference; 2016 Aug; Washington DC, United States.

Leston L, Bayne EM, Mahon CL, Sólymos P, Ball JR, Schieck J, Schmiegelow FKA, Song S. Assessing the efficacy of local control-impact models to predict cumulative effects on boreal birds. Poster presented at: University of Alberta Postdoctoral Fellow Association Research Day; 2016 Oct; Edmonton, AB, Canada.

Schmiegelow FKA. Systematic planning for conservation of boreal birds: Confronting conventional prioritization. Conservation of Boreal Birds Workshop at the North American Congress for Conservation Biology; 2016 Jul 21; Madison, WI, USA.

Sólymos P. Introduction to the analysis of messy data. 1-day workshop at the 8th biannual conference of the International Biogeography Society; 2017 Jan; Tucson, AZ. USA.

Sólymos P & Lele SR. Hierarchical models for conservation biologists made easy. 1-day workshop at the North American Congress for Conservation Biology; 2016 Jul 16; Madison, WI, USA.

Stralberg D. Anticipated Shifts in Boreal Ecosystems and Characteristics of Climatic Refugia for Boreal Ecosystems and Species. Adaptation Canada 2016 - A National Symposium on Climate Change Adaptation; 2016 Apr 13; Ottawa, ON, Canada. Available from: adaptationcanada2016.ca

Stralberg D. Incorporating climate refugia into conservation planning. Oral presentation presented at: Climate change and land use planning workshop: Practical approaches to incorporating climate change into land use planning; 2016 Mar 3 [cited 2016 May 27]; Edmonton, AB, Canada. Available from: www.cacpd.org/presentations/edmonton/10_Stralberg_Refugia.pdf

Stralberg D, Matsuoka SM, Handel CM, Bayne EM, Schmiegelow FKA, Hamann A. Biogeography of boreal passerine range dynamics in western North America: past, present, and future. North American Congress for Conservation Biology; 2016 Jul 19; Madison, WI, USA.

Stralberg D, Schmiegelow FKA, Bayne EM, Sólymos P, Nielsen SE, Carroll C. Identifying climate-change refugia and conservation priorities for boreal passerines. North American Ornithological Conference 2016; 2016 Aug 17; Washington, DC, USA.

Stralberg D, Tremblay JA, Berteaux D, Drever CR, Drever M, Naujokaitis-Lewis I. Conservation of boreal birds in a changing climate: Moving forward. Conservation of Boreal Birds Workshop at the North American Congress for Conservation Biology; 2016 Jul 21; Madison, WI, USA.

Suarez-Esteban A, Schmiegelow FKA, Cumming SG, Barker NKS. Wings of Change: how do boreal birds respond to anthropogenic forest disturbances? North American Congress for Conservation Biology; 2016 Aug 18; Madison, WI, USA.

Tremblay JA, Boulanger Y, Taylor A, Price D, Cyr D, Stralberg D. Simulating spatio-temporal dynamics of boreal bird habitats under natural and anthropogenic disturbances in a climate change context. North American Ornithological Conference 2016; 2016 Aug 18; Washington, DC, USA.

Van Wilgenburg SL, Stralberg D, Haché S, Sólymos P, Cumming SG, Bayne EM, et al. Leveraging temporally sparse data to identify possible causes for population change in boreal forest bird communities. North American Ornithological Conference; 2016 Aug 20; Washington, DC, USA.

Haché, S, Pankratz, R, Sólymos, P, and Bayne, EM, Detectability of roadside and forest-edge Autonomous Recording Unit-based avian point-count surveys: implications for the North American Breeding Bird Survey. North American Ornithological Conference; 2016 Aug 20; Washington, DC, USA.

Westwood A. Conservation of three forest landbird species at risk: Characterizing and modelling habitat at multiple scales to guide management planning. PhD thesis defence; 2016 Mar 3; Halifax, NS, Canada.

Westwood, A., Solymos, P., Fontaine, T., Mazerolle, D., Bayne, E., and Staicer, C. 2016. Predicting population size and density of species at risk in national park. Poster presented at CAG-ACG Annual Meeting 2016, May 30-June 4, Halifax, Canada.

## Webinars

On April 27th, 2016, BAM hosted a webinar by Péter Sólymos entitled "**Can we improve trend estimates for boreal birds? Integrating longitudinal roadside surveys with spatially extensive off-road surveys**". Invited participants included the BAM Technical Committee and members of the ECCC Landbird Technical Committee. The webinar discussed some preliminary results found during our efforts to combine BAM and BBS data to estimate trends for boreal species. Time was allotted for a discussion with participants.

# Project Management

## The Nature of the BAM Project

The BAM Project is supported by a core team of researchers, staff, and students, as well as extensive contributions of time, expertise, data and financial support from many partners and organizations.

### Project Team

**Steering Committee**

- Erin Bayne, University of Alberta
- Steve Cumming, Université Laval
- Fiona Schmiegelow, University of Alberta
- Samantha Song, Environment & Climate Change Canada

**Project Staff:** BAM welcomes Mélina Houle, who has taken on some GIS duties as Trish transitions to U.Alberta North.

- Coordinating Scientist: Nicole Barker, full-time
- Database Manager: Trish Fontaine, part-time
- Statistical Ecologist: Péter Sólymos, part-time
- Project Ecologist: Diana Stralberg, part-time
- Database and GIS Assistant: Mélina Houle, part-time

**Post-doctoral Fellows:** BAM welcomes Francisco Dénes, a new post-doctoral fellow

- Post-doctoral Fellow: Francisco Dénes
- Post-doctoral Fellow: Lionel Leston
- Post-doctoral Fellow: Alberto Suarez Esteban

**Students:**

- PhD candidate with Fiona Schmiegelow: Tara Stehelin

**Contributing Scientists:**

- Samuel Haché, Wildlife Biologist, ECCC-CWS
- C. Lisa Mahon, Wildlife Biologist, ECCC-CWS
- Steve Matsuoka, Research Biologist, United States Geological Survey
- Judith Toms, Wildlife Biologist, ECCC-CWS
- Steve Van Wilgenburg, Wildlife Biologist, ECCC-CWS
- Alana Westwood, independent

## Technical Committee

- Marcel Darveau, Ducks Unlimited Canada / Université Laval
- André Desrochers, Université Laval
- Pierre Drapeau, Université du Québec à Montréal
- Charles Francis, ECCC-CWS
- Colleen Handel, United States Geological Survey
- Keith Hobson, University of Western Ontario
- Craig Machtans, ECCC-CWS
- Julienne Morissette, Ducks Unlimited Canada
- Gerald Niemi, University of Minnesota – Duluth
- Rob Rempel, Ontario Ministry of Natural Resources / Lakehead University
- Stuart Slattery, Ducks Unlimited Canada
- Phil Taylor, Acadia University
- Lisa Venier, Canadian Forest Service
- Pierre Vernier, University of British Columbia
- Marc-André Villard, Université du Québec à Rimouski

## Support Team

Many additional people provide time and expertise to BAM project activities. This year, we would like to recognize the contributions of the following individuals:

- *Connie Downes*, *Marie-Anne Hudson,* and *Kate Campbell* (Environment & Climate Change Canada): BBS data support
- *Nash Goonewardena, Ian Paine,* and *Michael Abley* (University of Alberta): Technical support
- *Denis Lepage* and *Catherine Jardine* (Bird Studies Canada): Atlas data support
- *Paul Morrill*: website design, programming, and support
- *Brendan Ward, Mike Lundin, Tosha Comendant, James Strittholt* (Conservation Biology Institute): Web mapping gateway support

## Partnerships

Our partners have made important contributions to the success of the BAM project by providing avian data, access to environmental covariates, and financial support. The BAM project would not exist without the generous contributions of its funding and data partners.

### Funding Partners

We are grateful to the following organizations that have provided funding to the BAM Project since its initiation

*Founding organizations and funders*

- Environment & Climate Change Canada
- University of Alberta
- BEACONs

*Financial support received in 2016-17*

- Alberta Environmental Monitoring, Evaluation and Reporting Agency / Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring
- Alberta Pacific Forest Industries Inc.
- Boreal Songbird Initiative
- Canfor Corporation
- Environment & Climate Change Canada
- Mitacs Accelerate Program
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Sustainable Forestry Initiative
- Northwest Boreal Landscape Conservation Cooperatives
- Université Laval
- University of Alberta
- West Fraser Timber Co. Ltd.

*Past financial supporters*

- Alberta Biodiversity Monitoring Institute
- Alberta Conservation Association
- Alberta Climate Change Emissions Management Corporation (CCEMC)
- Alberta Innovates Technology Futures
- Alberta Land-use Framework (Government of Alberta)
- Amazon Web Services Education Research Grant Award
- Canadian Boreal Initiative
- Canada Foundation for Innovation
- Ducks Unlimited Canada
- Environmental Studies Research Fund
- Environmental Monitoring Committee of the Lower Athabasca (EMCLA)
- Fonds québécois de la recherche sur la nature et les technologies
- Forest Products Association of Canada
- Geomatics for Informed Decisions (GEOIDE)
- Government of Canada (Vanier Scholarship)
- Killam Trusts (Memorial scholarship to Stralberg)
- Ministère des Ressources naturelles et de la Faune, MRNF, Québec
- Northern Centre for Conservation Science
- Parks Canada
- Sustainable Forest Management Network
- United States National Fish and Wildlife Foundation (NFWF)
- United States Fish and Wildlife Service,

- Neotropical Migratory Bird Conservation Act Grants Program
- Landscape Conservation Cooperative

## Data Partners

The following institutions and individuals have provided or facilitated provision of bird and environmental data to the Boreal Avian Modelling Project. If you notice a name is missing, please inform the Coordinating Scientist, Nicole Barker: nbarker@ualberta.ca , so that we can correct the omission.

*Avian Data*

**Institutions**: Acadia University; Alaska Bird Observatory; Alaska Natural Heritage Program; Alaska Science Center; Alberta Biodiversity Monitoring Institute; Alberta Pacific Forest Industries Inc.; AMEC Earth & Environmental; AREVA Resources Canada Inc.; Avian Knowledge Network; AXYS Environmental Consulting Ltd.; Bighorn Wildlife Technologies Ltd.; Bird Studies Canada; Canadian Natural Resources Ltd.; Canfor Corporation; Daishowa Marubeni International Ltd; Canadian Wildlife Service and Science & Technology Branch, Environment and Climate Change Canada; Golder Associates Ltd.; Government of British Columbia; Government of Yukon; Hinton Wood Products; Hydro-Québec Équipement; Kluane Ecosystem Monitoring Project; Komex International Ltd.; Louisiana Pacific Canada Ltd.; Manitoba Breeding Bird Atlas; Manitoba Hydro; Manitoba Model Forest Inc.; Manning Diversified Forest Products Ltd.; Maritimes Breeding Bird Atlas; Matrix Solutions Inc. Environment & Engineering; MEG Energy Corp.; Mirkwood Ecological Consultants Ltd.; NatureCounts; Ontario Ministry of Natural Resources; OPTI Canada Inc.; PanCanadian Petroleum Limited; Parks Canada (Mountain National Parks Avian Monitoring Database); Petro Canada; Principal Wildlife Resource Consulting; Regroupement Québec Oiseaux; Rio Alto Resources International Inc.; Saskatchewan Environment; Shell Canada Ltd.; Suncor Energy Inc.; Tembec Industries Inc.; Tolko Industries Ltd.; U.S. Army; U.S. Fish and Wildlife Service; U.S. Geological Survey, Alaska Science Center; U.S. National Park Service; Université de Moncton; Université du Québec à Montréal; Université du Québec en Abitibi-Témiscamingue; Université Laval; University of Alaska, Fairbanks; University of Alberta; University of British Columbia; University of Guelph; University of New Brunswick; University of Northern British Columbia; URSUS Ecosystem Management Ltd.; West Fraser Timber Co. Ltd.; Weyerhaeuser Company Ltd.; Wildlife Resource Consulting Services MB Inc.

**Individuals**: K. Aitken, A. Ajmi, B. Andres, J. Ball, E. Bayne, P. Belagus, S. Bennett, R. Berger, M. Betts, J. Bielech, A. Bismanis, R. Brown, M. Cadman, D. Collister, M. Cranny, S. Cumming, L. Darling, M. Darveau, C. De La Mare, A. Desrochers, T. Diamond, M. Donnelly, C. Downs, P. Drapeau, C. Duane, B. Dube, D. Dye, R. Eccles, P. Farrington, R. Fernandes, M. Flamme, D. Fortin, K. Foster, M. Gill, T. Gotthardt, N. Guldager, R. Hall, C. Handel, S. Hannon, B. Harrison, C. Harwood, J. Herbers, K. Hobson, M-A. Hudson, L. Imbeau, P. Johnstone, V. Keenan, K. Koch, M. Laker, S. Lapointe, R. Latifovic, R. Lauzon, M. Leblanc, L. Ledrew, J. Lemaitre, D. Lepage, B. MacCallum, P. MacDonell, C. Machtans, C. McIntyre, M. McGovern, D. McKenney, S. Mason, L. Morgantini, J. Morton, G. Niemi, T. Nudds, P. Papadol, M. Phinney, D. Phoenix, D. Pinaud, D. Player, D. Price, R. Rempel, A. Rosaasen, S. Running, R. Russell, C.

Savignac, J. Schieck, F. Schmiegelow, D. Shaw, P. Sinclair, A. Smith, S. Song, K. Sowl, C. Spytz, D. Swanson, S. Swanson, P. Taylor, S. Van Wilgenburg, P. Vernier, M-A. Villard, D. Whitaker, T. Wild, J. Witiw, S. Wyshynski, M. Yaremko.

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**Breeding Bird Survey**: We would like to also thank the hundreds of skilled volunteers in Canada and the US who have participated in the BBS over the years and those who have served as State, Provincial, or Territorial coordinators for the BBS.

*Biophysical Data*

**Institutions**: BirdLife International & NatureServe; Global Land Cover Facility; Natural Resources Canada - Canada Centre for Remote Sensing & Canadian Forest Service; Numerical Terradynamic Simulation Group at the University of Montana.

**Common Attribute Schema for Forest Resource Inventory (CASFRI)**: Alberta Pacific Forest Industries Inc.; Canfor Corporation; Louisiana Pacific Canada Ltd.; Tolko Industries Ltd.; West Fraser Timber Co. Ltd.; Weyerhaeuser Company Ltd.; Blue Ridge Lumber; Buchanan Forest Products; Cenovus Energy Inc.; Daishowa Marubeni International Ltd.; Millar Western Forest Products Ltd.; Mistik Management Ltd.; Tembec Industries Inc.

Government of Alberta - Environment and Parks (formerly Environment and Sustainable Resource Development); Government of British Columbia - Forests, Lands & Natural Resource Operations; Government of Canada - Department of National Defence and Parks Canada; Government of Manitoba - Conservation and Water Stewardship; Government of New Brunswick - Natural Resources; Government of Newfoundland & Labrador - Natural Resources; Government of Nova Scotia - Natural Resources; Government of Ontario - Natural Resources; Government of PEI - Communities, Land and Environment (formerly Environment, Energy and Forestry); Government of Québec - Forests, Wildlife and Parks (formerly Natural Resources and Wildlife); Government of Saskatchewan - Environment; Government of the Northwest Territories - Environment and Natural Resources; Yukon Government - Energy, Mines and Resources.

# References


Badiou, P., R. Baldwin, M. Carlson, M. Darveau, P. Drapeau, K. Gaston, J. Jacobs, J. Kerr, S. Levin, M. Manseau, G. Orians, S. Pimm, H. Possingham, P. Raven, F. Reid, D. Roberts, T. L. Root, N. T. Roulet, J. Schaefer, D. Schindler, J. Stritthold, N. Turner, and J. Wells. 2013. Conserving the world's last great forest is possible: Here's how. Briefing note, International Boreal Conservation Science Panel, Washington, DC, USA. Retrieved July 29, 2013, from http://borealscience.org/wp-content/uploads/2013/07/conserving-last-great-forests1.pdf.

Ball, J. R., P. Sólymos, F. K. A. Schmiegelow, S. Hache, J. Schieck, and E. Bayne. 2016. Regional habitat needs of a nationally listed species, Canada Warbler (*Cardellina canadensis*), in Alberta, Canada. Avian Conservation and Ecology 11. doi: 10.5751/ACE-00916-110210.

BAM. 2012. Density Estimation. Retrieved November 19, 2015, from http://www.borealbirds.ca/index.php/density.

Barker, N. K. S., S. G. Cumming, and M. Darveau. 2014a. Models to predict the distribution and abundance of breeding ducks in Canada. Avian Conservation and Ecology 9:7. doi: http://dx.doi.org/10.5751/ACE-00699-090207.

Barker, N. K. S., S. M. Slattery, M. Darveau, and S. G. Cumming. 2014b. Modeling distribution and abundance of multiple species: Different pooling strategies produce similar results. Ecosphere 5:art158. doi: http://dx.doi.org/10.1890/ES14-00256.1.

Bayne, E. M., L. Leston, C. L. Mahon, P. Sólymos, C. S. Machtans, H. Lankau, J. R. Ball, S. L. Van Wilgenburg, S. G. Cumming, T. Fontaine, F. K. A. Schmiegelow, and S. J. Song. 2016. Boreal bird abundance estimates within different energy sector disturbances vary with point count radius. Condor. doi: 10.1650/CONDOR-15-126.1.

Carlson, M. 2015. Prioritization of Landbird Habitat in Canada's Boreal and Hemiboreal Region. Report to Environment Canada - Canadian Wildlife Service, Environment and Climate Change Canada, Ottawa, ON, Canada.

Environment Canada. 2016a. Recovery Strategy for Canada Warbler (Cardellina canadensis) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa.

Environment Canada. 2016b. Recovery Strategy for Olive-sided Flycatcher (Contopus cooperi) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa.

Environment Canada. 2016c. Recovery Strategy for the Common Nighthawk (Chordeiles minor). Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa.

Mahon, C. L., J. Smith, E. M. Bayne, P. Sólymos, and S. J. Song. 2014. Evaluation of Landscape Analysis Tools for Assessing Risks to Migratory Landbirds in the Oil Sands Areas of Alberta. JOSM Report, Edmonton, AB, Canada.

Moilanen, A., H. Kujala, and J. R. Leathwick. 2009. The Zonation framework and software for conservation prioritization. Spatial conservation prioritization:196–210. Retrieved March 28, 2017, from http://pfigshare-u-files.s3.amazonaws.com/969890/PosterZonation_v1_A3.pdf.

Schmiegelow, F. K. A., C. S. Machtans, and S. J. Hannon. 1997. Are boreal birds resilient to forest fragmentation? An experimental study of short-term community responses. Ecology 78:1914–1932. doi: 10.1890/0012-9658(1997)078[1914:ABBRTF]2.0.CO;2.

Sólymos, P. 2016. QPAD version 3 documentation. Technical Report, Boreal Avian Modelling Project, Edmonton, AB, Canada. Retrieved from http://www.borealbirds.ca/files/Solymos2016.QPAD_v3_report_2.pdf.

Sólymos, P., C. L. Mahon, and E. M. Bayne. 2014. Development of predictive models for migratory landbirds and estimation of cumulative effects of human development in the oil sands area of Alberta. Technical Report, Joint Oil Sands Monitoring: Cause-Effects Assessment of Oil Sands Activity on Migratory Landbirds, Edmonton, AB, Canada. Retrieved from http://www.borealbirds.ca/files/JOSM_Report_2014_AllSpecies.pdf.

Sólymos, P., L. Mahon, T. Fontaine, and E. M. Bayne. 2015. Predictive models for estimating the cumulative effects of human development on migratory landbirds in the oil sands areas of Alberta. Technical Report, Joint Oil Sands Monitoring: Cause-Effects Assessment of Oil Sands Activity on Migratory Landbirds, Edmonton, AB, Canada.

Sólymos, P., S. M. Matsuoka, E. M. Bayne, S. R. Lele, P. Fontaine, S. G. Cumming, D. Stralberg, F. K. A. Schmiegelow, and S. J. Song. 2013. Calibrating indices of avian density from non-standardized survey data: Making the most of a messy situation. Methods in Ecology and Evolution 4:1047–1058. doi: http://dx.doi.org/10.1111/2041-210X.12106.

Stralberg, D., E. M. Bayne, S. G. Cumming, P. Sólymos, S. J. Song, and F. K. A. Schmiegelow. 2015a. Conservation of future boreal forest bird communities considering lags in vegetation response to climate change: a modified refugia approach. Diversity and Distributions 21:1112–1128. doi: 10.1111/ddi.12356.

Stralberg, D., S. M. Matsuoka, A. Hamann, E. M. Bayne, P. Sólymos, F. Schmiegelow, X. Wang, S. G. Cumming, and S. J. Song. 2015b. Projecting boreal bird responses to climate change: The signal exceeds the noise. Ecological Applications 25:52–69. doi: http://dx.doi.org/10.1890/13-2289.1.

Yip, D. A., E. M. Bayne, P. Sólymos, J. Campbell, and D. Proppe. 2017. Sound attenuation in forest and roadside environments: Implications for avian point-count surveys. The Condor 119:73–84. doi: 10.1650/CONDOR-16-93.1.

# Boreal Avian Modelling Project

## Annual Report April 2016 - March 2017

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