Boreal Avian Modelling Project

2008-09 Annual Report to Environment Canada

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PROJECT OBJECTIVES & PROGRESS

The Boreal Avian Modelling Project (BAM)[1] was designed to synthesise quantitative information on boreal birds and their habitats across Canada. Recent ecological change in the boreal forests, due to increasing effects of industrial activity and climate change, has highlighted the need for integrated data and analysis that inform conservation and management decisions. With that vision, and fuelled by an unparalleled collaboration of researchers and agencies across the country, the BAM project has now collated a widespread range of studies into a comprehensive, national boreal bird and habitat database. Coupled with the development of analytical methods to standardise datasets from different surveys, this achievement marks a major technical advance in support of migratory bird management. BAM's database is being used to build statistical models of bird species distributions, habitat occupancy, and densities. These results will be regularly updated as new data are contributed and new analytical techniques are developed or applied. Future efforts include analyses to assess avian response to ecological change (habitat, climate, land use). Our work will be available to all interested parties, in support of conservation planning across the Canadian boreal and taiga.

The **project's objectives** are to:

a) Assemble and maintain the most complete and current repository of spatially referenced data for boreal birds and their habitats.

b) Apply and, where necessary, develop state-of-the art analytical methods to provide reliable information on boreal bird habitat associations, describe species distributions, and generate testable hypotheses about key mechanisms driving these patterns (e.g. climate, landuse, latitude).

[1] formerly the National Boreal Bird-Habitat Modelling Project

c) Improve the efficacy of avian data collection in Canada by informing the development of standards for bird sampling protocols and database structure.

d) Provide a conservation legacy for avian data collected in Canada's boreal forest, beyond the scope of individual research projects.

e) Build support from academia, industry, governments, non-governmental organisations and other interested parties for further development and testing of models of boreal bird distributions, populations, and habitats, and for the proactive application of such models to the conservation of boreal forests and biodiversity.

f) Encourage public awareness and education by providing ready access to the most current information on the status of boreal bird populations.

We achieved the following **key results** during the 2008-09 fiscal year:

1) Completed the first version of our fully national database of boreal bird surveys and habitats across Canada, including assembly of all available digital forest resource inventories from boreal Canada, and an expansion of our digital library of biophysical data with newly available covariates.

2) Revised bird abundance models for Western Canada, with refined habitat and climate variables and newly developed corrections for differences among survey methods.

3) Resumed the construction of national models of landbird abundance using our updated data, new correction factors, and a thoroughly vetted suite of new biophysical variables. In addition, we developed a method for computing bird density and produced national population estimates for 82 passerine species, to contribute to Environment Canada's planning process for Bird Conservation Regions.

4) Produced additional metrics to characterize landbird populations and communities: built a prototype regional bird-habitat model using forest resource inventory data for the Alberta-Pacific Forest Industries Forest Management Area in Alberta, began a risk assessment to estimate incidental take, and built preliminary models of bird species richness.

5) Redesigned the BAM website to have a more efficient structure, a more robust architecture to support display of future results, and better visual appeal. Using project results to date, we developed online materials that explain the life history, distribution and habitat use of boreal bird species. The new website will be launched in summer 2009.

6) Realised numerous communications opportunities to engage project partners / end-users and to broaden the awareness and credibility of the project among the research and management communities. Communications products included seminars, drafts of scientific publications, technical workshops, reports, and email updates.

RESEARCH UPDATE

1. Bird data assembly

(i) Compilation of data for eastern Canada

This year we obtained several new and important data contributions from eastern Canada, as we continued to build upon BAM's initial efforts in western boreal regions. We now have data for 17 projects in the east, including 15,339 point-count stations in Ontario and 2,318 stations across Quebec, Newfoundland and Labrador, and New Brunswick. Hydro Québec and Environment Canada's Québec Region have provided extensive datasets from otherwise unsampled regions. We anticipate obtaining additional data from Newfoundland and Labrador Hydro that will markedly improve our coverage of the easternmost parts of the Canadian boreal forest.

(ii) Updates to western datasets

Our partners in western Canada continue to provide new data from ongoing sampling at established sites and from new sampling locations. This year we incorporated 2750 new stations into the western dataset, in addition to annual updates received for many stations.

(iii) First national version of BAM's bird dataset

In December 2008 we completed the first fully national version of the bird dataset (Figure 1). This involved incorporation of the new data described above, and some additions to the database structure. We used analyses concurrent with this stage to test-drive the integrity of all data records, and to document and correct detected errors.

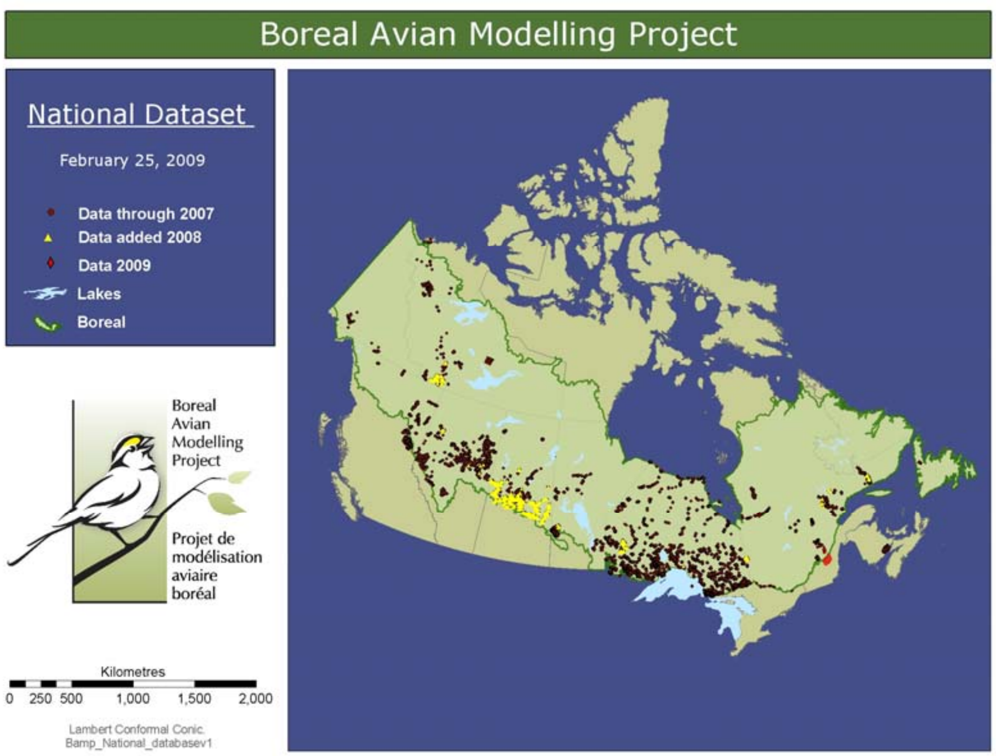

Figure 1. Project study area in Canada's boreal forest, showing the extent of the boreal forest (green lines) and all sampling locations as of February 2009.

To date, BAM has integrated point count data from 88 different research projects. contributed by 53 partner organisations, into a single consistent database. The database now contains a total of 581,806 data points (i.e. individual bird observations) from 37,100 point count stations. This represents an increase of about 30,000 data points sampled at 3300 stations, compared to last year. The contributing projects collectively span the 16 yr period from 1993 to 2008 (Figure 2a). Most stations were sampled in only one year, although there are several multi-year projects in the database (Figure 2b).

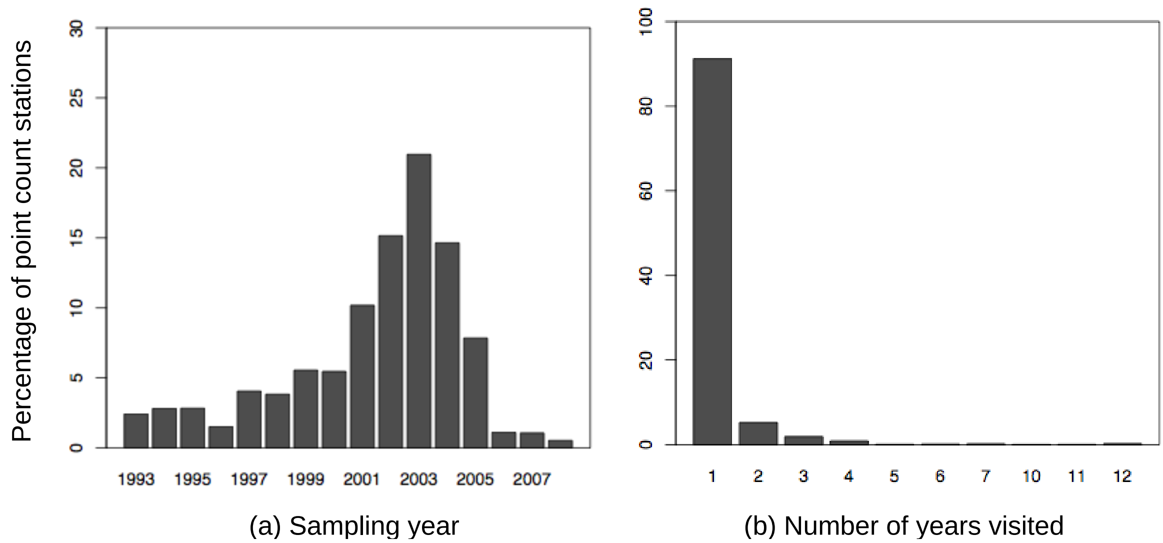

Figure 2. Temporal distribution of sampling effort in the project's boreal bird database: (a) years in which bird surveys were conducted; (b) number of years each point count station was visited.

We will continue to take every opportunity to address remaining gaps in our spatial coverage (Figure 1). To do so, we are targeting known data holders who have yet to participate, particularly in eastern Canada. We are pursuing opportunities (e.g. via our website, presentations, and scientific papers) to communicate our project goals more widely in an effort to attract participation from potential new contributors. However there are clearly large areas of the boreal and taiga regions forest where no surveys have ever been conducted. This underscores the need for targeted data collection, such as a long-term, national boreal-bird monitoring program.

2. Biophysical data assembly

(i) Update on national environmental data

An important component of BAM's data acquisition is continually augmenting our extensive library of spatial covariates. This digital data library contains many spatial covariates describing habitat and environmental conditions for modelling across our study area. It includes national cartographic data (e.g. streams, rivers and lakes, land use), spatially interpolated climate data, comprehensive fire history and fire regime data, and remotely-sensed measures of productivity and land or vegetation cover classes.

In anticipation of our national modelling initiatives, this year we undertook a substantial effort to research the availability of new biophysical data as a complement to our newly completed national bird database. This led to the incorporation of several new spatial covariates, and to significant updates and revisions of existing data layers. Notably, the Canadian Forest Service provided us with new point-level climate data for our entire study area, matched to our many thousands of bird survey locations. This is a significant advance over the grid surfaces of climate data to which we had access previously; the improved spatial resolution will allow us to explore finer-scale climate effects. We also updated or replaced our measures of mean productivity and leaf area, and added two higher resolution landcover products. We expect these advances will enable us to better model the influence of environmental conditions on boreal bird distributions.

(ii) Acquisition and integration of regional forest data (forest resource inventories)

Remote sensing of land cover data enables the study of vegetation patterns over vast areas, but at the cost of low spatial resolution and/or limited thematic precision. While we use some remotely sensed vegetation data in our habitat modelling, they are not sufficient for elucidating the impact of some land use practices on forest birds, because: (1) habitat selection by birds happens at a much finer scale than what is available from satellites, and (2) the development of planning tools for forest management requires projections of volumes of target tree species for harvest through time. Instead, to properly address these forest conservation and management needs at a regional scale, models must include vegetation attributes such as forest age, canopy height, and tree species composition.

This has been a barrier to national modelling because such information is only available piecemeal, from Forest Resource Inventory (FRI) data kept by individual governments or forest products firms. This year we made extensive progress on a collaborative effort (background detailed in our previous annual report) to obtain these FRIs and integrate them into a single format. Almost all available FRI data have now been assembled[2]. The process of translating these diverse formats into a common standard that will support consistent bird-habitat modelling across Canada is underway. Working with consultants at Timberline Natural Resource Group Ltd., we designed a standard representation for the 20+ source inventories, a protocol for translation of individual inventories into the standard, and we have developed a prototype of the programming required for parts of Alberta, Manitoba and Quebec. A full description of the Common Attribute Schema and metadata are detailed in draft report (see Project Communications) that will be posted to the BAM website after review and revision.

The completion of the standardised spatial FRI data will be a major achievement. It represents an enormous challenge that has previously been attempted previously only by the Canadian Forest Service, most recently with the 2001 version of Canada's National Forest Inventory. However, this NFI product is not available in the form of the high-resolution digital maps needed by BAM, and is also being superseded by a different system that is not suitable for spatial habitat modelling. In contrast, the product we have assembled will be maintained and accessible for the life of the project and beyond. This initiative will support models that link management actions to ecological indicators (e.g. of population size), and will ultimately ensure the applicability and utility of BAM products to forest management planning across the Canadian boreal forest.

[2] i.e. All provinces and territories other than New Brunswick and Nunavut.

3. Data storage and archiving

The project database is housed at the University of Alberta, Department of Renewable Resources. This includes the raw data, project metadata, spatial covariates and derivative products, all of which are backed up regularly. Data are also shared among Steering Committee members working on analysis at the U of A Department of Biological Sciences and Université Laval Département des sciences du bois et de la forêt. Further distribution is restricted by the data-sharing agreements that cover individual datasets. A more general data-sharing protocol is being developed, and options are being explored for a mirrored archival system to secure all survey and environmental data. For example, one authoritative version will be housed and maintained in a spatial data warehouse being established at S. Cumming's lab (Université Laval). We expect that mirrors will be maintained at other agencies, including Environment Canada, as the best safeguard of the data's integrity is replication among several responsible institutions with dedicated, long-term funding for database maintenance.

4. Data analysis and statistical modelling

(i) Innovation and refinement of methods to standardize survey data

In order to manage wildlife effectively, decision-makers need sound estimates of the size of animal populations. Accordingly, a central aim of the BAM project is to use our database to generate density estimates for boreal bird species, to inform forest planning and bird conservation initiatives across the Canadian boreal forest. As creation of the bird database involved compilation of data from thousands of point counts conducted by different researchers across the country, our estimates must correct for many of the factors that typically affect bird counts. Development of these corrections was essential before reliable population estimates were possible, and we recently concluded this integral step. (Technical aspects of the approaches summarised below are detailed in a draft manuscript that, upon completion and after Technical Committee review, will be available on the BAM website; see Bayne et al. under Project Communications, below).

<u>Corrections for survey design</u>

First, we had to overcome the important challenges of combining point count data collected with different protocols. For example, the time and distance over which surveys are conducted affect the number of individuals and species detected: longer counts over greater distances will likely detect more birds. We have now completed development of a method to standardize counts, by converting them to a common standard in order to correct for differences in survey design. This method used studies in our database that stratified observations by sampling duration (e.g. 3, 5 or 10 min) and distance class (e.g. 50,100, 200 m). We were then able to calculate precisely how those variables influenced bird abundances, and adjust all counts to a common standard (we used 10 minutes over an unlimited distance as the norm). Corrections for each distance-duration category were estimated from Generalised Linear Mixed Models with Poisson errors. The correction factors can be used as “offsets” in other modelling applications to standardise across multiple survey designs

<u>Corrections for detectability</u>

Second, we had to address the fact that surveys rarely detect all individuals, leading to an underestimate of animal densities. This required solving two related problems that influence “detectability”, the likelihood of observing a bird that is actually present. We used our extensive dataset and novel statistical methods developed for single-visit surveys to address both issues, which will therefore enable estimation of absolute density.

(a) Time of day and season:

Time of day and season are two of many external factors that influence avian singing behaviour and hence the results of point counts. Songbirds generally sing most frequently in early morning, and males tend to sing more earlier in the breeding season to establish territories and attract mates. The following graphs use BAM point count data to illustrate how time of day and season influence the singing rates of the Yellow-rumped Warbler (Figure 3): surveys conducted in periods of lower singing activity will detect fewer individuals, simply because birds are quieter, not necessarily because they are less abundant. Accordingly, we have standardised all BAM survey data to account for environmental factors that affect bird counts, based on the locations where they were conducted (i.e. time of year and local sunrise). We did this by adjusting all counts according to time since local sunrise and start of local spring.

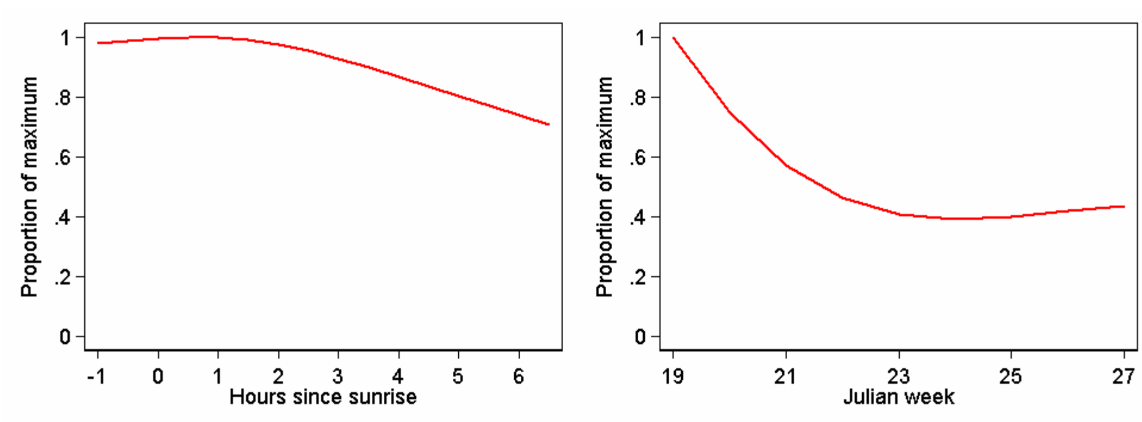

Figure 3. Influence of time of day and season on Yellow-rumped Warble abundance, as measured in point count surveys. Data are standardized as proportion of maximum, by dividing predicted count by highest predicted count per species.

(b) Effective detection radius:

Due to differences in the song properties of bird species, the effective sampling area of a point count differs among species, and also among habitats because of differences in how sounds travel through vegetation. Researchers often calculate “maximum detection distances”, the distance from an observer over which an individual bird can be heard. These values are obviously greater for species that produce louder sounds. Another approach to correcting for detectability is to use distance sampling to estimate an “effective detection radius”. This radius (EDR) is defined as the distance at which the probability of detecting an individual beyond a set distance is the same as the probability of missing an individual within this distance. We prefer this approach because EDR is less biased than assuming all birds are detected perfectly within a constant detection distance. EDR can be calculated for different habitat types or other strata, to test whether the assumption of equal detectability is met in different areas. We are using this method to compute bird population estimates across the boreal forest.

The novel correction factors that we have developed were made possibly only by the comprehensiveness of our database. They collectively represent an important contribution to ornithological study. This was evident at a recent workshop for Environment Canada's Western Boreal Conservation Initiative, which featured many presentations about the applied ecology of boreal birds. Virtually all researchers referenced the ongoing challenge of standardizing bird survey data, including the problems of detectability and consistency among surveys. By addressing these problems, our new methods provide an immediate example of the usefulness and cost-effectiveness of large-scale data compilation.

(ii) Evaluation of different land cover variables

The library of biophysical variables we have compiled for habitat modelling includes several remotely-sensed measures of land cover. One of the initial analytical challenges in the project was determining which of the available measures is best suited for modelling boreal bird distributions. To answer this question, we have explored habitat modelling using different remotely-sensed habitat descriptors that are available at a national extent. These data were obtained from three satellite sources, each at a different resolution: (1) at the finest scale (30m), data from the Earth Observation for Sustainable Development of Forests (EOSD) are based on Landsat imagery; (2) at a medium scale (250m), the Land Cover Classification 2005 (LCC05) from Natural Resources Canada used Moderate Resolution Imaging Spectroradiometer (MODIS) imagery; and finally, (3) at the largest scale (1km), the North America Land Cover (NALC) used Advanced Very High Resolution Radiometer (AVHRR) imagery. To date, we have achieved the best model performance with the second source, the LCC05 MODIS data—quite possibly because this intermediate scale is most commensurate with the spatial resolution of our avian data. As a result, we are using MODIS land cover data in current modelling exercises.

We have also established a partnership with Space for Habitat (an Environment Canada initiative that uses satellite data to map wildlife and habitat distributions for enforcement efforts) to inform further habitat analyses. We are embarking on a comparative study of the relative utility of the satellite habitat descriptors and the more detailed forest resource inventory (FRI). Following a recent boreal vegetation mapping workshop in Finland (see Project Communications), we are also developing a collaboration with a boreal vegetation mapping initiative within the Canadian Forest Service. This will provide access to an extensive set of standardised, classified, georeferenced vegetation plot data which will be used to assess the relative accuracy of the various land cover products. These initiatives will identify the best available habitat data for understanding and predicting boreal bird populations. As a broader contribution, they should also assist future large-scale modelling efforts in the selection of appropriate land cover products.

(iii) Bird density estimation: support for BCR planning

Environment Canada is undertaking a planning process for Canada's Bird Conservation Regions (BCR) that will be completed by 2010, to support management of these ecologically defined units of bird conservation. The plans require information about absolute bird densities, rather than indices of relative habitat suitability. Obtaining such information has been a long-standing, complex challenge for ornithologists, which BAM is now poised to tackle. Following the completion of our methods for standardizing survey data, we were recently able to begin the spatial estimation of bird population densities.

This is a complex process building on the corrections outlined above (i.e. calculations based on raw survey data, which are the number of individuals observed). The statistical method we are using is hierarchical regression, or Generalized Linear Mixed Models. To summarise, the steps involved in the estimation method that we developed are:

- Correction for differences among sampling methods (e.g. count duration or distance)
- Correction for environmental factors that affect counts (e.g. time of year and day)
- Account for inter-species differences in the detectability of bird sounds
- Calculate bird density in each habitat type, because factors like vegetation and human land-use affect the habitat preferences and behaviour of birds.
- Multiply density estimates by area to estimate actual population sizes.

How stratification by habitat type might influence population estimates across such a broad region is not known. Based on our evaluation of habitat variables (Section 4(ii), above), we are using the MODIS remote-sensed data and 2005 Land Cover Classification (LCC05) from Natural Resources Canada. We then determine the density of a species in all habitats in each stratum, such as a Bird Conservation Region or political jurisdiction, and multiple those densities by the area of the stratum to obtain a population estimate. (Statistical details are outlined in the draft manuscript Bayne et al., under Project Communications, below).

It is important to note that there is no single “correct” approach to estimating population size. Rather we are pursuing multiple methods, based on varying biological assumptions, so that we can report the full range of possible population sizes for boreal bird species. This will also enable us to conduct an analysis of the relative merits of the different available methods of estimation (e.g. BAM’s method, versus the Partners in Flight method and other published approaches).

To date we have used the BAM method to compute density estimates for 82 passerine species. An example of how density estimates can be mapped is shown for the Yellow-rumped Warbler (Figure 4), along with the corresponding habitat association plot (Figure 5). After we have completed evaluation of all estimation methods that we plan to test, the range of population estimates for each species will be posted on the project website. These results will be an invaluable tool to support bird conservation planning and management in the ecologically important, yet still poorly understood, boreal forest.

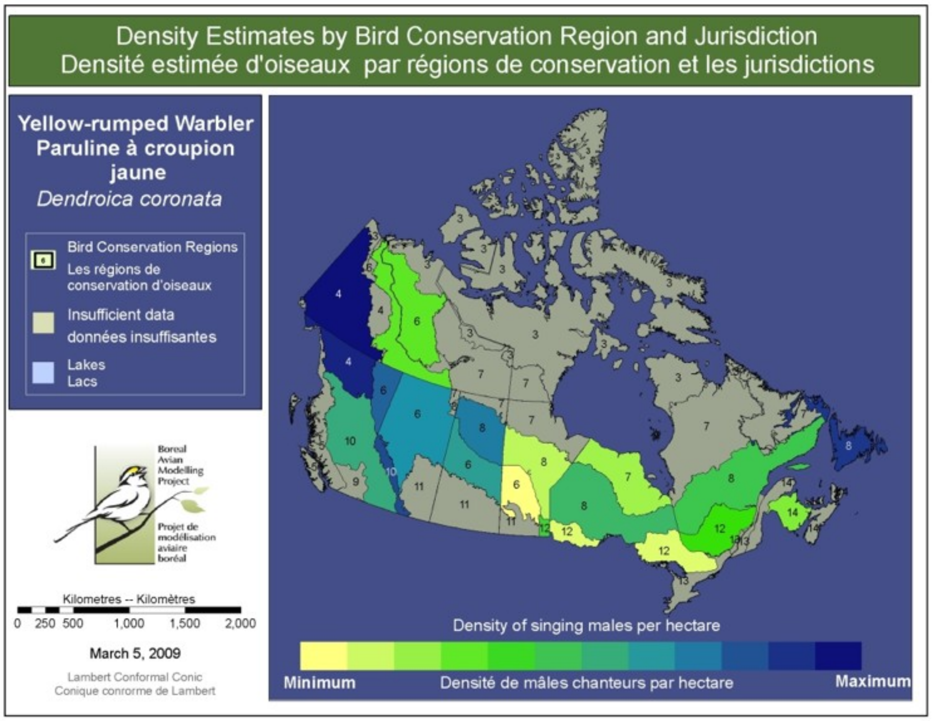

Figure 4. Estimated density of Yellow-rumped Warbler populations in Bird Conservation Regions within Canadian provinces.

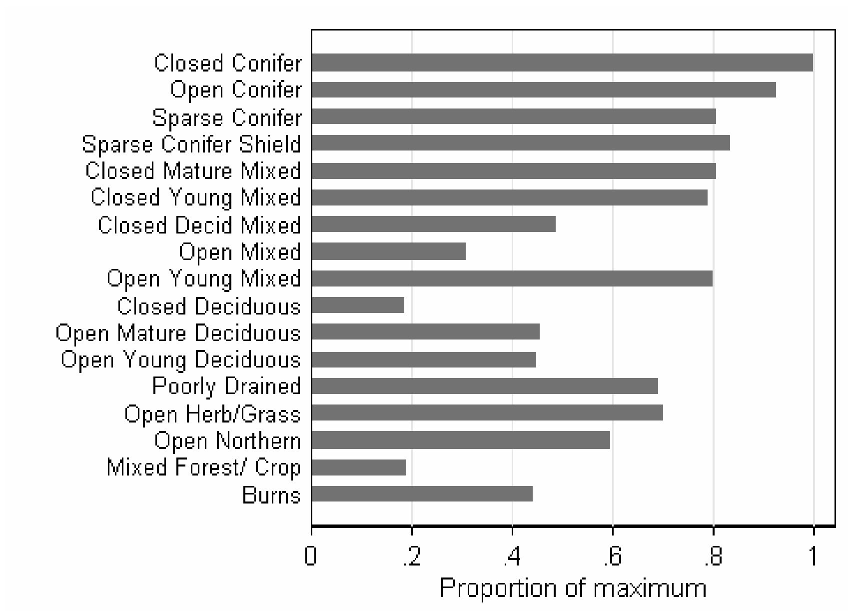

Figure 5. Habitat association plot for Yellow-rumped Warbler populations across Canada's boreal forest. Graph shows proportion of entire boreal population that is found in each habitat class. Vegetation classification is derived from 2005 Land Cover Classification (LCC05) from Natural Resources Canada.

(iv) Completion of potential niche models (CART)

Last year, we reported detailed results for our first generation of species distribution models, based on western boreal birds. This year, we updated all western models after the inclusion of additional survey data and our newly developed correction factors described above. These species distribution models were based on Classification and Regression Trees (CART) that help to identify key climate factors influencing species ranges. They describe the potential niches ("bioclimatic envelopes") of boreal birds, delineating areas that have suitable habitat based on where a species is known to occur based on existing records. CART models work by calculating how a group of explanatory variables is related to a response variable—in our case, how landscape, vegetation and climate features influence bird abundances. For each bird species, abundance data were split into similar groups of locations (i.e. survey stations) with roughly the same bird abundance, defined by some combination of the environmental factors. The end result of the process is a "regression tree", whose terminal nodes represent those groupings of locations (Figure 6).

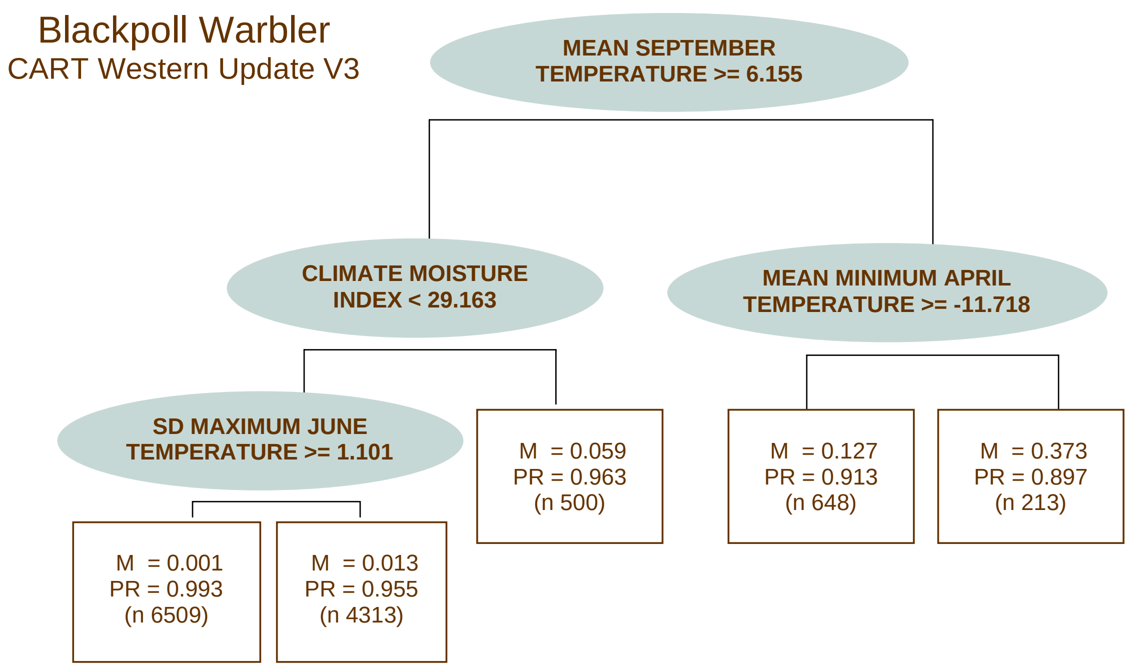

Figure 6. Example of a regression tree: updated western CART model for the Blackpoll Warbler. For each grouping of point count stations with similar bird abundance, data shown are mean abundance per count (M), predicted reliability of the model (PR), and number of stations surveyed (n).

Variables important for describing boreal bird distributions included type of land cover, number of growing degree days above 0°C, leaf area index, and the standard deviation of temperature measures. The resulting new maps of predicted abundance and reliability will be posted online, following the launch of our new website in summer 2009. These results are also being prepared for publication in the peer-reviewed literature (see Project Communications).

Following completion of the western models and the construction of pilot national models, the project's effort temporarily shifted away from species distribution models. We decided to proceed with developing the complex methods for population density modelling (outlined above), to coincide with Environment Canada's BCR planning process. Also, two important preliminary steps were required for the national CART models: obtaining adequate data coverage for the eastern half of the boreal region, and updating our biophysical database to include new environmental data that were not available for the western models.

Now, with those steps completed and the first national version of the bird database ready for analysis, we are proceeding with development of distribution models across the full extent of the Canadian boreal forest. Data have been exported and model building is now underway. Results will be posted online as soon as they are verified. This is an exciting step forward because our national CART models will be the first extensive characterization of avian habitat selection across the Canadian boreal forest. Another important outcome will be identification of a subset of the most useful climatic variables for our future population modelling.

(v) Regional-scale models

Significant progress has been made on a pilot regional study of the Alberta-Pacific Forest Industries Inc. (AlPac) forest management area in Alberta. Using their tenure area as a case study, we have developed an approach to conducting risk assessments for the incidental take of migratory birds in boreal forests. We are using our BAM method for population estimates to determine the density of individual bird species, applying habitat models derived from land uses analysis tools (such as ALCES, A Landscape Cumulative Effects Simulator) to obtain estimates of bird density in each habitat type, and then comparing the density of birds found under historic disturbance regimes (natural range of variation, or NROV) to current land use and future land use scenarios. This approach provides a mechanism to assess risk (e.g. bird density may be lower than NROV under current and future land use plans) and develop strategies to decrease risk (i.e., mitigation strategies, protection of habitat) for individual bird species.

Such regional analyses depend on the FRI data that BAM is in the process of integrating. The data required (i.e. tables of FRI attributes) have been successfully exported for two additional study regions (the province of Québec, and the Louisiana-Pacific FMA in the Duck Mountains of Manitoba) and will thus be available for analysis soon. This is an important technical advance because prior to BAM's initiative to standardise and integrate FRI data, it was impossible to extract these data with existing software.

(vi) Species richness

We have commenced analyses to investigate species richness patterns across the Canadian boreal (for example,Figure 7). As a preliminary step we used rarefaction (species accumulation with increased sampling effort) based on the number of individual birds detected at a survey station. We have since written a new model that will incorporate sampling effort, which will be the next step in this analysis.

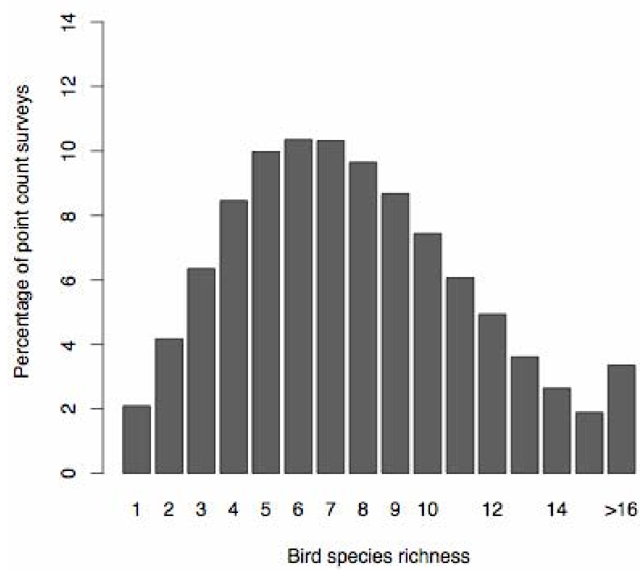

Figure 7. Number of bird species detected in point count surveys (for all stations in BAM database).

PROJECT MANAGEMENT

Steering Committee and Project Staff

The project Steering Committee consists of Drs. Erin Bayne, Steve Cumming, Fiona Schmiegelow and Samantha Song. This group is collectively responsible for project coordination, including staff management, liaison with project partners and the Technical Committee, and overall leadership of the project.

Core staff positions include data manager/administrator (Trish Fontaine) and project ecologist (Dr. Kara Lefevre). Our biostatistician (Dr. Shoufan Fang) recently moved on to another position; we are very appreciative of his contributions to BAM and wish him well in his new role.

Technical Committee

Our Technical Committee (TC) provides independent scientific advice on project direction and results. The BAM project is grateful for the participation of these ornithological experts:

Peter Blancher, Environment Canada
Marcel Darveau, Ducks Unlimited / U Laval
Jean-Luc Desgranges, Environment Canada
André Desrochers, Université Laval
Andrew Devries, Forest Products Assn of Can
Pierre Drapeau, U du Quebec à Montréal
Charles Francis, Environment Canada
Keith Hobson, Environment Canada
Craig Machtans, Environment Canada
Julienne Morissette, Ducks Unlimited Canada
Rob Rempel, Ontario Ministry of Natural Resources / Lakehead University
Stuart Slattery, Ducks Unlimited Canada
Phil Taylor, Acadia University
Steve Van Wilgenburg, Environment Canada
Lisa Venier, Natural Resources Canada
Pierre Vernier, University of British Columbia
Marc-André Villard, Université de Moncton

Contact with the TC was maintained this year through periodic research communications, small group discussions where possible (e.g. via related meetings such as the CWS landbird committee or the Western Boreal Conservation Initiative), and individual communication with the project team to address technical questions, as necessary. To discuss latest results and plan the project's next steps, the Steering Committee is preparing an update for spring 2009, and an ensuing physical meeting with the TC is anticipated for summer 2009.

Support Team

Many additional people provided their time and expertise to project activities this year:

Patrick Charlebois (Université Laval): computer programming
Paul Chytyk (YUNI Environmental Consulting): technical writing
John Cosco (Timberline Natural Resource Group): analysis and technical writing
Kevin Hannah (Environment Canada): avian life history and technical support
Bénédicte Kenmei (Université Laval): computer programming
Mélanie-Louise Leblanc (Université Laval): programming of statistical summaries
Lisa Mahon (University of Alberta): statistical analysis
Paul Morrill (Web Services): website design & programming
Sheila Potter (Blue Chair Designs): graphic design and website design and development
Pierre Racine (Université Laval): GIS programming
Stephanie Topp (Environment Canada): technical writing

PROJECT COMMUNICATIONS IN 2008-09

The enhanced BAM website is our main tool for communication about the project. It is a repository for modelling results and a vehicle for public education. This year we engaged web and graphic designers to enhance the look, architecture, and functionality of BAM's website. This will facilitate the ongoing addition of new results and our ability to communicate widely and effectively about the project. The website will present information about avian natural history, the history and objectives of the project, maps of sampling effort for each species, and density estimates for many boreal landbird species. The redesigned website will be housed at www.borealbirds.ca, in both official languages, and will be publicly accessible in summer 2009 (Figure 8).

In the coming year, we will continue to add population- and community-level results as material is produced. The functionality of the website will be continuously improved through feedback from end-users and, in the longer term, through technological updates that will increase the ability of users to query our web databases (e.g. end-user driven map production).

Figure 8. The new BAM website.

Presentations

BAM was represented in talks at several forums during the 2008-09 fiscal year:

Song SJ, et al. Boreal Avian Modelling Project. *Ontario Forest Birds Workshop*, Sault Ste. Marie, Ontario (April 2008).

Bayne, EM, FKA Schmiegelow, and SJ. Song. Overview of BAM project and its relationship with forestry planning in Al-Pac's FMA, *presentation to Alberta Pacific Forest Industries Inc.* (April 2008).

Cumming SC, FKA Schmiegelow et al. A science-based framework for identifying ecosystem benchmarks in Canada's boreal regions. Colloque: *Service des écosystèmes et de la biodiversité*, *Direction du patrimoine écologique et des parcs Ministère du Développement durable, de l'Environment et de Parcs*, Québec, QC (July 2008).

Bayne, EM, *L Habib*, and S Boutin. Chronic industrial noise and boreal birds. Invited symposium presentation at *American Ornithological Union's annual meeting*, Portland, OR, USA (August 2008).

Schmiegelow FKA, SC Cumming, et al. Benchmarks across the boreal: pro-active planning for system-level conservation and resilience. Symposium: *Boreal Zone Protected Areas, Canadian Council on Ecological Areas*, Québec, QC (September 2008).

Bayne, EM. How many boreal birds does it take to drive a Hummer? Invited presentation at *University of Regina Biology Seminar Series*, Regina, SK (September 2008).

Bayne, EM. How many boreal birds does it take to driver a Hummer*? University of Alberta Ecology Seminar Series*, Edmonton, AB (October 2008).

Cumming SC, FKA Schmiegelow et al. Benchmarks across the boreal: pro-active planning for system-level conservation and resilience. Seminar: *Département de biologie, Université du Québec à Montréal*, Montréal, QC (October 2008).

Bayne, EM. Development of ecologically-based criteria to assess the impact and recovery of linear features. *Resource Access and Ecological Issues Forum, Petroleum Technology Alliance Canada,* Calgary, AB (December 2008).

Bayne, EM. Cumulative effects and the impacts on boreal birds*. Prairie Habitat Joint Venture meeting* (December 2008).

Song SJ, et al. Boreal Avian Modelling Project update. *Canadian Wildlife Service Landbird Committee meeting*, Delta, BC (January 2009).

Bayne EM, et al. Boreal Avian Modelling Project*. Western Boreal Conservation Initiative Five-year Review Workshop*, Edmonton, AB (February 2009).

Bayne, EM. Old-growth spatial forest management planning, *presentation to Alberta Pacific Forest Industries Inc.* (March 2009).

Reports

These draft reports will be posted to the project website upon review and final editing:

Cosco JA. *Boreal Avian Modelling Project: Common Attribute Schema (CAS) for Forest Inventories Across Canada* (draft report submitted to BAM by Timberline Natural Resources Group, February 2009).

Cumming SC, Leblanc ML, and Lefevre KL*. Boreal Avian Modelling Project (BAM) Summary Statistics Report* (draft report is being prepared; estimated completion April 2009).

Scientific papers in preparation

Fang S, SG Cumming, FKA Schmiegelow, SJ Song and EM Bayne*. Prediction reliability measures for Classification and Regression Tree (CART) models of Poisson data*. Under revision for submission to Journal of Environmental Statistics.

(Lefevre et al.) *Toward continental conservation of the boreal forest avifauna: a pan-Canadian modelling project.* In preparation. (This was initially conceived as a review paper about boreal forest conservation and the role of bird habitat models. We subsequently decided there was a stronger need for a more targeted initial paper to introduce the project and solicit additional participation from the Canadian ornithology community). Final editing in progress and we anticipate submission to Avian Conservation and Ecology in summer 2009, following consultation with the BAM Technical Committee.

(Bayne et al.) *How many Ovenbirds are in Canada's boreal forest? A new approach to estimating population estimates*. In preparation.

Forging new links

We also communicated about BAM with several research groups—and simultaneously kept abreast of new developments and opportunities—by attending technical workshops:

Species distribution modelling course, *American Museum of Natural History*, Portal, Arizona, USA: BAM's project ecologist (K. Lefevre) attended this workshop to explore additional methods for modelling boreal bird habitat relationships (October 2008).

Waterfowl modelling workshop, Canards Illimité, Québec, QC: Steering Committee member S. Cumming participated in this workshop to discuss waterfowl modelling initiatives in relation to BAM (October 2008). As a result, we are helping to organise a workshop on transboreal waterfowl modelling in conjunction with the 5th North American Duck Symposium, August 17-20, 2009 in Toronto, ON.

CircumBoreal Vegetation Mapping workshop, Helsinki, Finland: S. Cumming attended this workshop to learn about new approaches to boreal habitat mapping (November 2008).

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Institutions

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