## Boreal Ecosystem Recovery and Assessment (BERA) – October 9 meeting, 11:30 AM – 12:30 PM

## Project Outline

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| Using spatial *N*-mixture models to relate bird abundance data from acoustic recorders to remote-sensed forest structure data | |
| Lead | Name and affiliation of person primarily responsible: Lionel Leston [BERA, Bioacoustic Unit, University of Alberta] |
| Collaborators | * Gustavo Lopez Quieroz [BERA, University of Calgary] * Mustafizur Rahman [BERA, University of Calgary] * Silvia Alejandra Losada [BERA, University of Calgary] * Erin Bayne [BERA, Bioacoustic Unit, University of Alberta] * Julia Linke [BERA, University of Calgary] * Greg McDermid [BERA, University of Calgary] |
| Data Requirements | * Avian point count data (provided by the Bioacoustic Unit) * Coarse-scale habitat and footprint data (provided by the Alberta Biodiversity Monitoring Institute) * LIDAR point cloud data (provided by Greg McDermid and Mustafizur Rahman) * Coarse woody debris data (provided by Gustavo Lopez Quieroz) * Snag data (provided by Mustafizur Rahman [BERA, University of Calgary]) * Shrub structural (and floristic?) data (provided by Silvia Alejandra Losada) (IF AVAILABLE) |
| Project Dependencies & Contingency Plans | **Dependencies**:   * Transcription of remaining recordings from Kirby Grid (16 stations) * Habitat and human footprint for Kirby Grid (to be digitized by ABMI) * Point cloud layer (max veg ht., mean veg ht., pt hits on/near ground/at a certain height above ground (determine what scale of point cloud data, by next week) (available November 20) * Remote-sensing layers provided by Gustavo, Mustafiz, and Silvia (Coarse woody debris layer already available, snag data assumed to be ready, additional shrub layer may be available by March)   **Contingency Plans**:   * Alternate coarse layers available as rasters (Beaudoin layer) or with permission from Al-Pac, possibly Al-Pac AVI layer from 2016 * Base analyses just on the already transcribed station data (84 stations) |
| Deliverables | * Base model results (no fine-scale data) for 20 species of birds in different guilds or most common species (Nov 6) * Interim report (Dec 2019): models incorporating point cloud data, snags, coarse woody debris * Interim report (Mar 2019): models incorporating shrub layer (IF AVAILABLE) * Final report (May 2020) * Published paper (2020-2021) |
| Status | Start date: September 2019  Status: ongoing  Scheduled completion: May 2020 |

## Overview:

Introduction: Energy sector development is increasing at a rapid rate in Alberta’s boreal forests, and there is a large, disproportionate increase in the cumulative length of linear footprint associated with this development, particularly seismic lines. The impact of seismic lines on mammalian species like wolves and woodland caribou is well known, but is less known for other components of boreal forest communities. Regeneration of forests along defunct seismic lines is a priority for reducing negative impacts of energy sector footprint on caribou. We are interested in knowing how boreal birds respond to restoration efforts related to this forest regeneration.

Objectives: To model how abundance of boreal birds (~20 species) varies with fine-scale vegetation structure associated with boreal forest regeneration along/adjacent to energy sector footprint like 2d and 3d seismic lines. We predict that models incorporating additional fine-scale data collected by drones and planes (e.g. LIDAR-based point clouds, coarse woody debris, snags, possibly shrub density) will improve prediction of bird abundance or occupancy relative to models without fine-scale data.

## Study Site(s):

The “Kirby” grid ~45 minutes north of Calling Lake (UTMs: 489525-494943, 6131568-6136993). If similar coarse-scale and fine-scale remote-sensed data are available alongside point count data outside of the Kirby grid in Alberta’s boreal forest region, then a larger study area might be considered. We will be using indices of bird abundance from autonomous recording unit (ARU) stations, and individual recordings (3-4 per station) will be the unit of analysis. Data consists of counts of each species detected in each recording; actual abundance is not known but estimated.

## Strategy:

September (Received bird data from 84 stations at Kirby grid; initial N-mixture model scripts developed; coarse woody debris layer received)

October 9 - meeting

October (Develop initial model scripts; acquire coarse-filter habitat and footprint data for base model; obtain snag data layer)

October 23 – interim meeting 11:30 Wed

Early November (Lionel: have base model ready and run model fit diagnostics, using just coarse-scale variables from ABMI; even )

November 6 – present results from base model for ~20 species of the most common birds

November 20 (receive remaining remote-sensed layers: LIDAR-based point clouds from Mustafiz)

December (Lionel: add fine-scale data as it comes along to the base model)

January-March (initial results obtained; add additional point count data from Kirby grid as recordings are transcribed; maybe Silvia will have shrub data ready but don’t count on it)

May (final report)

Figure 1. Location of Kirby grid in Alberta. There are multiple BERA studies (different point colours) taking place on the Kirby grid. We will be using at least 84 of the 100 ARU stations (red points) in our analyses.



![A screenshot of a cell phone

Description automatically generated]()

## Methods:

Multiple recordings of soundscapes at the ARU locations are similar to point counts that are visited multiple times to collect data of bird species abundance or occupancy. Counts or detections of birds during point counts or within recordings are estimates of true abundance or occupancy, since the probability of detecting a species that is present at a site is <1, due to environmental variables (detection covariates) affecting sound detection by humans (e.g. environmental noise, sound attenuation by vegetation) or singing activity by birds (weather, time of breeding season, time of day). If probability of detection is not accounted for, then estimates of relative abundance or occupancy from raw counts or detections will be biased. *N*-mixture and occupancy models are types of hierarchical models in which the number of birds counted is a function of two processes: those variables that affect abundance or occupancy of birds at sites; then, given that a species is present at a site, the probability of detecting that species due to detection covariates.

## Storyline:

Boreal forest bird communities are difficult to monitor effectively because much of their habitat is not easily accessible, especially since multiple visits to each survey point are necessary to accurately quantify bird abundance or occupancy as well as habitat features influencing abundance or occupancy. However, quantification of bird and habitat data in remote areas can be achieved efficiently for large numbers of sites by a combination of 1) remote sensing with drones or planes to collect fine-scale habitat data, and 2) use of programmable acoustic recorders or autonomous recording units to collect bird data over multiple recordings in place of human visits. Newer analysis techniques like N-mixture or occupancy models are then well-suited for estimating true abundance or occupancy of bird species at sites from multiple recorded visits while accounting for detection probability of each species on different visits due to weather, time of season and day, and environmental noise.

**Constraints, limitations, things to be aware of:**

Unless certain conditions are met (distances to individual birds in the recordings are known or can be estimated, either from noise levels, triangulation by closely-spaced ARUs, or simultaneous point count data collected by human observers with distance-sampling methods), point count data collected by ARUs can only provide measures of relative abundance, not densities of birds. The point counts in the Kirby grid are spaced 600 m apart, so cannot be used to triangulate bird locations and distances from ARUs. There are also no corresponding human observations of birds at the ARUs to use for estimating distances to birds. forest bird communities are difficult to monitor effectively because much of their habitat is not easily accessible, especially since multiple visits to each survey point are necessary to accurately quantify bird abundance or occupancy as well as habitat features influencing abundance or occupancy. Finally, counts of birds within ARU recordings are reliant on detection of bird sounds, so quietly or infrequently vocalizing bird species are less likely to be detected, and birds that are seen rather than heard will not be detected within recordings.

Eighty-four ARU point count stations and 3-4 recordings per ARU are currently available for analysis. This sample size will probably be insufficient for rarer species of interest such as owls, and some species of interest (e.g. Canada Warbler) have not been detected in the recordings transcribed so far.