Modelling the impact of environmental stochasticity in woodland caribou populations

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Abstract

A new way of simulating fire variation and evaluate it, under a caribou population model. Fires that consume large areas of forest affect Caribou populations, since for survival they depend on lichens, which are found in greatest abundance in old growth forests, in this context, due to its extension of damage it is crucial to improve prevention and detection Fire models. This project aims to improve the existing Landscape Fire model, parameterized from data that changes the forest age structure, by including inter-annual variation in the fire regime in each year.

Introduction

Studying the environmental stochasticity on woodland caribou populations, based in the viability estimation of caribou populations under environmental stochasticity caused by fire, by building a new fire model that incorporates environmental stochasticity in the form of the variation of the mean, number and size. These are models, which the demographic parameter depends on landscape state, by simulating the landscape state and the demographic parameter and acknowledging the risk of extinction of caribou populations.

Simulation

In the work Parameterizing Landscape Fire Models From Data: Recent Progress and Remaining Challenges, a Poisson distribution was exposed and this work aims to improve these Fire model, once recent data are biased and older data are even worse, as well as Frequency and Size are not the only parameters of interest; Human caused fires are increasing in importance, but are not controlled only by biophysical factors.

Figure 1. Ontario`s Natural Resources - Forest harvesting.

Figure 2. Wildfire. Photo credit: Shawn Wasel.

Figure 3. Mountain Pine Beetle in B.C.

Methods and Materials

This is a sophisticated complex computer Landscape Fire model [2], to forecast the characteristics of forest fires, including their frequency, size and intensity, developed with R Studio in R SpaDES package [3]. A Negative Binomial count is used, to study the inter-annual variation in the fire regime and evaluate if there are any changes, if the Caribou ranges are frequent or they last longer. To evaluate and compare simulations to account differences between the Negative Binomial count model and the Poisson Fire model. Environmental stochasticity was measured as the inter-annual variation in the number and size of wildland fires. Most of the characteristic function models only take into account the mean, in this fire regime model, we are going to use two parameters instead of one: the mean and the inter-annual variation. This is used to study some ecological consequences of ignoring or including this extra variation in our model. Exploring a new model of how to describe the true fire regime in terms of the inter-annual variability, in order to assess how important is that variation.

Data Analyses

In this project, the data is from Manitoba region, between the years 1969 and 2000. The research will be carried out using the data produced by the NRCAN (Natural Resources Canada) [4]. The data used will be collected in this open database and it is available in the open data portal of the Natural Resources Canada.

Figure 4. Manitoba (study region, 1968-2000).

Results

The negative binomial distribution also arises as a continuous mixture of Poisson distributions where the mixing distribution of the Poisson rate is a *gamma* distribution. That is, we can view the Negative Binomial as a Poisson (λ) distribution, where λ is itself a random variable, distributed as a *gamma* distribution with shape = dispersion NB and scale=*mu*. We use the gamma distribution to calculate the value of λ (*Poisson parameter*) and we consider where the shape is the number of year to estimate.

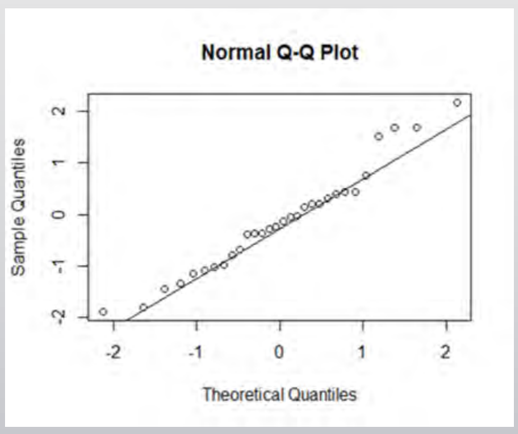

Figure 5. The qq plot for Negative Binomial model simulations.

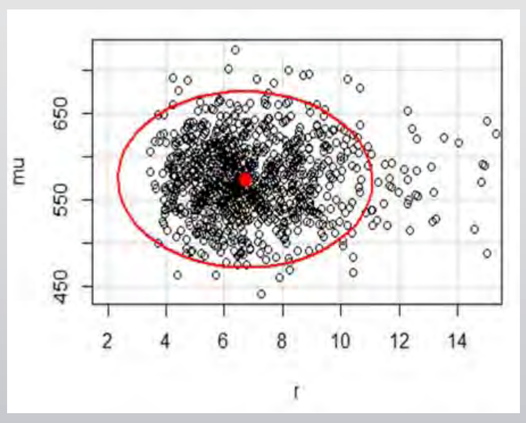

Figure 6. Ellipse of confidence interval 97.5% .

Discussion

Evaluation of the extinction risk on Caribou populations, see Recovery strategy for the woodland caribou, Canada (2012) [1], by taking into account the unpredictable spatiotemporal fluctuation in environmental conditions, such as wildfire disturbance.

Conclusions

Throughout this simulation model, we conclude that it clearly illustrate the Caribou population problematic, which shows a tendency of recession due to loss of territory from events like fire, woodland harvesting and transformation of habitat by humans.

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