Freshwater Results

Kwaku Peprah Adjei

1 Introduction

This document provides an overview of the results from the data analysis, and the full description of the methods will be written in the overleaf document very soon. To describe briefly, we are using the age-at-harvest model, where the data is formatted such that we count the number of fishes in a particular `age group` (0, 1, 2,3,4,5,6+) for a unique combination of `year`, `sex` and `age`.

2 Length at Age (L)

The length at age is modeled separately to predict the missing lengths (NAs) for the states. We model the length at age with a lognormal distribution with mean μ_i which is defined as a function of the fixed and random effects and variance σ^2. That is: $\ln(L) \sim N(\mu_i, \sigma^2)$. The linear predictor is modelled on on the linear scale with covariates `forest`(for), `Year` (Yr), `Weight per unit effort` (WPUE), `winter snow depth` (Snow) and `summer Temperature` (Temp); and `age`, `lake` and `sex`:

$$\mu_i = \beta_0 + \beta_1 * Yr_i + \beta_2 * Temp_i + \beta_3 * Snow_i + \beta_4 * for_i + \beta_5 * WPUE_i + $$
$$\beta_6 * sex_i + \beta_7 * Temp_i^2 + \beta_8 * Snow_i^2 + \beta_9 * Temp_i \times Snow_i + $$
$$\beta_1 0 * Temp_i * WPUE_i + \beta_1 1 * WPUE_i * Snow_i + \gamma_j;$$

where γ_j is the $j^t h$ level of age effect.

2.1 Results

Variable selection

We used the reversible jump MCMC to perform Bayesian model selection. For details on this, kindly refer to this.
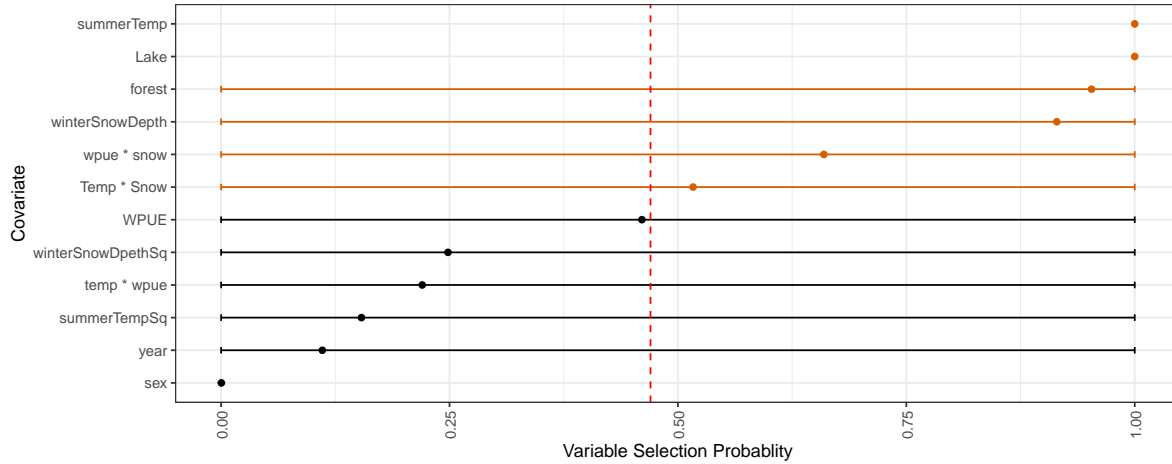

Figure 1: Variable selection of covariates used to model the length at age of the fish data. The horizonatal orange colored lines shows the covariates that contribute much to the model, and the red dashed line shows the value of the prior probability of including the variables

Snow depth during the winter, summer temperature, WPUE, the latitudinal gradient of the lake the fish was caught in and the forest had significant effect in predicting the length at age of the fish, as they have a probability of inclusion greater than 0.5 (Figure 1). These probabilities confirm the results from Figure 2, where the intervals of the effects of WPUE, year, sex and summer temperature contains 0.

The fish grows in length as the winter snow depth and weight per unit effort reduces and the forest, summer temperature increases. Moreover, the length of the fish decreased with increasing years. Why can this be so?

Predicted Length at age

This is the first ten columns of the data predicted length at age for group: 0, 1, 2,3,4,5,6+.

```
          [,1]     [,2]     [,3]     [,4]     [,5]     [,6]
 [1,] 4.289190 4.851485 5.156754 5.308474 5.383621 5.477161
```
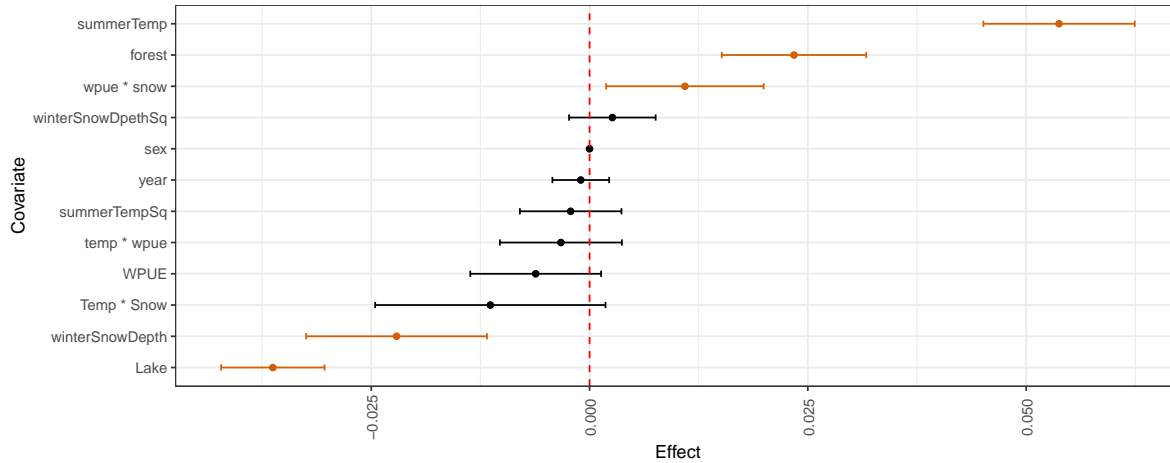
Figure 2: The effects of the covariates on the length at age of the fishes. The orange colored line are those whose Mean +- standard deviation interval does not contain 0.

```
 [2,] 4.265988 4.828784 5.177561 5.390316 5.519459 5.700444
 [3,] 3.799429 4.521495 4.935256 5.202219 5.397292 5.670652
 [4,] 4.125116 4.794964 5.161925 5.323498 5.376435 5.591559
 [5,] 4.189072 4.770949 5.117095 5.308268 5.510400 5.800733
 [6,] 4.164519 4.756958 5.077822 5.323985 5.483468 5.724377
 [7,] 4.377669 4.806513 5.112590 5.314075 5.445875 5.538318
 [8,] 3.885679 4.850914 5.261209 5.531694 5.669306 5.661720
 [9,] 3.970978 4.621887 4.955187 5.126342 5.435287 5.593371
[10,] 4.206557 4.823301 5.205379 5.474369 5.565797 5.633002
```

3 Age at harvest

The details of the age at harvest model will be discribed in the overleaf document. I will try to provide the information that will be needed to understand the results.

3.1 Defining models

3.1.1 Fecundicity

This is modeled as:

$$fecundicity_{i,a} = exp(log(L_{i,a}) * 2.21 - 6.15) * spawnProb$$
$$spawnProb \sim U(0.001, 0.3),$$

where $L_{i,a}$ is the length at age of an individual i at age a.

3.1.2 Survival Probability

We model the survival of the fishes as:

$$
\begin{aligned}
logit(\Psi_{i,a}) = {} & \alpha_0 + bsurvAge_{age_i} + bsurvSex_{sex_i} + bsurvYear_{year_i} \\
& + \psi[1] * \alpha_1 * Snow_i + \psi[2] * \alpha_2 * popnDensity_i + \psi[3] * \alpha_3 * Temp_i \\
& + \psi[4] * \alpha_4 * Temp_i + \psi[5] * \alpha_5 * Temp_i^2 + \psi[6] * \alpha_6 * WPUE_i \\
& + \psi[7] * \alpha_7 * Lake_i + \psi[8] * \alpha_8 * Temp_i * WPUE_i \\
& + \psi[9] * \alpha_9 * Lake_i + \psi[10] * \alpha_{10} * Temp_i * WPUE_i \\
& + \psi[11] * \alpha_{11} * popnDensitysq_i + \psi[12] * \alpha_{12} * Snow_i
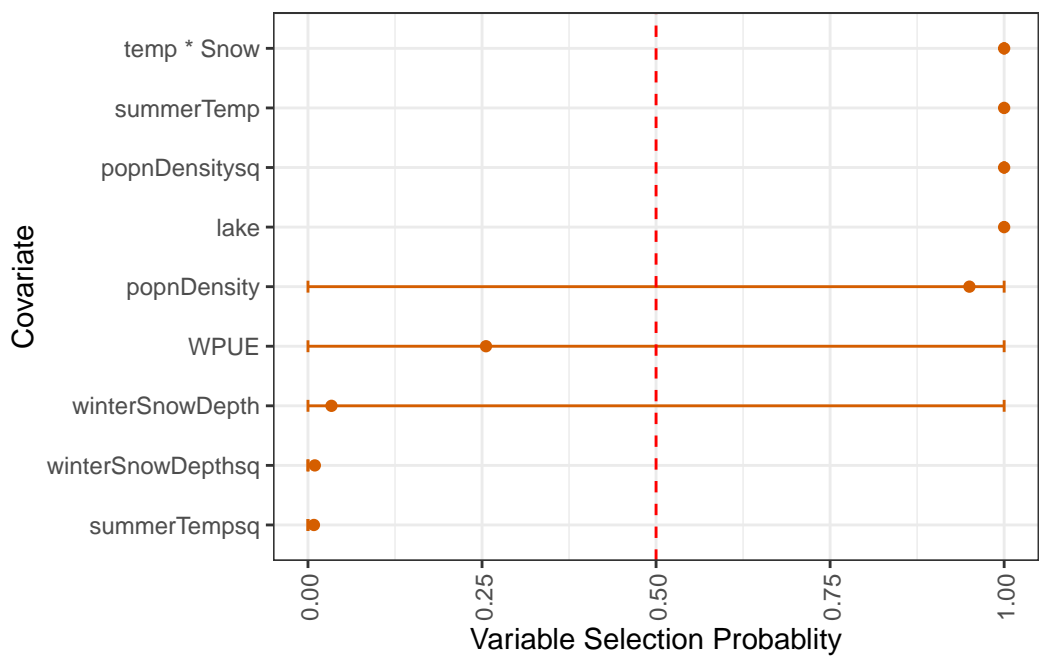\end{aligned}
$$

3.1.3 Population growth rate

We model the yearly population growth rate by drawing them from a Normal distribution with mean 1 and variance 0.35^2. We chose a mean of 1 to generate the growth rate around a 100% increase in population compared to the last year.
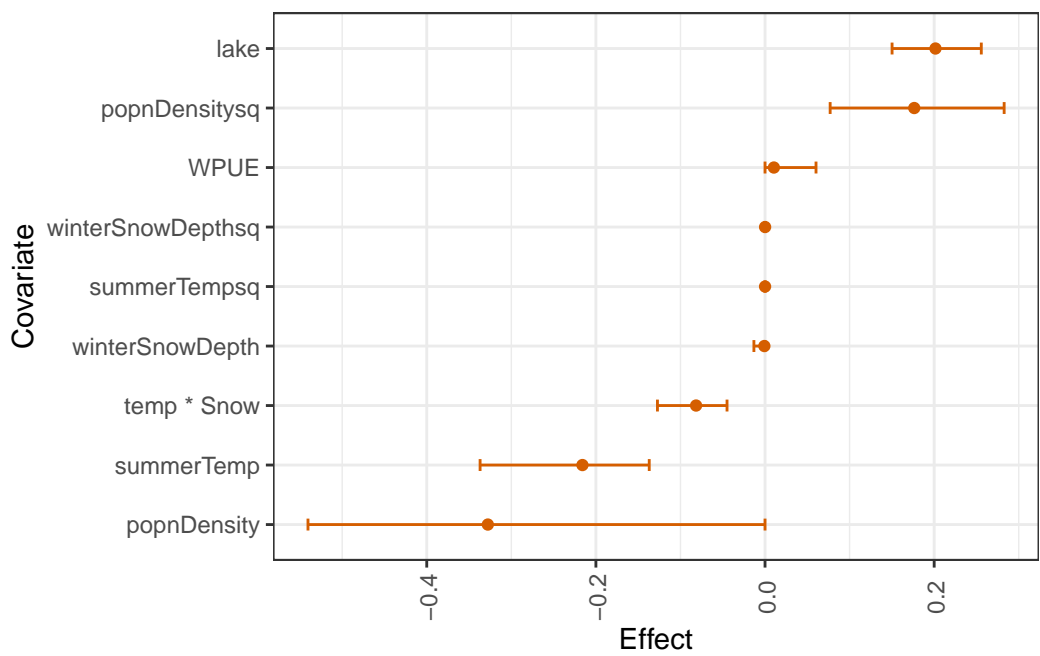
3.2 Results

We present the results from the population model.
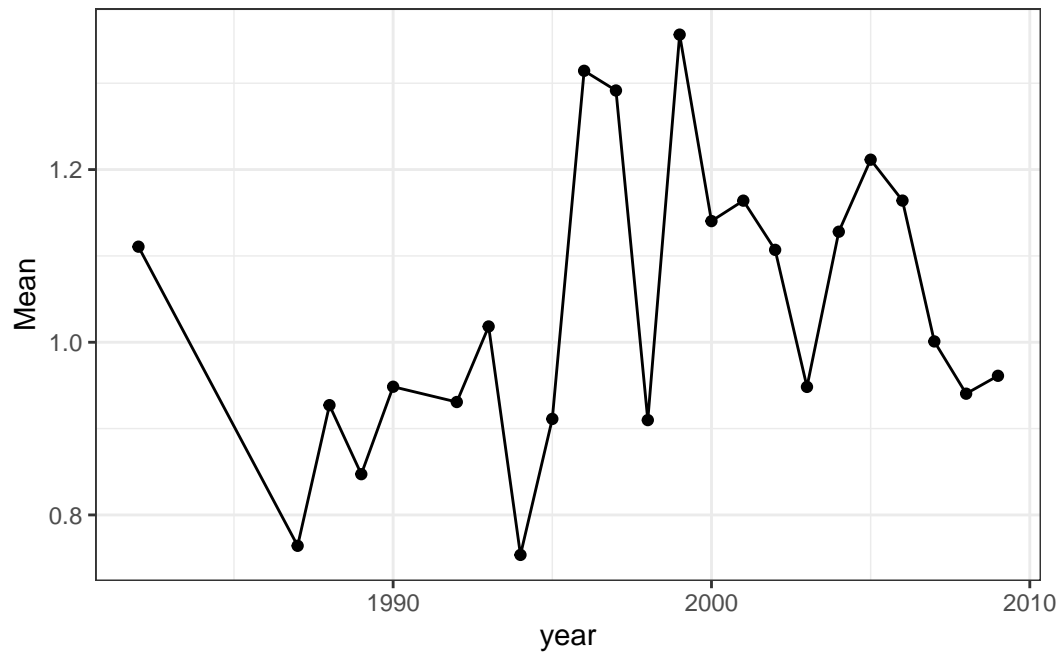
Variable selection probability

The

Covariate effects on population growth rate

Population growth by sex

4 Check convergence

5 Questions to ponder

Do we anticipate some interactions of the covariates that needs to be tested?