EEB313: Mid-Project Update
Group G

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Hypotheses and Predictions

Research Questions:

- How are Emerald Ash Borer (EAB) populations changing through time?
- Are populations evenly distributed amongst communities?
- Do differences in temperature year-to-year influence EAB outbreaks?

Hypotheses:

#1: Time impacts the abundance of emerald ash borers in various Ontario communities.

#2: Differences in population densities of rural and urban Ontario communities impact the abundance of emerald ash borers while population density plays a role in the changes in abundance over time in years.

- Rural Ontario communities have a higher abundance of EAB compared to urban Ontario communities, so low population density positively impacts the abundance of EAB.

#3: Differences in temperature impact the abundance of emerald ash borers in various communities of Ontario.

- Increases in mean temperature positively impact the abundance of emerald ash borers across Ontario.

Variables:

- Independent: Years (2002 - 2020), communities (in Ontario), Temperature, Community Type (Urban/Rural)
- Dependent: EAB abundance

Predictions:

- If time has an effect on the abundance of emerald ash borers, we would expect to see less detections of emerald ash borers in later years compared to earlier years.
- If differences in population densities of rural and urban Ontario communities positively impact emerald ash borer abundance, we can expect a larger abundance in rural areas compared to urban communities that have less green space.
    - Urban areas have a higher population density and less green space, providing less opportunities for emerald ash borers to invade.
- If differences in temperature positively impact the abundance of emerald ash borers in various communities of Ontario, we can expect to see larger increases in emerald ash borer abundance in communities with higher yearly temperatures.
    - It is expected that warmer temperatures may facilitate more reproduction, development, and survival, leading to population growth of emerald ash borers.

Description of Data

Link to dataset: https://open.canada.ca/data/en/dataset/69f4ecd8-9761-4d40-b0f9-e186f2fcce5b

We are using a dataset found on the Government of Canada website called “Emerald Ash Borer (*Agrilus planipennis*) Surveillance Data 2002 to 2020” which includes observations for the population of emerald ash borers across the entire country between the years 2002 and 2020. It also contains information regarding the latitudinal and longitudinal position of the site of observation as well as its location (community and province). The results column specifies whether the presence of emerald ash borers was detected or not detected. We couldn’t find any information on how the data was collected outside of the dataset being published by the Canadian Food Inspection Agency. The record was released on 2017-12-21 and modified 2022-04-15, with the maintenance and update frequency being annually. The author listed for the excel file is Thierry Poiré, who is a Survey Biologist.

We subsetted the data to just the Ontario communities due to time constraints and feasibility. In addition, we’re mainly looking at the year, community, and results columns of this dataset for our analysis. We created a new column to specify whether the community is an urban or rural area to analyze the impact of population size and green space on the abundance. To categorize the communities into urban or rural, we used data of population centres from the Canada 2021 census found on Statistics Canada. Since Statistics Canada defines any area that is not a population centre as rural, we matched the community names from our surveillance data with the population centres to determine which ones were urban and the rest were assigned rural. We also used weather data obtained from the Government of Canada’s historical climate data to obtain the mean annual temperature for each community within the dataset. We used the longitude and latitude measurements to match each community to the nearest weather station that has data available from 2002 to 2020. We will observe temperature differences across the communities in Ontario over the years and compare them with the results of our primary dataset to determine whether increases in mean temperature do positively impact the abundance of emerald ash borers.

Statistics Canada 2021 Census Population Centres Data Website:
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810001101

Government of Canada Historical Climate Data:
https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

EAB Surveillance Data Citation:
Government of Canada. 2017b. CFIA Observations of EAB: Government of Canada, Emerald Ash Borer Surveillance Data 2002-2020, Canadian Food Inspection Agency. [online] https://open.canada.ca/ data/en/dataset/69f4ecd8-9761-4d40-b0f9-e186f2fcce5b. [accessed 1 October 2023].

Plan for Analyses

All of our hypotheses and predictions measure EAB abundance, which for our dataset is observed as a binary ("Detected" or "Not Detected") in the *RESULT* column. As such, all of our data analyses use the general linear model (GLM) with a specification that the distribution of our data is binomial. For our first hypothesis, our model is a regression of result on year with community as an interaction. Then, we have 2 models to help us with the second and third hypotheses. The first is a regression of result on latitude and the second is result on longitude. These two models can tell us whether geographical position has an effect on EAB abundance, which would suggest that community type and temperature might be involved. For our second hypothesis, we want to model the effects of community type on result to determine whether EAB abundance is affected by population density. We have yet to decide on what test we will use for this model, but we are considering using either a chi-square test or a likelihood approach. For our last hypothesis, our model is a regression of result on seasonal temperature with community as an interaction. Since we are using a general linear model, the only assumption we have to fulfill is independence of observations.

In addition to the 2021 census data, we were also hoping to use 2001 population and population density census data to examine how humans contribute to the abundance of EAB. We are considering selecting a small number of communities to examine whether there is correlation between the increase/decrease in population density from 2001 to 2021 and EAB abundance (as our EAB dataset includes data for the years 2002-2020). This will be useful in discussing how human influence, urbanization, and population density can impact the spread of invasive insect species as a whole.

Implications

This study has implications on the management of invasive species, specifically what policies may be important in limiting human-influenced spread.

The data set being used in the study is surveillance data to monitor the spread of the invasive Emerald Ash Borer across different regions of Canada. Our study examining the patterns of this invasive species helps focus on how human influence plays a role in containment and abundance. As mentioned, emerald ash borers primarily spread through the human movement of infected wood products. Our management controls have been methods such as burning, cutting down infected trees, limiting the movement of Ash tree material, and systemic insecticide. By studying the abundance of emerald ash borers in rural and urban communities, future studies can help explain whether this abundance is a direct result of human activity.

Moreover, here are some more implications of our study for future research:

1. The effectiveness of current management and removal strategies

There are currently many policies in place to manage the spread of the EAB, therefore, by examining the abundance of EAB in districts across Ontario, one can determine if procedures such as insecticide treatments and quarantining infected wood products help keep EAB populations within one district or allow spread into nearby communities.

2. The impact of climate change on EAB populations

By examining variables such as temperature, there is potential in our study to examine future climate scenarios by incorporating climate data and seeing if rising temperatures and climate change can increase the breeding season and abundance of the EAB.

3. Overall human impact and assistance in spread

We understand that EAB primarily spreads with human assistance through the transport of infected wood products. Our study could help analyze patterns of human movement, population density, and wood trade to see if they influence the spread of the EAB. If these movement dynamics are influenced by human activity, it can be informative in developing new targeted interventions and regulation to control the EAB spread.

Distribution of Work:

Eva and Santhija work on census data to add to the excel column.
Jem and Jess work on temperature data to add to the excel column.
Santhija: Implications of our study, assisted with developing population density analysis dataset, wrote jot paragraph on 2001 census data, editing
Jem: sourced the original EAB dataset, researched EAB biology and life cycles, editing
Jessica: led/developed research questions/hypothesis, jot notes on how we planned to use data
Eva: primary analysis of EAB data and 2021 census dataset on r, wrote jot notes into paragraphs, editing
All: add r scripts to the group gitHub