Introduction

Purpose and context: the background behind my project um it originally came about due to my interest in native plant species uh honestly a lot of it was due to uh just planting in my yard I've always been interested in just kind of plants in general but specifically native plants do their importance in the ecosystem in Missoula and the surrounding Montana area and just worldwide it's very important. Uh well I I couldn't figure out a project that had direct relation to native plant species um I'm sure there are many out there I did feel like another way to support native species is to prevent the spread of non-native or as it were deemed invasive species. So with that I decided that my project was going to involve tracking and doing some sort of data analysis on the overall spread of invasive species I decided to do Missoula just due to uh to uh uh restrict the scope of the project uh I think it's statewide project has uh kind of been done already by the uh Montana natural heritage program by via Bryce Maxwell uh who has been somewhat of my inspiration in this project. Uh so that is when I approached the uh Missoula County ecology extension uh saying , I I would like to do a project involving invasive species in Missoula County. Uh that is when they kind of gave me the information on all the invasive species in the county um and specifically the big one that they we're curious about and they have done some field surveys around with the Russian Olive in Missoula. They uh have recently listed the Russian olive as a new invasive species in the county I believe that was in 2024. This report can help them provide a little more context as to why they listed it as an invasive species in the city and the county and what here he is are most susceptible to spread or are currently overtaken by Russian olive.

This report is for the staff of the Missoula County ecology extension as well as the Missoula County weed board who they report to on items such as this. It is also a report for the public uh and any other interested parties. The goal of this project is to help inform any decision making done around the mitigation and slash or removal efforts relating to the Russian olive. These outcomes are important to decision making due to the large area in Missoula County and the importance of efficiently using resources and funding to combat the spread of Russian olive.

The main question this project aims to address, is identifying the areas in Missoula County have the highest susceptibility to invasion from Russian olive. I hope answering this question can provide background and information about the whereabouts of Russian olive currently in Missoula County, and the potential areas it may inhabit in the future.

**Background**

according to the Montana natural heritage program Missoula County has seen a increase in Russian olive in the recent years. looking at the data given to me from the Montana natural heritage program , we can see that there has been a relative uptick in the number of observations of Russian olive in Missoula County per the figure below.

*Figure 1*

Russian olive is a small tree native to southern Europe and western Asia and was introduced to North America in the colonial times it was an originally planted for windbreaks, ornamental appeal, wildlife habitat, or erosion control. It has since escaped this cultivation and is now rapidly spreading especially in riparian zones. It was first noted in Montana in 1959 but by the mid 1980s it started 2 spread. There have been a number of studies on Russian Olive distribution in Montana, including lesica and miles study following distribution along the Marius and the lower Yellowstone rivers. Another recent study used naip imagery and random forest to generate a land cover map of valley bottoms for 10 eastern Montana rivers, Russian olive being one of the land covers mapped.

Despite numerous studies surrounding Russian olive in Montana, there have not been as many on the western edge of the state and specifically in Missoula County. I thought this project has the opportunity to fill gaps in the knowledge surrounding the spread of Russian olive in Missoula County. **There are others reasons why this project is important, why?**

**Methodology**

there are several ways you can go about modeling an invasive species, for my specific project I decided to do a habitat suitability model. This model predicts how will an area is suited to accommodate a given animal or plant. It takes in numerous variables the tricky part is deciding which ones are the most important to your particular species of plant or animal. My project I tried to build off of the efforts of previous ones such as the 2017 paper or the Montana natural heritage program’s habitat suitability model for the Russian olive in the state. The Findings conclude that the following environmental variables are critical in developing a model for Russian olive.

**Figure 3: the variables**

I used two distinct sets of data 4 the Russian olive locations, one set was field survey data from Missoula County ecology extension. The other set of data comes from the Montana natural heritage program, this data is less reliable because is not all been confirmed. For the environmental variables above, I went through the Montana State library MSDI framework.

There are a couple ways to combine all this data, it can be done programmatically in R or Python, or it can be done in arc GIS or a similar software. I used arc GIS in order to simplify the modeling in R and resulting output into arcgis. To begin the process I had to combine the data points given to me from Missoula County with the data points from the state . To speed up this process I clipped the data points from the state to only in cloud include the data points for Missoula County. And then I had to filter the state data set to only include data points that had a spatial precision under 800m as recommended in the model from Montana natural heritage program combining the two datasets I wanted to preserve the data included with both of them. This was done bye doing a left join between the two datasets and preserving all the late columns from this St. From here I also had to take into account any overlapping data points between the two to do this **I used blank function in arc gas which allows you to select random points between two similar points**. Next had to take into account the fact that they are only points where Russian olive is found there is presence only modelling using the maxent program but for my case I was also interested in areas where Russian olive isn't found that may contain it. To do this I have arc GIS generate pseudo absence points around Missoula County specifically I tried to have around double the number of presence points. Once I finally have the combined data set including Missoula County points Missoula County state data points and pseudo absence points I could introduce environmental variables. I began to overlay each layer from the variables listed above *figure 3* onto the point data set. Once this is done I can extract all the data from each point into a single table that contained in point and all the environmental values four said point.

Using the table I can import it into R where I can begin preparing it for modeling. Some important steps in this preparation include converting the presence absence column to a factor, and converting all text columns such as land cover to a factor as well. This also involved dropping several columns that were either an ID or have so many factors that they couldn't be used. Finally I need to split the data into training and testing sets, this split needs to take into account spatial autocorrelation. To account for this I used the block CV package in R, this allows for a separation of data in generation of training in testing folds. These folds are then used to reference the data set randomly in the random forest model.

**Other potential processing steps?**

**Analysis**

Before getting to the model output I first wanted to answer a couple of questions that I was curious about in regards to the current spread of Russian olive in Missoula County. The first question I had and well that was also asked by the Missoula County was which areas caused Russian olive to escape or reproduce more. Another question but I personally had was who owned the land where Russian olive was found famously uh Russian olives is planted ornamentally which means many of the infestations could be found on private property, which introduces some red tape surrounding action. To take this into account I first just want to display a chart that shows where it is most prevalent based on to the land ownership. Finally in the same vein as reproduction slash escaped I want to look at the age or estimated age distribution in Missoula County, this might tell us where Russian oil is is more likely to spread as well. Using age on Russian olive is obviously tougher but could be a valuable tool.

the model found that the following variables had the most significant impact on the chance of Russian olive having presence at said location.

*Insert Figure 4*

This is where I want to include visualizations of the model findings including areas of interest and potential areas of future infestation.

The model accuracy is round blank percentage, there are several limitations to this model OK 1 limitation is that it is based on the data fed to it and relies on preprocessing heavily. OK

**recommendations**

based on the model findings I think these specific areas are of interest in regards to immediate action.

*Figure 5*

I am not an expert on removal of invasive plant or trees species, my father was an arborist in the city for a long time so my only experience with removal is cutting them down and removing the stump. However, the Russian olive despite being invasive can harbor native species such as birds or bugs which complicates drastic removal without replacement.

My recommendation is solely focused on areas where removal or other treatment would be most beneficial. In Lusaka and miles 2001 they recommend medicating mature Russian olive trees every 10 years were all trees every 30 years as an effective strategy to control population and mitigate effects on native wildlife and plants.

I also would recommend replacement with a native species of some sort ohh the Cottonwood is generally deemed as the best replacement as that is the native species that Russian olive tends to overcrowd.

**Conclusion**

This project can provide a significant boost to the knowledge of Russian olive in western Montana in primarily Missoula County. Providing the Missoula County ecology extension and Missoula County weed board with information that can help with the management of the Russian olive in Missoula County. I realize that this task of managing and eradicating invasive species in the county is a large one, I hope that this report and project can provide support to This task in potentially pave the way for future efforts with other invasive species in the area.

When creating this project I want to have the ability to change or alter the species of interest without completely rebuilding the program from the ground up. The Montana natural heritage program seems to have a similar system in place where they can plug in a species and spit out a model like this. Having this ability would have large benefits in invasive species control in the county, savings staff time and resources that can be dedicated elsewhere.

**Appendices**

Technical details including technical information, code snippets, or any related table slash figures.

**References**