Tobin Haefele

uNIVERSITY OF mONTANA

Russian Olive Report

rEPORT ON THE CURRENT AND FUTURE STATUS OF RUSSIAN OLIVE IN MISSOULA COUNTY

Table of Contents

[1. Introduction 2](#_Toc193392968)

[2. Background 2](#_Toc193392969)

[3. Methodology 4](#_Toc193392970)

[3.1 Model and Variable Selection 4](#_Toc193392971)

[3.2 Data Sources 6](#_Toc193392972)

[3.3 Data Cleaning and Integration 6](#_Toc193392973)

[3.4 Model Preparation 7](#_Toc193392974)

[4. Analysis 7](#_Toc193392975)

[4.1 Initial Analysis 7](#_Toc193392976)

[4.2 Random Forest Results 8](#_Toc193392977)

[5. Recommendations 8](#_Toc193392978)

[6. Conclusion 9](#_Toc193392979)

[7. Appendices 9](#_Toc193392980)

[8. References 9](#_Toc193392981)

# Introduction

The Russian Olive project originated from my interest in native plants and their ecological importance in Missoula and the surrounding Montana area. This interest was sparked by personal experiences, such as planting native species in my yard, and grew into a desire to contribute to local conservation efforts. While I initially sought a project directly related to native plants, I realized that supporting native ecosystems also involves addressing the spread of invasive species. This led me to focus on invasive species management, specifically the Russian Olive, which was recently listed as a new invasive species in Missoula County in 2024.

To narrow the scope of the project, I chose to concentrate on Missoula County, as statewide efforts, such as those led by the Montana Natural Heritage Program (MTNHP) and Bryce Maxwell, have already made significant progress in this area. After reaching out to the Missoula County Ecology Extension, I learned about their ongoing field surveys and concerns regarding the Russian Olive. They provided valuable data and context, which became the foundation for this project. This report aims to support their efforts by identifying areas most susceptible to Russian Olive invasion and providing actionable insights for mitigation and removal strategies.

This report is intended for the staff of the Missoula County Ecology Extension, the Missoula County Weed Board, and other interested parties, including the public. Its goal is to inform decision-making around resource allocation and mitigation efforts, ensuring that limited resources are used efficiently to combat the spread of Russian Olive.

The primary question this project addresses is: Which areas in Missoula County are most susceptible to invasion by Russian Olive? By answering this question, the report provides critical information about the current distribution of Russian Olive and identifies potential areas for future management efforts.

# Background

Russian Olive (*Elaeagnus angustifolia*) is a small tree native to southern Europe and western Asia. Introduced to North America during colonial times, it was initially planted for practical purposes, such as windbreaks, and for its ornamental appeal. However, it has since escaped cultivation and is now considered an invasive species, particularly in riparian zones—areas along riverbanks where it thrives and spreads rapidly. In Montana, Russian Olive was first planted as a windbreak as early as 1953, but its unchecked spread has led to significant ecological concerns. As of 2010, the Olive is listed as State Regulated by the Montana Department of Agriculture, which means it is illegal to intentionally spread or sell.

One of the main issues is the overcrowding and eventual overtaking of native species within the ecosystem. Native species such as the cottonwood and willow occur in the same environment as the Russian Olive, causing competition between the species. This is an issue due to certain characteristics that give Russian Olive an advantage in this competition. Unlike the native Cottonwood the Russian Olive can reproduce in the shade[[1]](#endnote-1), as the Cottonwood’s die off the Russian Olive lives on. Since the cottonwood can’t reproduce in the shade, the Russian Olive begins to take over as the dominant species.

Another advantage is the aversion of Beavers to Russian Olive, researchers found that Beavers tended to damage 57 to 78 percent of cottonwood trees, while only damaging a mere 15 to 18 percent of Russian Olive Trees[[2]](#endnote-2). Furthermore, the damage to Russian Olive tended to be primarily the limbs, while damage to the Cottonwood tended to be at the trunk or base of the tree.

Additionally, Russian Olive thrives in areas with regulated river flows, such as those impacted by dams or irrigation systems. These human-altered environments create ideal conditions for their growth, allowing them to spread more aggressively. As a result, Russian Olive not only disrupts natural ecosystems but also exacerbates the challenges of managing riparian areas in the face of human activity.

The loss of native species like the Cottonwood also means the loss of habitat for native animal species, for example cavity-nesting birds that rely on the Cottonwood to reproduce do not appear to use Russian Olive as a replacement. Ungulates such as the White-Tailed Deer prefer to forage near cottonwood trees at a much higher proportion when compared to the Russian Olive. Preserving these fragile ecosystems is an important step in combatting climate change at the local level, this is something I hope my project can aid in.

Several studies have examined the distribution of Russian Olive in Montana, including a notable study by Lesica and Miles, which tracked its spread along the Marias and lower Yellowstone rivers in eastern Montana. More recently, researchers used NAIP imagery and a random forest model to create a land cover map of valley bottoms for ten eastern Montana rivers, with Russian Olive included as one of the mapped land cover types. These studies have provided valuable insights into the species’ behavior and impact in Eastern Montana.

However, fewer studies have focused on the western part of the state, particularly in Missoula County. According to data from the Montana Natural Heritage Program (MTNHP), observations of Russian Olive in Missoula County have increased in recent years, as shown in Figure 1 below. This uptick in observations underscores the need for localized research to understand the current distribution of Russian Olive and predict areas where it may spread in the future.

**Figure 1: Increase in Russian Olive Observations in Missoula County (MTNHP Data)**

(Placeholder for visualization)

Given that Russian Olive was recently added to Missoula County’s watch list of invasive species, this project seeks to fill critical gaps in knowledge about its spread in the region. By identifying areas most susceptible to invasion, the findings can inform targeted mitigation efforts and help allocate resources more effectively to protect native ecosystems.

# Methodology

## Model and Variable Selection

I chose to use Habitat Suitability Modeling for this project, as it is a well-established approach for predicting how well an area can support a given species. This type of model relies on environmental variables that influence the species' ability to survive and thrive, and selecting the most relevant variables is one of the most critical and challenging aspects of the process. For my project, I built on previous efforts, including a 2017 study and the Montana Natural Heritage Program’s (MTNHP) statewide habitat suitability model, to inform my approach.

Selecting the appropriate environmental variables requires careful consideration. I drew on insights from Lesica (2012), who described the typical habitat of Russian Olive in Montana as including woodlands, thickets, riparian forests, and moist meadows around wetlands in plains and valleys. Russian Olive also tends to grow in soils with low to moderate soluble salt concentrations and exhibits some tolerance for saline conditions[[3]](#endnote-3). Additionally, I referenced the MTNHP’s Maxent model, which used 22 statewide biotic and abiotic environmental layers. Their results highlighted the importance of several key variables, including:

* **Land Cover:** Wetland Riparian, Introduced Vegetation, and Conifer Forests
* **Climate:** Frost-free days, Degree Days, and Maximum Summer Temperature
* **Soil:** Soil pH and Bulk Density.

To gather the necessary data, I used the Montana Spatial Data Infrastructure (MSDI) and ArcGIS. Below is an overview of the environmental variables I incorporated into my model:

**1. Land Cover**

Land Cover data categorizes ecological systems and human land use into 30-meter pixels, with three levels of classification:

* **Level 1:** Broad categorizations (8 classes).
* **Level 2:** Intermediate detail (27 classes).
* **Level 3:** Highly granular, with each pixel assigned a unique value.

To simplify the modeling process, I used Level 2 classifications, which align with the approach taken in the MTNHP model. This level provides sufficient detail without being overly complex.

**2. Climate Data**

Climate data was sourced from the **Montana Climate Office**, and the key variables I included are:

* **Frost-Free Days:** Estimated number of days without frost (daily minimum temperature > 32°F).
* **Relative Effective Annual Precipitation (REAP):** 30-year precipitation data adjusted for slope and aspect.
* **Precipitation:** Mean annual precipitation (mm) for the 1991–2020 period.
* **Degree Days:** Mean annual total number of days above 32°F.
* **Maximum/Minimum Temperature:** Mean maximum and minimum temperatures (°C) in July and January, respectively.

**3. Soil Data**

Soil variables were selected based on their relevance to Russian Olive’s growth preferences:

* **Soil pH:** pH of the topsoil layer (0–5 cm depth).
* **Bulk Density:** Mass of the topsoil layer (0–5 cm depth).

By incorporating these variables, I aim to create a robust model that reflects the environmental conditions most conducive to Russian Olive’s spread in Missoula County. A detailed table summarizing these variables and the corresponding sources can be found in Appendix B.

## Data Sources

I used two distinct datasets for Russian Olive presence points. The first dataset, provided by the Missoula County Ecology Extension, consists of field survey data collected within the past year. I consider this dataset to be the more reliable of the two, as each Russian Olive location has been confirmed through field observations. In addition to latitude and longitude coordinates, this dataset includes important fields such as "Woody Growth" and "Woody Setting," which describe the plant’s growth stage and its surrounding environment, respectively.

The second dataset comes from the Montana Natural Heritage Program (MTNHP), which aggregates data from surveys, iNaturalist users, and other sources. While this dataset is less reliable due to the number of unverified observations, it provides broader spatial coverage. In addition to location data, the MTNHP dataset includes details such as the observer’s name, the observation date, and any additional comments. It also contains a spatial precision value, which estimates how closely the mapped location matches the real-world position, with lower values indicating higher accuracy.

## Data Cleaning and Integration

There are several ways to combine datasets like these: programmatically in R or Python, or using GIS software like ArcGIS. I chose to use ArcGIS to streamline the process and avoid transferring data back and forth between platforms.

To begin, I combined the data points from the Missoula County Ecology Extension with those from the Montana Natural Heritage Program (MTNHP). To simplify this process, I first clipped the state dataset to include only points within Missoula County. Next, I filtered the state dataset to retain only points with a spatial precision of less than 800 meters, as recommended in the MTNHP model.

Now that I have two datasets, I wanted to preserve the data from both. This was achieved using a left-join in ArcGIS, which combined the datasets while retaining all relevant columns from the state dataset. I also needed to address overlapping data points between the two datasets. To handle this, I used the [insert specific tool/function, e.g., "Select by Location" or "Near" tool] in ArcGIS, which allowed me to randomly select points between two similar locations.

Next, I considered that the combined dataset only included points where Russian Olive was present. While methods like Maxent can use presence-only data, my random forest model required pseudo-absence points—locations where Russian Olive is not found. To generate these, I used ArcGIS to create pseudo-absence points across Missoula County. It is recommended to have a large amount of pseudo-absence points[[4]](#endnote-4), I aimed for approximately double the number of pseudo-absence points compared to presence points to improve model accuracy.

Once I had the combined dataset—including Missoula County points, state data points, and pseudo-absence points—I introduced the environmental variables. I overlaid each variable layer (listed in **Figure 3**) onto the point dataset. After this step, I extracted the environmental data for each point into a single table, which included the point’s location and all corresponding environmental values.

## Model Preparation

Using the final combined table, I imported the data into R for further preparation and modeling. Several critical steps were involved in preparing the data for analysis. First, I converted the presence-absence column to a factor, as this is required for classification tasks in random forest modeling. Similarly, I converted all text-based columns, such as land cover, into factors to ensure they were treated as categorical variables rather than numeric ones.

Next, I reviewed the dataset for irrelevant or redundant columns. I dropped several columns that served only as identifiers (e.g., unique IDs) or contained too many categories to be meaningful for the model. For example, columns with highly granular or sparse data were removed to simplify the dataset and improve model performance.

Once the data was cleaned and formatted, I needed to split it into training and testing sets. However, standard random splitting methods are not suitable for spatial data due to spatial autocorrelation—the tendency for nearby locations to have similar environmental conditions. To address this, I used the blockCV package in R, which is specifically designed for spatial data. This package divides the dataset into spatially separated folds, ensuring that training and testing data are independent and representative of the study area.

The blockCV process involves generating multiple spatial folds, each containing a subset of the data. These folds are then used to create training and testing sets, which are referenced during the random forest modeling process. By accounting for spatial autocorrelation, this approach helps prevent overfitting and ensures that the model’s performance is robust and generalizable to new, unseen locations.

*Insert visual of folds*

# Analysis

## Initial Analysis

Before getting to the model output, I first want to answer a couple of questions that can help provide more context regarding the current distribution of Russian Olive in Missoula County.

Looking at the current distribution of datapoints, we can see that they tend to be concentrated in town near a river or stream. **There are several areas where there is no visible water source nearby however, including X Y and Z.**

*Insert Figure: Russian Olive in Missoula*

The next topic I want to investigate is the setting in which the data point was recorded. There are 4 possible settings including:

* **Ornamental**: Planted by someone
* **Escaped:** Grown via seed from another plant
* **Windbreak:** ??
* **Other:** Not in any other category or NA

*Insert Figure: Russian Olive Categorized by Setting*

Last, I want to know what growth stage the observed plant is at. Similar to the woody setting there are several different stages that are observed, including:

* **Immature:** not full grown
* **Mature:** Full grown
* **Seedling:** Just sprouting
* **Senescent:** ??
* **Other: NA or other value**

*Insert Figure: Russian Olive by Growth Stage*

One issue with both maps is there are many values that have NA or others, this is due to the datasets being used. The state dataset does not keep a record of setting or growth stage for a given data point.

Another topic that I want to address is who owns the land where Russian olive is found. Russian Olive trees tend to be planted ornamentally which means many of the infestations could be found on private property, which introduces some red tape surrounding remediation. 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.

*Insert Figure: Russian Olive by Land Ownership*

## Random Forest Results

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

*Table: Significant Variables*

Taking these variables into account, we can now produce the habitat suitability map for Missoula County.

*Figure: Habitat Suitability Map*

The model accuracy is close to X%, there are several limitations to this model one limitation is that it is based on the data fed to it and relies on preprocessing heavily.

*Figure: ROC Curve or other accuracy measures*

# Recommendations

Based on the model findings I think these specific areas are of interest regarding immediate action.

*Figure 5: Areas of Interest*

I am not an expert on removing 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 species, can also harbor native animals 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 replacing any removals with a native species such as the Cottonwood or Green Ash. These 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

* Insert Full table of Variables

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

# References

[**https://mtaudubon.org/wp-content/uploads/2017/09/Lesica-Miles-1999.pdf**](https://mtaudubon.org/wp-content/uploads/2017/09/Lesica-Miles-1999.pdf)

[**https://fieldguide.mt.gov/speciesDetail.aspx?elcode=PDELG01010**](https://fieldguide.mt.gov/speciesDetail.aspx?elcode=PDELG01010)

[**https://archive.org/details/Predictingthedi100**](https://archive.org/details/Predictingthedi100)

**https://mtnhp.org/models/files/Elaeagnus\_angustifolia\_PDELG01010\_20230314.pdf**

[**https://mtnhp.org/models/files/Elaeagnus\_angustifolia\_PDELG01010\_20230314.pdf**](https://mtnhp.org/models/files/Elaeagnus_angustifolia_PDELG01010_20230314.pdf)

Manual of Montana Vascular Plants 2012

**https://besjournals.onlinelibrary.wiley.com/doi/10.1111/j.2041-210X.2011.00172.x**

1. [↑](#endnote-ref-1)
2. Lesica [↑](#endnote-ref-2)
3. [↑](#endnote-ref-3)
4. [↑](#endnote-ref-4)