### Thesis Prospectus 2023-24

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**Student Final Submission (date): 28 Nov 2023**

**Faculty Reader Approval (date):**

**MES Director Approval (date):**

1. Working title of your thesis[[1]](#endnote-1).

Eyes in the sky: Detecting Himalayan blackberry (Rubus armeniacus) and reed canary grass (Phalaris arundinacea) in a mixed habitat restoration site

1. In 250 words or less, summarize the key background information needed to understand your research problem and question.

Restoration of disturbed or degraded land requires management of invasive species to allow for the regeneration or re-establishment of native plants, but resources are extremely limited (Sheley & Smith, 2012). Mapping abundance of invasives across restoration sites provides restoration project managers with a critical tool for efficient planning, management, and monitoring treatment of invasive plants (Yager & Smith, 2009). Remote sensing technology has greatly improved due to improvements in capturing higher resolution across time, space, and the light spectrum, as well as increased computing power which enables faster data processing (Neyns & Canters, 2022). There are many exciting applications for this technology, and in the context of environmental work, there is great potential to improve classification of vegetation (Neyns & Canters, 2022), which will support monitoring of ecosystem health and habitat restoration. Once collected, whether in the field or remotely, this data can be collated in a geographic information system (GIS) to create a map which allows users to measure species abundance, and track changes over time (Yager & Smith, 2009). There are several different technologies available to accomplish such work, including remote sensing from aerial or satellite imagery, as well as LiDar, infrared and multispectral photography (Neyns & Canters, 2022, Chance et al., 2016, Narumalani et al., 2009). When feasible, collecting data from the ground is the most accurate data collection method, but potentially the most expensive and time-consuming (Mack et al., 2007). By testing different remote sensors on various habitats and species, research can inform land managers on the decision to invest in remote sensing or data collection on the ground.

1. State your research question(s).

What is the distribution of Himalayan blackberry (*Rubus armeniacus*) and reed canary grass (*Phalaris arundinacea*) at the Deschutes River Preserve? How well does drone imagery capture extent and enable geospatial analysis of these species across different habitat types? 

1. Situate your research problem within the relevant literature. What is the theoretical and/or practical framework of your research problem?

The theoretical framework of my research problem is based on using a geographic information system (GIS) to produce a map of invasive species, gathering data through field surveys and remote sensing (Mack et al., 2007). The use of unmanned aerial vehicles (UAV), commonly known as drones, can achieve higher resolutions and is generally less expensive than manned aircraft, enabling data acquisition at more flexible spatial and temporal scales (Feng & Gong, 2015). The practical framework of my research problem revolves around restoration work and efficiently managing invasive species within the confines of extremely limited resources. If drone imagery is not accurate enough to assess spread of invasives, whether it be based on the hardware, software, or site conditions, it would be more efficient to build maps from data collected during treatment. Having a clearer understanding of remote sensing capabilities in this application can inform which step in the invasive species management process data collection would be most efficient (Chance et al, 2016). This study will produce a geodatabase for land managers at OlyEcosystems to track the presence of two particularly aggressive invasive species and visualize the spread and abundance.

1. Explain the significance of this research problem. Why is this research important? What are the potential contributions of your work? How might your work advance scholarship?

As remote sensing technology improves, researchers continue to test and apply them in various habitats and on a variety of plant species. By comparing the data collected through different methods, this study will add an example of the viability of using remotely sensed data in the context of managing two invasive species on a restoration site with mixed habitats. This research also supports the landowner, OlyEcosystems, in their restoration work of the Deschutes River Preserve (OlyEcosystems, n.d.). The workflow I will design will enable restoration managers to more effectively budget, coordinate, and apply treatments, as well as accurately measure outcomes over time with subsequent mapping, with a smartphone and access to software available through ArcGIS.

1. Summarize your study design[[2]](#endnote-2). If applicable, identify the key variables in your study. What is their relationship to each other? For example, which variables are you considering as independent (explanatory) and dependent (response)?

This study is an assessment of invasive species, which will be visually identified. The preserve is 367 acres, and I will survey predicted areas of HBB and RCG identified by analyzing drone imagery, potentially with trained volunteers, to ground truth remotely sensed data. Drone imagery was taken over the summer by Evergreen professor, Mike Ruth, who has kindly offered to fly more if necessary. I will analyze the orthomosaic layers he has created from the imagery to do manual spatial identification of Himalayan blackberry patches and patches of reed canary grass and draw polygons around each. I will refer to this layer as “drone predictions” until I find a more technical term. I will note which habitat type it falls within or overlaps, e.g. a continuous patch could be found crossing from marsh to wetland or field habitats. Referencing a habitat map made by Melinda Wood of this preserve, the habitat types include field, marsh, wetland, mixed trees/shrubs, forest, forest riparian, clearcut, and built. Then I will go to the preserve and document patches of HBB and RCG by dropping points along the perimeter of each, using ESRI’s Field Maps app on a location-enabled smart device, for a streamlined data collection process. Other data points are visible on the map, so enumerators will be able to see which areas have been evaluated. This study will take place over the course of multiple days, and all time spent in the field will be recorded.

Field surveys will generate a new map layer with all observations, and polygons will be created based on these points. The two sets of polygons will be compared to assess the accuracy of the manual spatial identification using drone imagery. Using the Intersect geospatial analysis tool in ArcGIS, it will produce a new polygon layer of where these polygons overlap, enabling numerical outputs such as percentage of area identified correctly by drone predictions, and total acres of coverage of each species within the assessed range. ￼Habitat type is a categorical explanatory variable, while drone prediction percentage and total acres of each species are the response variables. My hypothesis is that I will underestimate the total area of each species in habitats such as forests, marsh, and wetlands, but overestimate in fields, clearcut, and built areas, if I were to only use drone imagery.

1. Describe the data that will be the foundation of your thesis. Will you use existing data, or gather new data (or both)? Describe the process of acquiring or collecting data[[3]](#endnote-3).

I will gather new data and use existing data. Drone imagery of the preserve was taken over the summer, but I will need to walk the preserve and ground truth what is seen in the images. I will probably use a 10m radius/accuracy, unless advised otherwise. Using a smartphone is an intentional choice because it is more readily available to work crews and land managers alike. Mike Ruth has a Geode (for more precise GPS measurements) that he has encouraged me to use, but we both agreed it may not be necessary to be more precise than what can be achieved with a smart device. Volunteer enumerators will be trained in identifying HBB and RCG and will need to be able to use ESRI’s Field Maps app to collect data for this project. They will document which species, location (coordinates), habitat type, and an image taken from the ground level at that location. Field Maps is very user friendly, and while I do not anticipate needing volunteers, I will gladly use their assistance if offered.

1. Summarize your methods of data analysis. If applicable, discuss any specific techniques, tests, or approaches that you will use to answer your research question.

By mapping the data collected, I will be able to use various analysis tools in ArcGIS. The Intersect geoprocessing tool would produce a new layer of polygons where the drone prediction layer and field data polygons overlap. I would be able to compare the difference in area between “successful” overlap and “missed” areas by habitat type. I could also use Kernal density estimation, which produces “heatmaps” which could display areas with highest count of a certain species, or where they overlap, etc.

1. Address the ethical issues[[4]](#endnote-4) raised by your thesis work. Include issues such as risks to anyone involved in the research, as well as specific people or groups that might benefit from or be harmed by your thesis work, perhaps depending on your results. List any specific reviews you must complete first (e.g., Human Subjects Review or Animal Use Protocol Form).

This study will be conducted on a privately held preserve, which has gated access. There are neighborhoods adjacent to entry points that OlyEcosystems would like to maintain good relationships with, and at least one of the HOAs would like to be notified when we are conducting research. I will be sure to follow any guidelines given to me by OlyEcosystems for visiting the preserve. I will also ensure anyone accompanying me is respectful of these guidelines, and practice good safety protocols like staying within earshot of another volunteer. I believe the benefits of this study far outweigh the risks. There is very minimal risk of anyone being harmed by my thesis work, and the results will mainly affect OlyEcosystems and any contractors they may hire to treat HBB and RCG. My results will hopefully save them time in planning and prioritizing where they apply treatments. I am not aware of any reviews I may need to complete for this project.

1. List specific research permits[[5]](#endnote-5) or permissions you need to obtain before you begin collecting data (e.g. landowner permissions, agency permits).

I have permission from OlyEcosystems to conduct these field surveys, and Sarah Hamman has notified the rest of the board about this project, and they are excited. She is on the board of directors. I met with the Land Conservation Director, Daniel Einstein, at the site on November 30, 2023.

1. Reflect on how your positionality as a researcher could affect your results and how you will account for this in the research process[[6]](#endnote-6).

As a researcher with little ecological or biological training, I am relying on academic literature to impress upon me why and how we should manage invasive species like Himalayan blackberry. I personally like picking and eating these berries. I use them to make jelly in the summer, and I have fond memories of my mom doing the same when I was a kid. That being said, my main motivation for studying this topic is ecosystem resilience. HBB can overgrow native plants and change areas by suppressing seedling establishment of shade intolerant trees.

I am also interested in the concept of assisted migration – I am currently working for a nonprofit called PropagationNation, with a mission to bring coast redwoods and giant sequoias to the Pacific Northwest. I am conflicted when it comes to planting these giant trees in urban areas, as I am not sure how the people living near them will fare as they need tending or die off, hundreds if not, thousands of years from now. However, these trees are incredibly fast growing, rot resistant, and the redwoods are shade tolerant – could they grow out of HBB patches? Is there an effective planting strategy where HBB patches could be managed with redwoods? Since these trees are not “native”, should we plant them here at all? What is the functional time scale for determining whether a plant is “native”, “invasive”, or “acclimatized”? These are all gaps in my knowledge that I hope to fill someday.

Overall, I am aware that I am probably more risk tolerant than others in my ignorance. Facing the rapidly changing climate we are experiencing, I am biased to act, and to not wait for 95% certainty. People are already “migrating” plants to new ecosystems, even if it is just one at a time in their front yard. Land managers can affect larger plots of land, and when their task is to restore a degraded site, I think I would support trying new species, especially trees like redwoods, which have such important and unique qualities. When I consider the loss of habitat and decline of redwoods in California, I am compelled to try them somewhere else, even if it is my backyard.

While I conduct my research, I will diligently record all observations of the species I am studying at the Deschutes River Preserve. I will do my best to understand as many perspectives on restoration work as I can, especially that of the primary landowner, OlyEcosystems. I hope my thesis will provide helpful and useful information for the recovery of riparian habitat along the Deschutes and add another data point, expanding implementation of remote sensing in restoration work.

1. Provide at least a rough estimate of the costs associated with conducting your research, if any.  Provide details about each budget item so that the breakdown of the final cost is clear.

Since I have access to ArcGIS through Evergreen, Mike Ruth has already collected the drone imagery, and I plan to use smartphones as data collection devices because they are sufficiently accurate and widely available, I should not have any costs. If I need to purchase flags and stakes to delineate transects because they cannot be supplied by the Science Support Center, I can get 100 from Home Depot (3.5 in. x 2.5 in. Glo Orange Flag Stakes, 21” tall) for $9.97.

1. Provide a detailed working outline of your thesis.

* Introduction
* Background
* **Heading 1: Restoration management of invasives**
* How invasives are managed, including description of treatments for the specific invasive species found at DRP. Outline the challenges with ecosystem-based restoration, and the various motivators for continued investment in restoration efforts.
* **Subheading 1.1: Practices**
* General overview of common invasive species management practices.
* **Subheading 1.2: Challenges**
* Barriers to implementation include land ownership, resource deficit, and difficulty of tasks.
* **Subheading 1.3: Motivations**
* Impacts of restoration work on the environment.
* **Heading 2: Applying GIS to Invasive Species Management**
* **Subheading 2.1: Using remote sensing**
* Hardware (cameras, drones, satellites, etc.) and software involved
* **Subheading 2.2: Types of analysis**
* What tools are available that are helpful in the context of invasives mapping?
* **Subheading 2.3: Uses**
* Assessment
* Quantifying abundance through geolocation of invasive species.
* Monitoring
* With subsequent measures, management can be measured over time.
* **Heading 3: Deschutes River Preserve**
* A brief overview of the study site, including a historical perspective on how Deschutes River Preserve (DRP) came to be, and the restoration goals of the land managers at OlyEcosystems.
* **Subheading 3.1: Location and Historical Land Use**
* Description of where the preserve is in relation to urban development and nearby wilderness areas. Note any unique characteristics about this particular preserve. Prior land use to present day.
* **Subheading 3.2: Restoration goals**
* If established, what they are, but if not established, some possibilities.
* Methodology
* [GIS workflow graphic]
* Analysis of drone imagery (map 1)
* Field study (map 2)
* Study site
* Data collection protocol
* [GIS tools/process of comparing the generated maps]
* Results
* Description of maps produced
* Implications on prioritization of invasives management
* Conclusion

1. Provide a specific work plan and a timeline for each of the major tasks in the work plan. Be as realistic and specific as you can at this point, including the deadlines for Spring quarter.

Work plan and timeline (writing deadlines in blue)

1. Finalize which invasives I will map (HBB/RCG/Canadian thistle, others, all, just one etc.) – **mid Dec**
2. Determine if work crew will need flags or if location will be visible on data collection software – **end of Dec**
3. Assess/analyze drone imagery for presence of invasives – **throughout Jan**
4. Working draft: **Introduction** (peer review) **–** **11 Jan 2024**
5. Draft due to reader **– 18 Jan**
6. Working draft: **Methods** (peer review) **– 25 Jan**
7. Draft due to reader **– 1 Feb**
8. Find and coordinate volunteers – **mid Jan**
9. Schedule 6 field survey dates, with contingencies for weather (throughout Feb) – **end of Jan**
10. Conduct field surveys (plan 6, hopefully only need 3) – **throughout Feb**
11. Final draft of **Lit Review** (peer review) **–** **8 Feb**
12. Draft due to reader **– 15 Feb**
13. Map points as collected – **throughout Feb**
14. **Storyline** of results **– 22 Feb**
15. Finalize map and compare results (drone imagery/field surveys) – **29 Feb**
16. Working draft: **Results** (peer review) – **7 Mar**
17. Draft due to reader **– 14 Mar**
18. Complete draft: **Results/Discussion** (peer review) – **4 Apr**
19. Draft due to reader – **11 Apr**
20. Complete draft: **Conclusion –** **18 Apr**
21. **Revise, revise, revise – throughout Spring quarter**
22. Submit “Request to Present Thesis Research” form – **2 May**
23. Thesis Presentations **– 23/30 May**
24. **Final Draft – 30 May**
25. Who (if anyone), beyond your MES thesis reader, will support your thesis (in or outside of Evergreen)? Be specific about who they are and in what capacity they will support your thesis. If you are working with an outside agency or expert, be specific about their expectations for your data analysis or publication of results.

I met Daniel Einstein, the Land Conservation Director at OlyEcosystems, and he showed me the site so I have a clear understanding of what their mapping needs are, and I have communicated what I can provide. I intend to produce a map that can be added to in the future by any member of the OlyEcosystem team, and if possible, their partner organizations. I also have access to the site and will not need to depend on Dan for entry. Sarah Hamman is on their board and believes there will be other board members and volunteers who would be interested in helping document invasives. For GIS support, I will work with Mike Ruth. I know he has other classes and other thesis students to support, so I hope to make efficient use of his Sunday office hours and not need to schedule extra time on his calendar. I have also been introduced to Jonathan Batchelor, the undergraduate GIS professor at Evergreen, who has a background in mapping invasives, and I hope to ask him questions about my study design and references.

1. Provide the 5 most important references you have used to identify the specific questions and context of your topic, help with issues of research design and analysis, and/or provide a basis for interpretation. Annotate these references with notes on how they relate to/will be helpful for your thesis. For any other sources cited in your prospectus in other answers, provide a complete bibliographic citation here as well.

Catlin, K. (2023). An Exploratory Assessment of High-resolution SUAS Imagery and Deep Learning Supported Ecosystem-based Management in the Pacific Northwest. Evergreen State College. <https://collections.evergreen.edu/s/repository/item/11645>

This thesis is a helpful reference for methodology, as I intend to use a similar set of methods, with the exception of using machine learning to classify objects on the map.

Chance, C. M., Coops, N. C., Plowright, A. A., Tooke, T. R., Christen, A., & Aven, N. (2016). Invasive shrub mapping in an urban environment from hyperspectral and LiDAR-derived attributes. *Frontiers in Plant Science*, 7(1528), 212-243. <https://doi.org/10.3389/FPLS.2016.01528/BIBTEX>

This study also looks at Himalayan blackberry through remotely sensed data, but the authors used LiDAR and hyperspectral imagery. Some of their methods are applicable to my study. The authors also established that a “single point” symbolized patches with an area greater than 40m2 and at least 10m from another plot. I will likely need to decide how to define a point for data collection among “large, discrete, established patches” that are all HBB or RCG.

Neyns, R., & Canters, F. (2022). Mapping of Urban Vegetation with High-Resolution Remote Sensing: A Review. *Remote Sensing*, 2022, Vol. 14, Page 1031, 14(4), 1031. <https://doi.org/10.3390/RS14041031>

This review provides a great summary of the technologies and studies relevant to my project.

* Vegetation typologies (no text, only heading)
* Functional vegetation types
* Taxonomic classes
* Remote sensing data (no text, only heading)
* Optical sensors
* Imagery with a High Spatial Resolution (1–5 m)
* Imagery with a Very High Spatial Resolution (≤1 m)
* LiDAR
* Fusion of LiDAR Data and Spectral Imagery
* Terrestrial sensors
* Importance of Phenology in Vegetation Mapping
* Mapping approaches (no text, only heading)
* Feature definition
* Spectral features
* Textural features
* Geometric features
* Contextual features
* LiDAR-derived features
* Image segmentation
* Classification approaches
* Supervised learning approaches
* Library-based classification
* Deep learning

McGinnis, M., & Krippner, L. (2008). *Keeneland Park Project, A Planned Rural Residential Development, Final Habitat Management Plan*.

This plan was developed at the time of the adjacent housing developments, and includes details about the site’s history, vegetation, wildlife species, and nesting habitats. There is also a section of the plan dedicated to mitigation measures. I received this document from Sarah Hamman.

Yager, L. Y., & Smith, M. (2009).  Use of GIS to Prioritize Cogongrass ( *Imperata cylindrica* ) Control on Camp Shelby Joint Forces Training Center, Mississippi. *Invasive Plant Science and Management*, 2(1), 74–82. <https://doi.org/10.1614/ipsm-08-074.1>

If I am advised to use transects while doing field surveys, I may reference this article. The authors used transects of 50m while mapping cogongrass, which may be like reed canary grass. I am contemplating 10, 50, or 100m transects.

**Other References**

Feng, Q., Liu, J., & Gong, J. (2015). UAV Remote sensing for urban vegetation mapping using random forest and texture analysis. *Remote Sensing*, *7*(1), 1074–1094. <https://doi.org/10.3390/rs70101074>

Mack, R., von Holle, B., & Meyerson, L. (2007). Assessing invasive alien species across multiple spatial scales: working globally and locally. *Frontiers in Ecology and the Environment*, *5*(4), 217–220. [https://doi.org/10.1890/1540-9295(2007)5[217:AIASAM]2.0.CO;2](https://doi.org/10.1890/1540-9295(2007)5%5b217:AIASAM%5d2.0.CO;2)

Narumalani, S., Mishra, D. R., Wilson, R., Reece, P., & Kohler, A. (2009). Detecting and Mapping Four Invasive Species along the Floodplain of North Platte River, Nebraska. *Technology*, *23*(1), 99–107. [https://doi.org/10.1614/WT-08-007.1](https://doi.org/10.1614/WT-08-007.1 )

OlyEcosystems. (n.d.). *Deschutes River Preserve*. Retrieved November 14, 2023, from <https://olyecosystems.org/preserves/deschutes-river-preserve/>

Sheley, R. L., & Smith, B. S. (2012). Prioritizing invasive plant management strategies. *Rangelands*, 34(6), 11–14. <https://doi.org/10.2111/RANGELANDS-D-12-00064.1>

1. You are not locked into this title; we want you to identify the main point or topic of your thesis. [↑](#endnote-ref-1)
2. You might discuss a selection of case studies, sampling methods, experimental design, and/or specific hypotheses you will test. You should also address any specialized knowledge or skills that are necessary to complete the research. [↑](#endnote-ref-2)
3. If you are planning to use existing data, explain the specific source, contact information, arrangement with collaborating agencies, and expectations about use of data and final products of your research. If you are planning to gather new data, describe specific methods, time, place, and equipment that will be required. [↑](#endnote-ref-3)
4. If you’re not sure where to start, consult a ‘Code of Ethics’ or other similar document from an academic society in an applicable field of study. [↑](#endnote-ref-4)
5. If you are collecting ANY samples or data, even observational data, on public lands (city, county, state and/or federal) it is your responsibility to find out the permit requirements BEFORE you collect data. Conducting research with tribal members/on tribal lands will have different and additional requirements. [↑](#endnote-ref-5)
6. Your *positionality as a researcher* refers to the fact that one’s “…beliefs, values systems, and moral stances are as fundamentally present and inseparable from the research process as [one]’s physical, virtual, or metaphorical presence when facilitating, participating and/or leading the research project…” (The Weingarten Blog 2017). [↑](#endnote-ref-6)