**The Evergreen State College**

**Graduate Program on the Environment**

### Thesis Prospectus

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| **Name** | **Jaileen Merced** | | | **ID Number** |  |
| **Mailing Address** | | | **1506 Columbia St SW, Olympia WA 98501** | | |
|  | | |  | | |
| **Telephone** | | **( 312 ) 721-2182** | |
| **E-mail** | | **Jaileen.merced@upr.edu** | |

**STUDENT AGREEMENT:**

**SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**FACULTY READER APPROVAL:**

**SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**MES DIRECTOR APPROVAL:**

**SIGNATURE:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. **Provide the working title of your thesis[[1]](#endnote-1).**

Detecting threatened and endangered plant hotspots in western forested areas of Washington State.

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

Approximately one third of the US flora is considered threatened and plants account for over one half of the federal listed species (Havens et al.,2014; NatureServe, 2012). From these federal listed species, plants conservation research receives on average a 4.1% of the available government funding (Negron-Ortiz, 2014). As of 2019, 50 endangered, 148 sensitive and 142 threatened plant species (species of concern) grew in Washington State (W.N.H.P., 2019). Plant conservation still lacks the support compared to wildlife conservation. Understanding plant communities is the most powerful tool to guide our resolve to protect species of concern.

The Rare Care Program, based out of the University of Washington, has gathered data on species of concern since 2007 (W.R.P.C.C.,2020). This data provides a unique opportunity to enable the development of studies that can be analyzed at a community and species level. By identifying hotspots, government agencies may develop conservation management at a community level rather than at a species level. The detection and protection of threatened species hotspots can increase the protection of a larger amount of species of concern (Reid, 1998). The IUCN Plant Conservation, World Conservation Monitoring Center, Bird Life International, Conservation International and the World Wildlife Fund are some of the organizations that have attempted to identify hotspots to protect areas of high species richness. High angiosperm composition has been used as a biodiversity indicator to detect diversity of other groups and consequently an indicator of hotspots (Murphy et al.,2009; Primack, 2014)

**State your research question(s).**

Where are the threatened and endangered plant hotspots in the western forested areas of Washington State?

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

Conservation biogeography is a relative new field in conservation. It seeks to predict the effects of humans on biodiversity and inform management decisions on behalf of the conservation of biodiversity (Serra-Diaz, 2019; Lomolino,2004; Whittaker,2005). Lomolino (2004) argues that this discipline has two focuses: 1) conservation of the biological diversity and 2) the preservation of the geographic, ecological and evolutionary context. This study falls within the modelling of biogeographic pattern and distribution of biodiversity (Whittaker, 2005). Statistical methods like species distribution models (SDM) have become a common manner to achieve this type of application (Tikhonov et al., 2020). SDMs have been critical instrument to: 1) identify the conservation problem, 2) define possible conservation actions 3) predict consequences of actions and, 4) detect habitat suitability at a local and global scale (Guisan et al., 2013; Maguire,2016). More recently developed models, like the joint species distribution model (JSDM), allow the analysis of distribution of species at a community level. In order to carry on these model’s data on species occurrence, environmental predictors and phylogeny need to be available.

One of the primary limitations in conservation is the lack of data to develop assertive conservation decisions (Lomolino, 2004). However, citizen-science programs like Rare Care in Washington, Plants of Concern in Illinois and the New England Plant Conservation Program in the New England area are examples of critical data hubs (Havens, 2012). The Rare Care program, based out of the University of Washington Botanical garden, collects demographic data, preserves seeds and determines population threats for plant species of concern in Washington State. This program partners with government agencies to provide information that can inform them on potential recovery of these endangered and threatened species (Rare Care,2019). Programs like Rare Care are fundamental to expanding our understanding on species of concern. My study will take advantage of Rare Care valuable data to add to the understanding of these species of concern by detecting potential habitat suitability and potential areas of conservation prioritization.

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?**

By identifying hotspots of endangered species, this research will provide information for government agencies to use in prioritizing the conservation of specific areas and species prone to extinction. This study will provide information that documents plant diversity to increase the monitoring of rare species in critical “hotspots”. This information can be used to help identify other threats to this population like invasive species, animals and pathogens. Finally, the results can be used to inform policy and management decisions to allocate funding to the areas with higher needs.

More generally, we need to conserve these endangered and threatened species to keep our ecosystem functioning. Every species on Earth has a key ecological role in maintaining the balance in the community (Havens, 2014). Human actions are rapidly degrading the ecosystem and we need to understand the consequences of our actions, otherwise we will leave behind irreparable and broken land, that cannot support plant species. This project will help discover areas in the conservation biogeography and plant conservation fields that need more attention and research in the Pacific northwest region.

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)?**

For this study I will be using a Joint Species Distribution model to predict potential habitat suitability for multiple species.

Potential variables

Independent variables:

* land cover, precipitation, temperature, soil properties, vegetation type, seed size, life form and evolutionary history

Dependent variables:

* potential population distribution, high diversity areas, taxa abundance, species niches,

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).**

For this study I will use existing data. The foundational data that would be used for this study are:

1. 2019 Washington State Vascular Plant Species of Special Concern List developed by Washington State Department of Natural Resources. This list is available online on the Department of Natural Resources website (W.N.H.P.,2019).
2. Historic records of endangered and rare plant species found on the Consortium of the Pacific Northwest Herbaria. This website is a public access online herbarium specimen collection (Herbaria,2020).
3. Recent population distribution data on rare and endangered plant species collected by Rare Care Program. I will communicate with Rare Care to access to this data.
4. Soil data from the USDA Natural Resources Conservation Service Soil website (S.D.,2020)
5. Land cover data will be obtained from the National Land Cover Database (NLCD,2019)
6. Current and future climate data will be gathered from the WorlClim 2.0. Open source dataset is available online (Fick et al., 2017) and the Climate Impact Group from Washington State University program dataset.
7. If phylogeny is going to be included, I will use data from the Angiosperm Phylogeny website from the University of Missouri, St Louis (Stevens, 2001)
8. **Summarize your methods of data analysis. If applicable, discuss specific techniques that you will use to understand the relationships between variables (e.g., interview coding, cost-benefit analysis, specific statistical analyses, spatial analysis) and the steps and tools (e.g., lab equipment, software) that you will take to complete your analyses.**

I will use the R-Package HMSC in R software (Tikhonov et al., 2019; R Core Team, 20013). The exact details of the statistical analysis will be determined later. I will be using the Joint Species distribution Modelling (with applications in R) book by Otso Ovaskainen (2020) to develop the model for my study.

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)**

When working with rare and endangered species, I have a responsibility to the ecosystem. The ethical issues that my project will face is maintaining confidentiality of the location of these rare plant populations to avoid poaching. Trampling, removing vegetation, seed, fruits and spread of diseases is detrimental to these populations that already face potential extinction. It is important to note that my project does not require any field collection. I will not be visiting endangered or threatened species population. Finally, government agencies and Rare Care would be the main beneficiaries of the projects’ results of my study.

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).**

My project will utilize the data from Rare Care program. This means I will require permission from the program to provide me access to use their sensitive data. An email request has been made to Rare Care and I am waiting for their response.

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).**

Working in the herbarium for two years is where I first found my love for plants. I was trained to mount, collect, work with data entry, and digitalize specimens. I further improved these skills during my participation in an ethnobotany undergraduate research project where I taught other students the skills I had developed in the Herbarium. Later, I took a plant taxonomy class which gave me the useful tools to understand and identify the flora in the island where I lived, Puerto Rico. I also had the opportunity to work on a project of a rare and possibly endangered species in Puerto Rico (*Eugenia fajardensis*). Working with such a delicate organism has given me the skills to recognize the value of every specie and continue my career in the conservation area.  During the summer 2014 I was chosen to participate as a research intern in the Chicago botanic garden.  It one of the most enriching experiences during my bachelor’s degree. I was mentored by Rachel Goad of the Plants of Concern program where I developed a protocol to help understand the floristic composition along the ravines. This experience introduced me to the Midwest vegetation and monitor rare/endangered species with the help of citizen scientists.  During other research projects I have helped with the monitoring of invasive pines in Puerto Rico, (*Pinus caribaea var. hondurensis*) and understanding a coastal secondary forest in an ecologically valuable corridor in Puerto Rico in order to protect it from development. Finally, working for the Bureau of Land management gave me a better understanding of government agency protocols and knowledge of the flora in the Great Basin region.

All this experience has solidified my passion for plant conservation and keeps pushing me to continue to work to develop a better understanding of the status of plants of concern. I understand that any mistake that this study may have could misinform government agencies and policy makers. Such misinformation could be detrimental to the survival of the species of concern. I will make sure to be clear and honest throughout the research process and with the results obtained. I will also constantly reach out to my reviewer to make sure that I am being objective throughout the research process. I hope to continue my professional career in this field. I feel I have the power to improve conservation efforts through my project, but I also have the responsibility to develop an ethical research question and recognize the researchers’ methods that I am replicating.

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

There will be no cost associated with my research. All the data has already been collected and is open source. At the same time, the software programs that will be used for data analysis, like R, are available as open-source applications.

1. **Provide a detailed working outline of your thesis.**
2. Title
   1. Detecting threatened and endangered plant hotspots in western forested areas of Washington State.
3. Abstract
4. Acknowledgements
   1. Rare Care, Department of Natural Resources, Consortium of the Pacific Northwest, Herbaria, USDA Natural Resources Conservation Servia Soil, Washington Geospatial Open Data Portal, WorldClim, Evergreen State College, National Land Cover Data,
5. Introduction
   1. Threatened flora in the US and recent efforts to plant conservation
   2. Washington State and Rare Care program efforts
   3. Hotspot in conservation biology
   4. Joint Species distribution models in conservation biogeography
6. Literature Review
   1. Loss of biodiversity
   2. Plant conservation in the world
   3. Plant conservation in US
   4. Plant conservation in Washington state
      1. Rare Care
   5. Hotspots in conservation biology
   6. Biogeography conservation
      1. Mapping biodiversity
      2. Joint species distribution models applications
7. Methods
   1. Data collection
      1. Explain data sources
   2. Model fitting
   3. Algorithms
8. Results
   1. Table with the rare species list analyzed
   2. Map with hotspot areas
9. Discussion
10. Conclusion
11. **Provide a specific work plan and a timeline for each of the major tasks in the work plan. Be as realistic as you can, even though you will probably need to alter this schedule as you complete the tasks. Remember that faculty readers take time to return your drafts and that the final polishing and formatting of your thesis for binding will take longer than you ever imagined.**

Winter 2021

Week 1: Gather data from all sources

Week 2: Organize and clean data

Week 3: Organize and clean data

Week 4: Start model fitting and meet with John Withey

Week 5: Data analysis- Write result from week 5 and come up with final species list

Week 6: Data analysis

Week 7: Data analysis

Week 8: Data analysis

Week 9: Meet with John Withey

Week 10: Data analysis- Finish model and obtain results

Spring Quarter 2021

Week 1: Write discussion and meet with John Withey

Week 2: Write introduction

Week 3: Meet with John Withey

Week 4: Finish details

Week 5: Meet with John Withey and finish details

Week 6: Finish final details and breath

Week 7: Prepare presentation

Week 8: Present thesis

Week 9: Prepare the final draft

Week 10: Submit thesis to MES director

1. **Who, beyond your MES faculty reader, will support your thesis? Indicate support both within and 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 will not be working with any other agency or reader. Rare Care program will provide data but will not be reviewing or providing any other support.

1. **List the 3-5 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. For each annotated reference, explain how your project specifically connects to the source by extending, challenging, or responding to the conclusions, methods, or implications. For any other sources cited in this document provide a complete bibliographic citation**.

Havens, K., Kramer, A. T., & Guerrant, E. O. (2014). Getting Plant Conservation Right (or Not): The Case of the United States. *International Journal of Plant Sciences*, *175*(1), 3–10. <https://doi.org/10.1086/674103>

* In this study Havens et al. (2014) compared US efforts on plant conservation with other countries. It also portrayed the lack of priority and funding given to plant related projects and the necessity of reallocating those funds. The author also goes over the different programs in USA that work on ex situ and in situ projects to restore threatened plant populations. Finally, the author concludes that the lack of priority, insufficient financial support, the decreasing botanist training and lack of student interest are some of the factors that United States plant conservation need to work on. More importantly the focus should be to develop a better communication between government agencies, academia, and nongovernmental organizations to protect our native flora. This study can be a valuable baseline to support my introduction and better understand the status of plant conservation in the United States.

Serra‐Diaz, J. M., & Franklin, J. (2019). What’s hot in conservation biogeography in a changing climate? Going beyond species range dynamics. *Diversity and Distributions*, *25*(4), 492–498. https://doi.org/10.1111/ddi.12917

* In this paper Serra-Diaz et al (2010) investigates the new methods to improve species distribution models (SDM). The author gives a list of different studies that have implemented biophysical models, ecological network approaches, disturbance and management scenarios into their models to better capture our rapid changing environment. This study is pivotal on the development of my study because the author demonstrates how conservation biogeography could better inform policy and management on the effects of humans on nature.

Whittaker, R. J., Araújo, M. B., Jepson, P., Ladle, R. J., Watson, J. E. M., & Willis, K. J. (2005). Conservation Biogeography: assessment and prospect. *Diversity and Distributions*, *11*(1), 3–23. https://doi.org/10.1111/j.1366-9516.2005.00143.x

* In this paper the authors analyze the role of conservation biogeography on the goal of preserving the earth ecosystems. The authors provide case studies to explain and criticize the various applications of conservation biogeography. This article contains important insight on how hotspots have been used to depict conservation areas. Also, described is how the power of mapping biodiversity and ecosystem are important for conservation.

Primack, R. B. (2014). *Essentials of Conservation Biology* (6th ed.). Sinauer Associates is an imprint of Oxford University Press.

* This book is crucial for understanding different aspects of the conservation process. It was the textbook for my Conservation Biology course in Fall 2019. The textbook provides a general introduction to topics like extinction, habitat destruction, fragmentation, degradation, global climate, establishing conservation priorities and identifying areas to protect. It also contains a section on hotspots and the applications in conservation.

Ovaskainen, O. (2020). *Joint Species Distribution Modelling (With Applications in R)* (1st ed.). Cambridge University Press. <https://doi.org/10.1017/9781108591720>

* This book is a great introduction to Joint species distribution model, hierarchical modelling of species communities and community ecology. The author also makes comparisons with other multi-species models and explains the details of HMSC, JSDM and SDM. The author presents a step by step on building a JSDM. This book will serve as the main reference to develop the JSDM for my study.

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Andrade, A. F. A., Velazco, S. J. E., & De Marco Júnior, P. (2020). ENMTML: An R package for a straightforward construction of complex ecological niche models. *Environmental Modelling & Software*, *125*, 2–35. https://doi.org/10.1016/j.envsoft.2019.104615

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1. You are not locked into this title; its purpose is to help you identify the main point or topic of your thesis at an early stage. [↑](#endnote-ref-1)
2. You might discuss 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)