### Thesis Prospectus 2022-23

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**Student Final Submission (date): 12/16/2022**

**Faculty Reader Approval (date):**

**MES Director Approval (date):**

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

Exploring the relationship between soil properties and *Vulpia myuros* abundance at Pacific Northwest prairie restoration sites

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

To understand my research problem and help answer my question I will need to gather literature on rattail fescue, land use legacy effects, and background information on the prairie restoration sites. The restoration sites have varied land use histories, from recently restored prairies to abandoned agricultural fields being restored to prairie habitat. Soil properties among sites likely vary do to differing land use histories. This variance, or land use legacy effect, could play a role in how much rattail fescue abundance differs between the restoration sites. Relevant literature will focus on one or more of the following: the legacy effects of historic agricultural land use, rattail fescue biology & ecology, soil & rattail fescue growth, and control & management of rattail fescue. Researching and understanding annual vs perennial grass life cycles, and specifically rattail fescue’s life cycle, will also be important. Its annual life cycle gives it a competitive edge.

1. State your research question(s).

Is there a relationship between soil properties and rattail fescue that promotes its abundance? How do soil properties at nine restoration sites with differing land use histories affect the extent of rattail fescue abundance?

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

Current research has limited information on the interaction between rattail fescue abundance and soil properties. Rattail fescue has low nutrient requirements which could give it a competitive advantage in low fertility soils (Hill et al., 2005) although a direct relationship between soil fertility and rattail fescue density has not been observed (Dowling et al., 2004). In studies that compared rattail fescue’s response to a gradient of phosphorous (P) fertilizer application concentrations, it reached maximum aboveground vegetative growth at lower P concentrations and did not benefit from increased applications (Asher & Loneragan, 1967; Rossiter, 1964). Rattail fescue’s response to nitrogen (N) fertilizer applications indicates a low sensitivity to varying N levels, in that its growth is not limited at low levels and is not significantly enhanced at higher levels (Cocks, 1974; Hill et al., 2005). Even with statistically significant variations between study sites in soil N, percent organic matter, and pH, rattail fescue abundance did not vary significantly (Stylinski & Allen, 1999) and the authors concluded that rattail fescue abundance variation was not explained by soil property variations. The most promising and clear response reported so far is to P and has been explored as part of an integrated plan of control.

Traditional vegetation control methods have not been as effective at controlling rattail fescue. Multiple studies have reported limited success with single herbicide applications and found that the timing and frequency of applications were important (Ball et al., 2007; Forcella, 1986; Leys et al., 1991) and rattail fescue’s physical structure make it unpalatable for grazing most of the time. Integrated management was found to effectively control and reduce rattail fescue populations, but populations returned to pre-control levels without continued management (Dowling et al., 2004; Tozer et al., 2008). In one study, P applications were used in conjunction with herbicide applications to rattail fescue and seeding plots with subterranean clover. Researchers noted that increased P applications benefitted the clover and helped it take up the space vacated by the sprayed fescue, reducing rattail fescue’s regeneration rate (Dowling et al., 1997). They noted that this response could be possible because rattail fescue does not benefit from higher P concentrations in the soil, citing Asher & Loneragan (1967) and Rossiter (1964). The success of integrated management on controlling rattail fescue requires further developing our understanding of its relationship with the soil.

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?

Rattail fescue (*Vulpia myuros*), sometimes called silvergrass, is an invasive annual grass that has spread across prairie restoration sites in the Pacific Northwest (PNW), possibly via contaminated seed stock (Alderman et al., 2011). Dr. Sarah Hamman presented a research project exploring the relationship between rattail fescue abundance and soil properties at restoration sites in Thurston County. It has been observed that the abundance of rattail fescue between the prairies in question varies considerably, sometimes varying between locations within a single prairie. The land use history varies between prairies as well, ranging from abandoned agriculture fields to restored prairies, and likely has resulted in varying legacy effects on the soil (Cuddlington, 2011). This situation provides a unique opportunity to analyze the relationship between rattail fescue and soil properties. Doing so will improve the general understanding of how rattail fescue grows.

Rattail fescue has become a greater problem in the PNW over the last few decades while Australian wheat farmers in the southern part of the continent have dealt with it since the mid-1900’s (Lyon et al., 2018). The occurrence of V. myuros has increased as more farmers adopt no-till or low soil disturbance practices because the plant’s germination process does not tolerate regular tilling (Büchi et al., 2021; Lyon et al., 2018). It has also spread to restoration sites due to contaminated seed stock (Alderman et al., 2011). The body of literature contributing to this discussion has understandably canalized towards an agricultural focus, highlighting either rattail fescue’s adverse impacts (Büchi et al., 2021; Forcella, 1984) or methods of control (Jemmett et al., 2008). Some observational studies have been performed on rattail fescue’s behavior in non-agricultural settings (no previous or present agricultural use) (Stylinski & Allen, 1999), but overall the literature lacks research focused solely on prairie and grassland habitats.

Understanding its relationship to soil characteristics could lead to improved control methods, but to date there has been limited research in this area. The most related article to my questions is nearly 60 years old. Asher & Loneragan (1967) is currently the only article I’ve found that directly explores how a soil characteristic, in this case phosphorus concentration in the soil solution, is related to the growth of V. myuros. General overview articles like Lyon et al. (2018) also list rattail’s preferred soils as acidic and sandy, but no details regarding possible correlations between soil properties and spread. This thesis project has the potential to provide invaluable information on what soil conditions benefit and adversely affect V. myuros, as well as expand the focus from agriculture to restoration project sites. Practical framework for my project - improved understanding of the interactions between rattail fescue and soil - will help develop integrated management methods. There could be ways to amend the soil to either discourage rattail growth, or help native vegetation compete better.

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)?

In this study, the following soil properties are the independent variables: % organic matter, % moisture, pH, phosphorous, nitrogen, and bulk density. The dependent variable will be rattail fescue abundance. The soil properties listed affect growing conditions and influence the growth of vegetation. Using rattail fescue abundance as a response variable to the listed soil properties will allow for the analysis of any potential trends or significant influence of them on rattail fescue growth.

Samples from sites with low/med/high rattail fescue abundance will be compared and analyzed for statistically significant relationships between the soil properties measured and the recorded abundance.

a) Establish 6 randomized plots, size yet to be determined, at each of 9 infestation sites

b) Collect enough soil cores within each plot to provide 2 cups of soil to the lab and 1 cup for in house testing and combine to create a composite sample. Each infestation site will have 6 composite soil samples, making a total of 54 composite samples for 9 infestation sites. Soil cores will be collected in a grid pattern within plots.

c) Split each composite sample into 2 even parts by weight

d) Ship halved composite samples to lab for nutrient testing

e) Run percent moisture content, and bulk density tests on campus

f) Get abundance data from Dr. Hamman

g) Conduct Multiple linear regression

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).

My research will use a mix of existing data and gathering new data. Dr. Hamman has agreed to provide existing *V. myuros* abundance data collected from these restoration sites. I will also use the Soil Web Survey to gather general information on site soil types to help provide landscape level context to my study. Soil cores from low, medium, and high abundance sites will generate new data on soil properties. Most of the analysis will be done through outside lab, but I will test for bulk density and percent moisture.

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.

Sampling scheme

To ensure representative data I will collect subsamples and create composite soil samples. Soil cores will be collected at a 6-9 in depth based on standard soil sampling techniques (Fery et al., 2021) and the typical rattail fescue root depth (Lyon et al., 2018). I will determine suitable plot sizes after a field visit to observe the infested sites. The locations of the six sampling plots per site will be randomly selected and subsample cores will be collected in a grid pattern within each plot.

Data analysis

I will use R to conduct a multiple linear regression analysis using rattail fescue abundance as the dependent variable and the soil properties as independent variables. The labs test results will include more independent variables than I intend to analyze. I will prioritize analyzing % organic matter, % moisture, pH, phosphorous, nitrogen, and bulk density with rattail fescue abundance.

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).

The main risks to me and anyone else involved will be general field conditions and working in uneven terrain. I believe the greatest potential for harm would be damage or adverse impacts to native vegetation in culturally sensitive prairies. I will take steps to ensure these sites are left as undisturbed as possible by being careful of where we walk, using established pathways whenever possible, and do my best to avoid damaging native vegetation. Prairie restoration practitioners, agricultural folks controlling rattail fescue, and researchers exploring control methods will benefit from the results of this 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).

I do not think I’ll need any specific permits. I will need to work with WDFW to sample within their Scatter Creek Wildlife Area and with the restoration practitioners of my sites to coordinate a sampling schedule.

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).

Viewing invasive plants as inherently bad could influence my perspective and my writing. I think also hoping to find a statistically significant relationship could limit my ability to interpret data that is not statistically significant. To combat these potential issues, I will review my writing with a focus on objectivity, and when I’m reviewing and analyzing data I will keep an open mind about the results.

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.

The costs of my research will come from tools for sampling and shipping samples for analysis and will slightly depend on what equipment the Science Support Center has available. The cost of a soil core probe is between $30-100 depending on the size. The cost of sample bags, shipping boxes, and postage to Midwest Laboratories is unknown as it will depend on the combined weight of the samples but will run at least $10. The soil analysis tests themselves will cost between $621 - $1377 depending on the level of analysis selected. At the most, the estimated costs for my research are approximately $1500.

1. Provide a detailed working outline of your thesis.

a) Introduction

 a. What is rattail fescue

 b. Why is it an issue overall

 c. What is the local issue

 d. Research question

b) Literature Review

 a. Broad overview

 b. Rattail Fescue Biology

 c. Soil Properties and Rattail Fescue

 d. Control and Management

 e. Impacts

 f. Legacy effects on soils

c) Sampling Site Background

 a. Glacial Heritage Preserve

 b. Wolf Haven Preserve

 c. Tenalquot Preserve

 d. Johnson Prairie

 e. Scatter Creek Wildlife Area

 f. Deschutes Prairie Preserve

 g. Violet Prairie Preserve

d) Methodology

 a. Sampling methods

 b. Plot selection

 c. Data analysis

e) Results

f) Discussion

 a. Discuss results in the context of current literature

 b. Potential management/control suggestions

 c. Integrated management

 d. Potential errors in the research process

g) Conclusion

Connect results and discussion to the larger issue

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.

 Apply for funding – Dec 2022 – Jan 2023

Gather sampling equipment – Jan 2023-March 2023

1. Complete equipment request form for the science support office
2. Get form approved by Dr. Hamman and the Science Support Center

Meet with site managers – Dec 2022 - February 2023

Revise literature review – Dec 2022 – February 2023

Draft and revise introduction, sampling site background, and methodology - Dec 2022 – February 2023

Collect soil samples – Early spring, probably March 2023

Send samples for testing – March 2023

Test samples myself – March 2023

Analyze data – March - April 2023

Draft and revise Results, Discussion, and Conclusion – March – April 2023

1. 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.

No major support from other folks outside of my thesis reader. There could be some support and expectations from the WDFW Scatter Creek wildlife area manager and from restoration site managers, but that will not be known until I speak with them this winter. I imagine at the very least, managers will expect to receive a copy of my data and results.

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.

 Alderman, S. C., Elias, S. G., & Hulting, A. G. (2011). Occurrence and Trends of Weed Seed Contaminants in Fine Fescue Seed Lots in Oregon. *Seed Technology*, *33*(1), 7–21.

 Asher, C., & Loneragan, J. (1967). Response of plants to phosphate concentration in solution culture: I. Growth and phosphorus content. *Soil Science*, *103*(4). https://doi.org/10.1097/00010694-196704000-00001

 This article is one of the original studies exploring rattail fescue's relationship with phosphorous. The authors applied phosphate solutions in 5 different concentrations. Rattail fescue reached it's maximum growth, measured by dry weight, at a lower concentration (1 micromoler) compared to the other plants in the study. Its growth declined at the 5 and 25 micromoler solutions. These findings paved the way for future research furthering this work.

 Ball, D. A., Frost, S. M., Bennett, L. H., Thill, D. C., Rauch, T., Jemmett, E., Mallory-Smith, C., Cole, C., Yenish, J. P., & Rood, R. (2007). Control of Rattail Fescue (Vulpia Myuros) in Winter Wheat. *Weed Technology*, *21*(3), 583–590. https://doi.org/10.1614/WT-06-120.1

 Büchi, L., Cordeau, S., Hull, R., & Rodenburg, J. (2021). Vulpia myuros, an increasing threat for agriculture. *Weed Research*, *61*(1), 13–24. https://doi.org/10.1111/wre.12456

 Cocks, P. S. (1974). Response to nitrogen of three annual grasses. *Australian Journal of Experimental Agriculture*, *14*(67), 167–172. https://doi.org/10.1071/ea9740167

 Another one of the few studies exploring how rattail fescue responds to different nutrient concentrations. This study includes a density variable, and the author found rattail fescue's response to nitrogen was density dependent. Using the leaf area index as a comparison variable, a reflection of growth rate, the author observed that only at a high density did the grass respond to nitrogen fertilizer applications. This makes me curious to see how soil N varies at sites with higher abundance.

 Cuddington, K. (2011). Legacy Effects: The Persistent Impact of Ecological Interactions. *Biological Theory*, *6*(3), 203–210. <https://doi.org/10.1007/s13752-012-0027-5>

 Dowling, P. M., Leys, A. R., & Plater, B. (1997). Effect of herbicide and application of superphosphate and subterranean clover seed on regeneration of vulpia in pastures. *Australian Journal of Experimental Agriculture*, *37*(4), 431–438. https://doi.org/10.1071/ea95116

 The authors found that hitting rattail fescue with a one-two punch improved control of it. Herbicide was applied followed by an application of superphosphate and seeding of subterranean clover. Regeneration of rattail fescue was lowest in plots that used the combined approach. The important piece from this study is that rattail fescue did not respond to additional P, providing further insight into its relationship with the soil. The control of rattail fescue was managed through boosting soil P to the benefit of the subterranean clover, enabling the clover to better compete with rattail fescue.

 Dowling, P. M., Leys, A. R., Verbeek, B., Millar, G. D., Lemerle, D., & Nicol, H. I. (2004). Effect of annual pasture composition, plant density, soil fertility and drought on vulpia (Vulpia bromoides (L.) S.F. Gray). *Australian Journal of Agricultural Research*, *55*(10), 1097–1107. https://doi.org/10.1071/AR04032

 Fery, M., Choate, J., & Murphy, E. (2021). *A Guide to Collecting Soil Samples for Farms and Gardens* [Extension Catalog publication]. Oregon State University Extension Service. https://extension.oregonstate.edu/pub/ec-628

 Forcella, F. (1986). Timing of Weed Control in No‐Tillage Wheat Crops. *Agronomy Journal*, *78*(3), 523–526. https://doi.org/10.2134/agronj1986.00021962007800030027x

 Hill, J. O., Simpson, R. J., Wood, J. T., Moore, A. D., Chapman, D. F., Hill, J. O., Simpson, R. J., Wood, J. T., Moore, A. D., & Chapman, D. F. (2005). The phosphorus and nitrogen requirements of temperate pasture species and their influence on grassland botanical composition. *Australian Journal of Agricultural Research*, *56*(10), 1027–1039. https://doi.org/10.1071/AR04279

 This is the only study that studied rattail fescue's response to both nitrogen and phosphorous. Rattail fescue had a higher relative growth rate at low P applications compared to the other plants in the study. It also experienced only a 15% increase in it's growth rate at higher P applications. Rattail fescue's response to N is interesting because it seems indifferent to the amount of N available. It had one of the lowest relative growth rate responses at both low and high N applications. This article is an important piece to my theoretical framework because it draws some definitive conclusions about rattail fescue's relationship to soil properties.

 Leys, A. R., Cullis, B. R., & Plater, B. (1991). Effect of spraytopping applications of paraquat and glyphosate on the nutritive value and regeneration of vulpia (Vulpia bromoides (L.) S.F. Gray). *Australian Journal of Agricultural Research*, *42*(8), 1405–1415. https://doi.org/10.1071/ar9911405

 Lyon, D. J., Ball, D. A., & Hulting, A. G. (2018). *RATTAIL FESCUE: BIOLOGY AND MANAGEMENT IN PACIFIC NORTHWEST WHEAT CROPPING SYSTEMS*. Pacific Northwest Extension. https://rex.libraries.wsu.edu/esploro/fulltext/report/Rattail-fescue--biology-and-management/99900502629001842?repId=12332815490001842&mId=13332919910001842&institution=01ALLIANCE\_WSU

 Rossiter, R. C. (1964). The effect of phosphate supply on the growth and botanical composition of annual type pasture. *Australian Journal of Agricultural Research*, *15*(1), 61–76. https://doi.org/10.1071/ar9640061

 The author performed a series of 4 different experiments. In two of these, rattail fescue responded best to P at lower concentrations. The first experiment was to apply superphosphate at different concentrations over a t 13 yr period. Rattail fescue's percent composition of the community declined with increasing superphosphate applications, although the trend was not statistically significant. The second experiment was similar, but annual grass data was not broken down to the species level. Rattail fescue dominated the annual grasses for the first 5 years, and in this time the annual grass cover varied little. Barley grass began to dominate in the 6th year, after which the annual grass response to superphosphate applications increased with increasing application concentrations.

Stylinski, C. D., & Allen, E. B. (1999). Lack of native species recovery following severe exotic disturbance in southern Californian shrublands. *Journal of Applied Ecology*, *36*(4), 544–554. https://doi.org/10.1046/j.1365-2664.1999.00423.x

 Tiver, N. S., & Crocker, R. L. (1951). The Grasslands of South-East South Australia in Relation to Climate, Soils and Developmental History. *Grass and Forage Science*, *6*(1),

29–80. https://doi.org/10.1111/j.1365-2494.1951.tb00911.x

 Tozer, K. N., Chapman, D. F., Quigley, P. E., Dowling, P. M., Cousens, R. D., Kearney, G. A., Tozer, K. N., Chapman, D. F., Quigley, P. E., Dowling, P. M., Cousens, R. D., & Kearney, G. A. (2008). Effect of grazing strategy, ryegrass overdrilling and herbicide application on vulpia content, tiller density and seed production in perennial pastures. *Australian Journal of Experimental Agriculture*, *48*(5), 632–640. https://doi.org/10.1071/EA06144

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 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)