evergreen
Master of Environmental Studies

The Evergreen State College
Graduate Program on the Environment
Thesis Prospectus

Name Graham Klag **ID Number** A00236157

Mailing Address 2323 Burbank Ave. NW Apt. 18B Olympia, WA 98502

Telephone (971) 998- 6604

E-mail graham.klag@gmail.com

STUDENT AGREEMENT:

SIGNATURE: _____ **DATE**_____

FACULTY READER APPROVAL:

SIGNATURE: _____ **DATE**_____

MES DIRECTOR APPROVAL:

SIGNATURE:_____ **DATE**_____

1) Provide the working title of your thesis[1].

Prioritizing areas for restoration and enhancement of the Early blue violet *Viola adunca* and associated plant species in Pacific Northwest coastal prairie ecosystems using coconut coir mats

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

A myriad of native plants, pollinators, and other species depend on the Pacific Northwest coastal prairie habitat for their lifecycle. Since 1982 the Oregon silverspot butterfly *Speyeria zerene hippolyta*, has been federally listed as a threatened species whose numbers continue to decline at an alarming rate, in large part due to the loss of the butterfly's host plant the Early blue violet *Viola adunca* (*Speyeria zerene hippolyta* W.H. Edwards; USFWS 2001). The caterpillar of the butterfly depend on the leaves of the Early blue violet and needs to consume ~250 leaves of the plant to complete its slow growing life cycle (Bierzychudek & Warner, 2015). As defined in the Oregon silverspot butterfly recovery plan, the butterfly has only four populations left in the world, with three in Oregon and a small disjunct population in northern California (*Speyeria zerene hippolyta*

W.H. Edwards; USFWS 2001). Characteristics of the prairies that still provide habitat for the violet and butterfly include poor, thin or rocky soils that support a variety of sparse, low growing native vegetation and low nutrient growing conditions (McCorkle & Hammond, 1988). Unfortunately, most of the prairies along the coast have lost these qualities, due to conversion to non-native pasture grasses for and by livestock, the subsequent addition of nitrogen from manure and the removal of historic fire disturbance.

3) State your research question.

Will vegetative mats growing Early blue violet (*Viola adunca)*, Roemer's Fescue (*Festuca romeri),* and Beach Strawberry *(Fragaria chiloensis)* made from coconut coir and Red Alder (*Alnus rubra*) clips promote the Early blue violets' ability to establish and maintain interstitial spacing within the mat more effectively than the traditional plug planting techniques?

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

(See Figure 1)

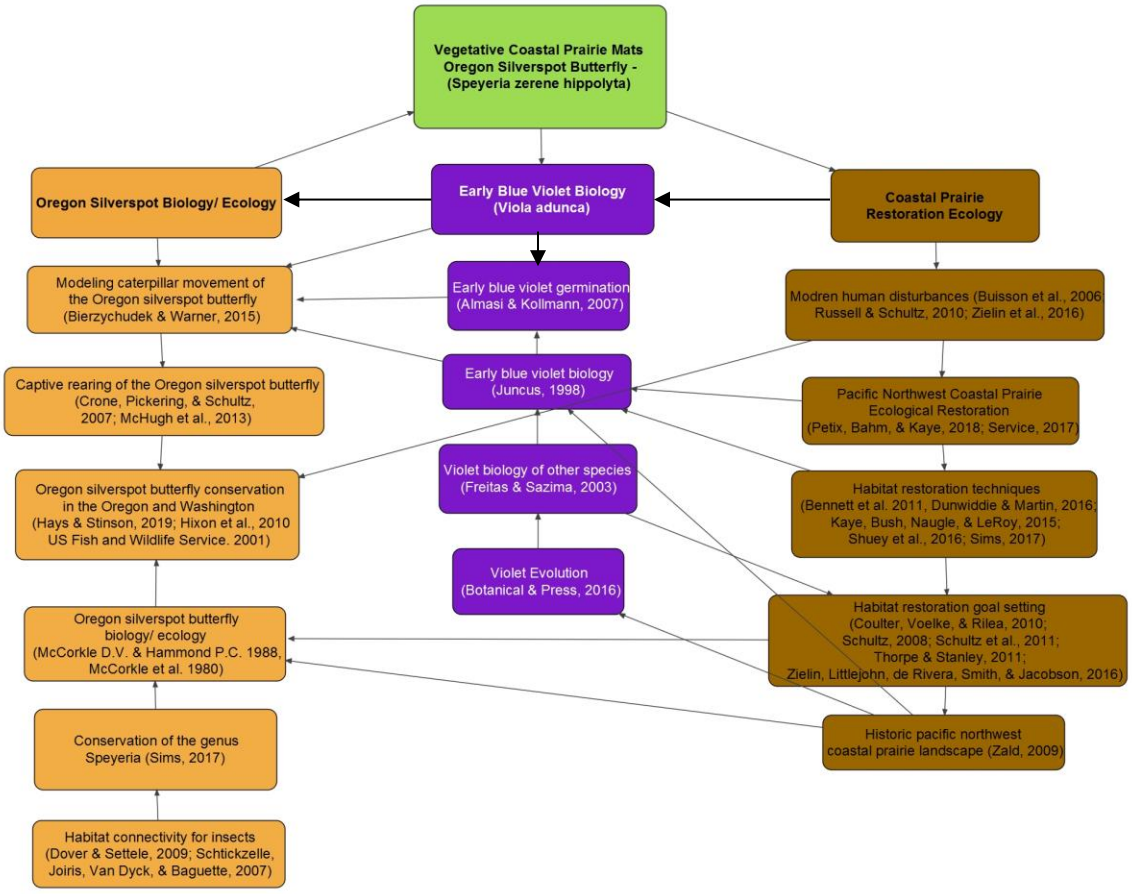
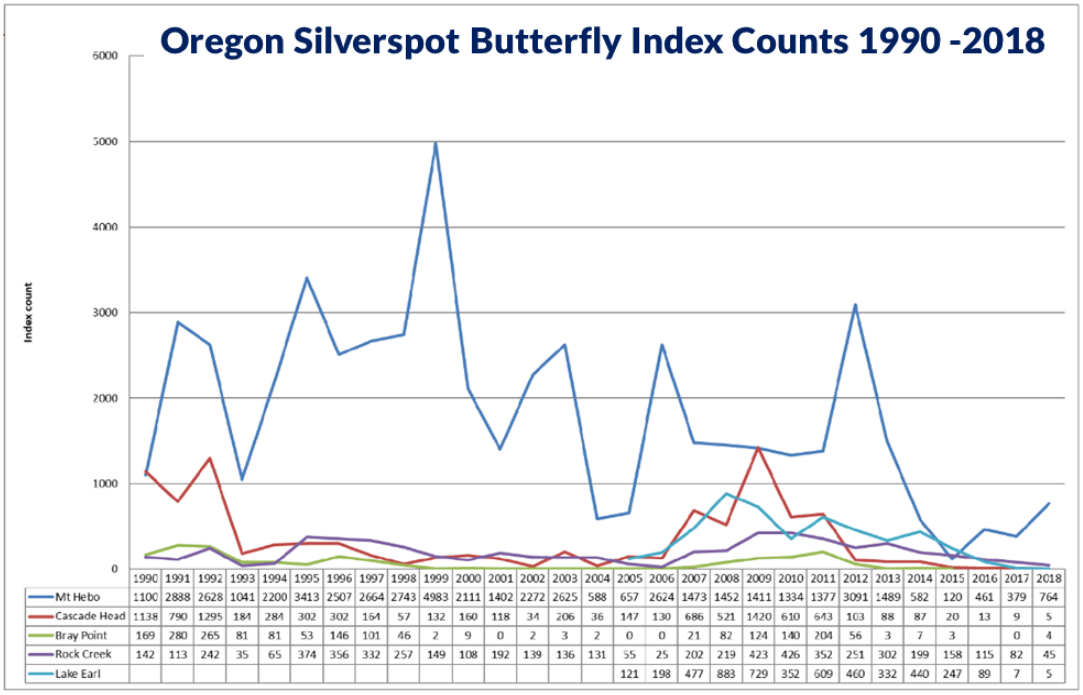


Figure 1: Mind map of the theoretical framework for the vegetative coastal prairie mat research question. The diagram represents the four major areas of research related to my thesis research pictured in green. The three other colored boxes represent topics with literature relationships covering issues related the topics with Orange relating to Oregon silverspot butterfly biology and ecological habitat needs, purple relating to Early blue violet biology/ overall violet evolution and brown relating to restoration ecology and the methods and targets available to landscape practitioners. Each arrow represents the nature of how each piece of literature will be cross-referenced in my literature review and thesis. Top bold arrows show the direction of the relationship across the research problems major areas.

5) 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?

Grasslands are a critically endangered ecosystem. Native grassland ecosystems have experienced a dramatic decline in species across North America over the past century due to agricultural conversion and fire removal (Noss et. al, 1995). Along the Washington and Oregon's coast prairie grassland ecosystems are a rare, and endangered habitat. The growing body of research on coastal prairie restoration in the Pacific Northwest points to many tested techniques that could provide valuable contributions to restoring these prairie grassland ecosystems for species such as the Oregon silverspot butterfly, by improving the size and quality of habitat. However, the cost and feasibility of soil removal for large scale restoration continues to be a hurdle for large scale and site-specific restoration (Meaghan et al., 2018). In order to address these issues and add to the ecological restoration toolkit, there is a direct need for research. My thesis research will focus on how to establish and maintain density and abundances of the Early blue violet and other native plant species, suitable for the larval development of the Oregon silverspot butterfly. My thesis research problem will explore the primary literature available to frame my research question within the contemporary context of restoration ecology and the known historic ecological conditions of the Early blue violet and the Oregon sliverspot butterfly (Figure 1).

This research project will take an innovative non-herbicidal approach to ecological restoration by utilizing a common environmental engineering and soil conservation tool - coconut coir mats (Sivakumar et al. 2008). With this research project I hypothesize that using the mats as a medium to grow the Early blue violets in will create an environment suitable to the violet's historical habitat, while inhospitable to non-native invasive plants and their seed above and within the soil. If the vegetative mats are more effective than traditional plug planting, they will provide a new restoration tool to support the threatened Oregon silverspot butterfly's larval development (Figure 2), in Pacific Northwest coastal prairie ecosystems by suppressing non-native invasive plants, retaining soil moisture and creating a low nutrient substrate.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mt Hebo	1100	2888	2628	1041	2200	3413	2507	2664	2743	4983	2111	1402	2272	2625	588	657	2624	1473	1452	1411	1334	1377	3091	1489	582	120	461	379	764
Cascade Head	1138	790	1295	184	284	302	302	164	57	132	160	118	34	206	36	147	130	686	521	1420	610	643	103	88	87	20	13	9	5
Bray Point	169	280	265	81	81	53	146	101	46	2	9	0	2	3	2	0	0	21	82	124	140	204	56	3	7	3		0	4
Rock Creek	142	113	242	35	65	374	356	332	257	149	108	192	139	136	131	55	25	202	219	423	426	352	251	302	199	158	115	82	45
Lake Earl																121	198	477	883	729	352	609	460	332	440	247	89	7	5

Figure 2: Oregon silverspot butterfly abundance index at extant sites in Oregon and California 1990 to 2018 (A. Walker, pers. comm)

There's a consensus among federal, state and non-government agencies such as the Xerces Society that invertebrate and pollinator conservation is an important aspect for not only the agricultural production of the United States but also understanding how vertebrates act as indicator species reflecting the health of our habitats both human and nonhuman (Thorpe & Stanley 2011). This research project will allow for a better understanding of how to come up with creative solutions that address a specific species needs while also taking into account the complexity of the ecosystem and the challenges that altered habitats face in being restored to fully functioning ecosystem. By creating ecological functionality both structurally and biology for the Early blue violet and the butterfly within the coconut coir mats, this research offers the opportunity to showcase how restoration ecology can work from small successes to larger conservation goals. The successes of this project could also allow for enhancement of habitat as opposed to just restoration of former habitat areas. In areas where habitat does not exist the mats could create habitats for rooftop gardens, roadsides, plazas as well as other areas that are proximal to human existence. Providing a better experience of nature for humans who get to experience them and the plants and animals that benefit from them.

The research project could provide the opportunity to create a form of habitat restoration currency for species, providing people with a metered material they can use to conceptualize and estimate the costs of restoration and effective habitat enhancement. The material could help people conceptualize the structure of the plant communities that need to exist in order to support the Oregon silverspot butterfly. The project could provide the opportunity to facilitate a new fundraising mechanism around the mats and public support for non-herbicide solutions to prairie restoration. One fundraising technique would mirror that of the sponsoring bricks for a courtyard as the sponsoring of bricks for a courtyard: buying mats to revegetate and repopulate a prairie with native species.

6) Summarize your study design[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 project will test the effectiveness of experimental coastal prairie vegetative mats to enhance and restore coastal prairie areas currently and formally utilized by the Oregon silverspot butterfly. The project will utilize three plant species associated with the life history of the Oregon silverspot butterfly based on ecological field data associated with the Oregon silverspot butterfly's habitat usage at Mt. Hebo, Oregon. Restoration areas prioritized for the out planting of plant material will include sites that have received restoration treatments; scraping and mowing. Within these two treatment types, vegetative mats made from coconut coir and red alder chips sown with Early blue violet, Roemer's Fescue seed, and Beach Strawberry cuttings will be out planted in the treatment areas. As a control to the vegetative mats, an equal number of plants grown in plugs will be out planted within 1x1 meter plots. Plots will be measured as the percent native and bare ground aerial cover to non-native invasive plant aerial cover within the 1x1 meter quadrat of the vegetative mat and control plug planting areas. The surrounding 3x3 meter treatment area of the mats and plug plots will also be measured as 8 1x1 meter quadrats to understand the response of the existing plant community to the treatment types and its potential effect on the experiment's variables (Figures 3, 4 & 5). Out planting of the mats and plug plots will occur within the two types of restoration treatments, with the plots spaced evenly across the areas (Figures 7 & 8). To account for edge effect on the mats and plug plots, both will have a buffer treatment area of at least 2 meters surrounding the plots and be planted at least 2 meters apart from each other.

Explanatory Variable	*Response Variable*
Scraping	Percent aerial cover of native plant species
Mowing	Percent aerial cover of Early blue violet
Control Plugs	Percent aerial cover non-native invasive plant species
Vegetative Mats	Percent aerial cover of bare ground

Figure 3: Table of the experiments' explanatory and response variables

Substrate for the vegetative coastal prairie mats consists of coconut coir sourced from Sri Lanka and a layer of Red Alder (*Alnus rubra*) clips sourced from Washington. All plant material associated with the mats has been sourced from areas in Oregon and Washington that represent the same genetic region and integrity as the restoration sites proposed for out planting.

The Sustainability in Prisons Project, a partnership between the Evergreen State College and the Washington Department of Corrections, is currently growing a total of 36 1x1 meter mats and control plant plugs within a controlled nursery environment at Stafford Creek Correctional Facility's Conservation Nursery in Aberdeen, Washington. Of the 36 mats, 18 will be installed in areas where scraping has occurred, along with 18 installed in mowed areas. The mats will be moved from the nursery to the restoration sites where they will be out planted. The vegetative mats will be pinned using heavy duty yard sign stakes. Each mat and control plot will contain 24 *Viola adunca*, 9 *Festuca roemeri* and 2 *Fragaria chiloensis* plants. Each piece of vegetative mat will be securely installed using lawn sign stakes to insure direct substrate treatment contact and stable (Figure 5).

7) 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].

The first type of data that I will collect within the planting plots will be the percent cover aerial of native plant species. The second type of data I will collect will be the percent aerial cover of bare ground. The third type of data I will collect will be the percent cover aerial of non-native invasive plant species. All data will be collected within the 1x1 meter quadrat planting area of the vegetative mats and control plugs within scraped and mowed restoration treatment areas

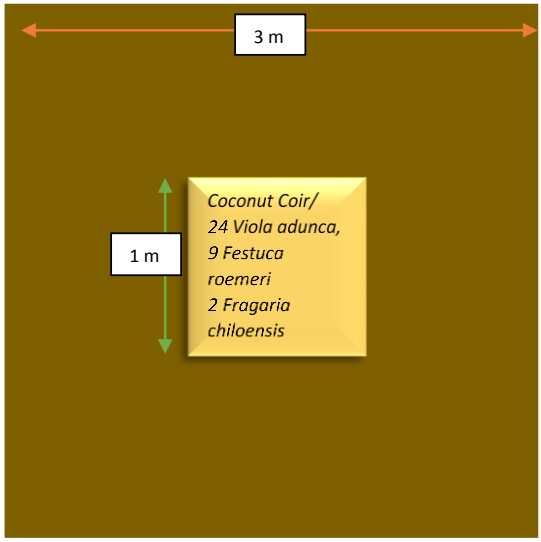
Figure 4: Vegetative coastal prairie mats growing in SCCC hoop house with *Viola adunca*, *Festuca roemeri* and *Fragaria chiloensis*

Experiment Design of Study Plots

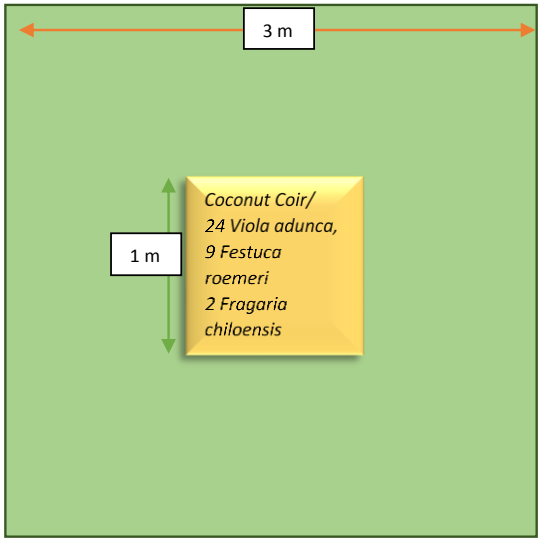
Illustration of study area for each vegetative mat and control plug planting area.

Vegetative Mats

Scraped treatment

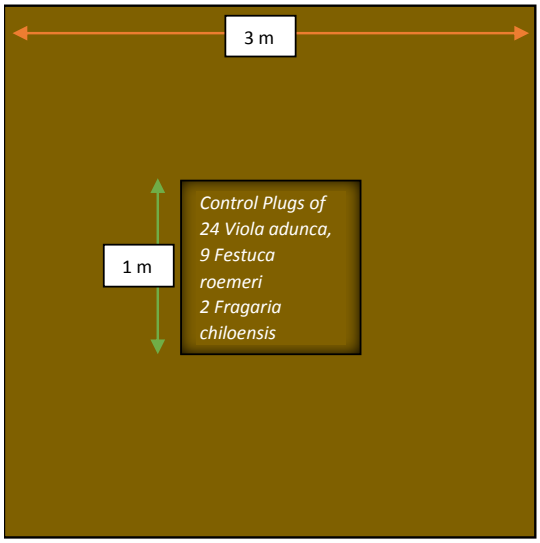


Mowed treatment



Control Plugs

Scraped treatment



Mowed treatment

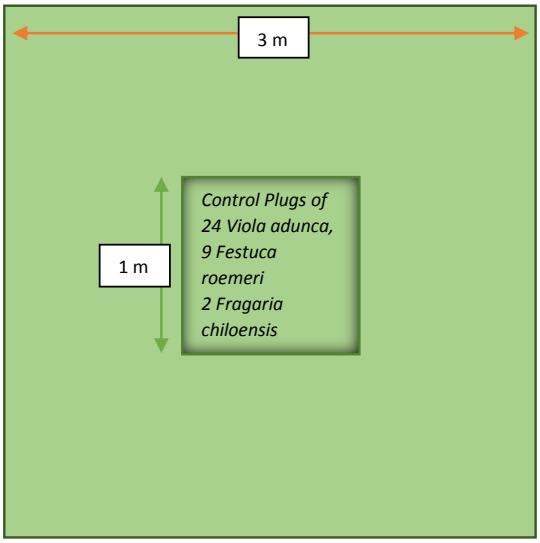
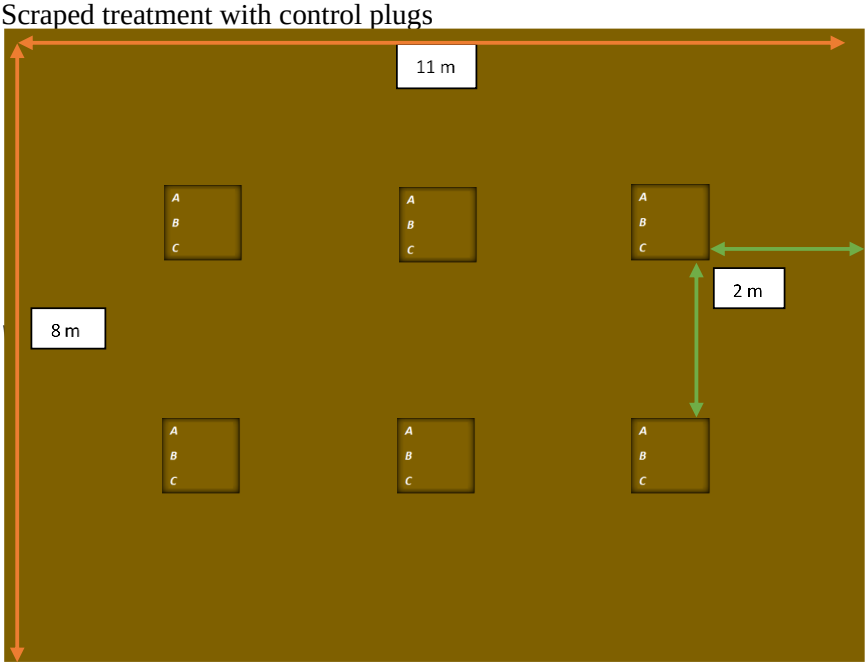


Figure 5: Study area for vegetative coastal prairie mats plant plug control installation design within treatment types

Experimental Design of Treatment Areas

Illustration of treatment sizes for each site

Scraped treatment with control plugs



Legend for plantings

A = 24 *Viola adunca*

B = 9 *Festuca roemeri* and

C = 2 *Fragaria chiloensis*

Scraped treatment with vegetative mats

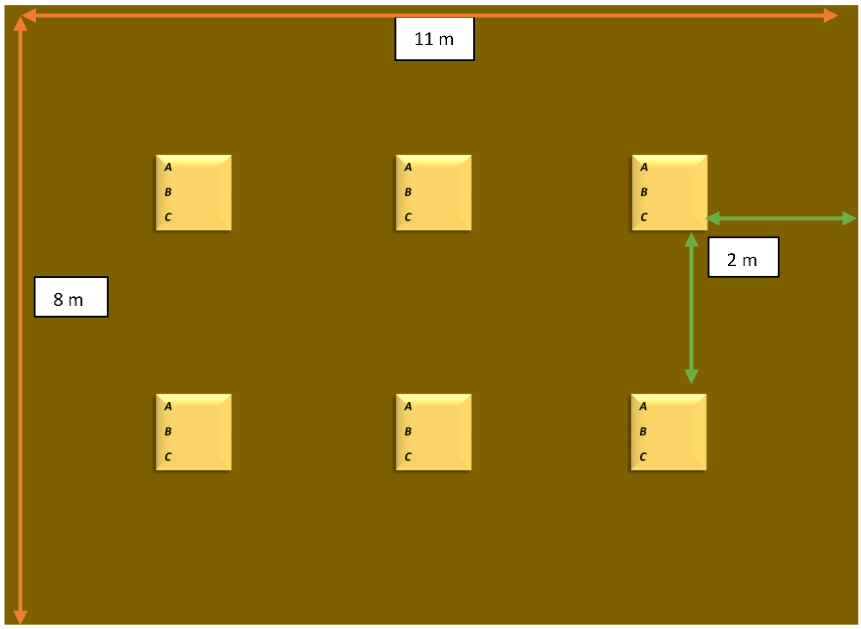
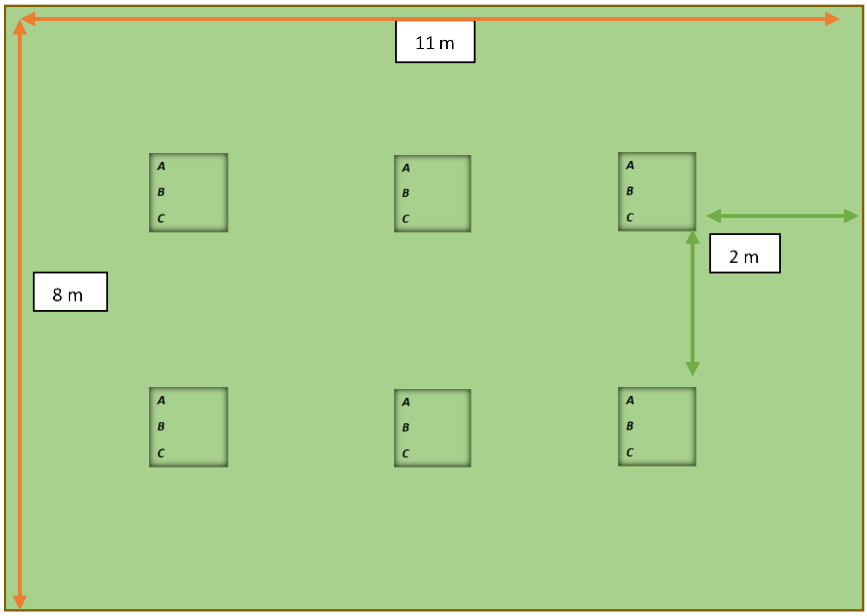


Figure 6: Scraped treatment out planting designs for control plugs and vegetative

Mowed treatment with control plugs



Legend for plantings

A = 24 *Viola adunca*

B = 9 *Festuca roemeri* and

C = 2 *Fragaria chiloensis*

Mowed treatment with vegetative maps

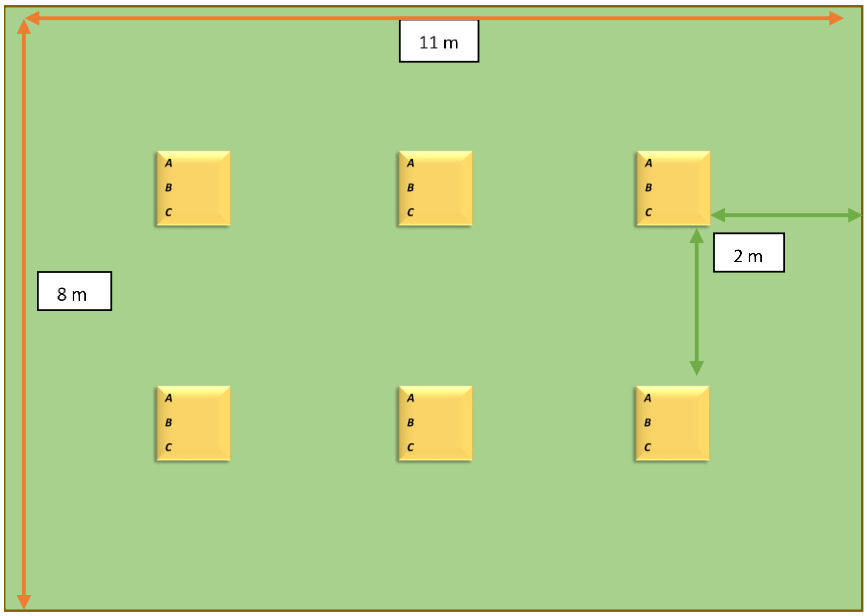


Figure 7: Mowed treatment out planting designs for control plugs and vegetative mats

Proposed Restoration Research Sites

Of the 36 1x1 meter mats and 36 1x1 meter control plug plots the following sites are requested for research permitting:

Washington:

Willapa Bay National Wildlife Refuge

6 (1x1 meter mats) in a scraped area 8x11 meters

6 (1x1 meter mats) in mowed areas 8x11 meters

Total mat experiment area including buffer treatments 176 square meters

6 (1x1 meter control plug plantings plots) in scraped areas 8x11 meters

6 (1x1 meter control plug plantings plots) in mowed areas 8x11 meters

Total control plug experiment including buffer treatments 176 square meters

Oregon:

Nestucca National Wildlife Refuge

6 (1x1 meter mats) in a scraped area 8x11 meters

6 (1x1 meter mats) in a mowed area 8x11 meters

Total mat experiment area including buffer treatments 176 square meters

6 (1x1 meter control plug plantings plots) in a scraped area 8x11 meters

6 (1x1 meter control plug plantings plots) in a mowed area 8x11 meters

Total control plug experiment including buffer treatments 176 square meters

Rock Creek Siuslaw National Forest

6 (1x1 meter mats) in a scraped area 8x11 meters

6 (1x1 meter mats) in a mowed area 8x11 meters

Total mat experiment area including buffer treatments 176 square meters

6 (1x1 meter control plug plantings plots) in a scraped area 8x11 meters

6 (1x1 meter control plug plantings plots) in a mowed area 8x11 meters

Total control plug experiment including buffer treatments 176 square meters

Each proposed restoration research site will utilize a total of 352 square meters. See (Figure 8) for site locations.

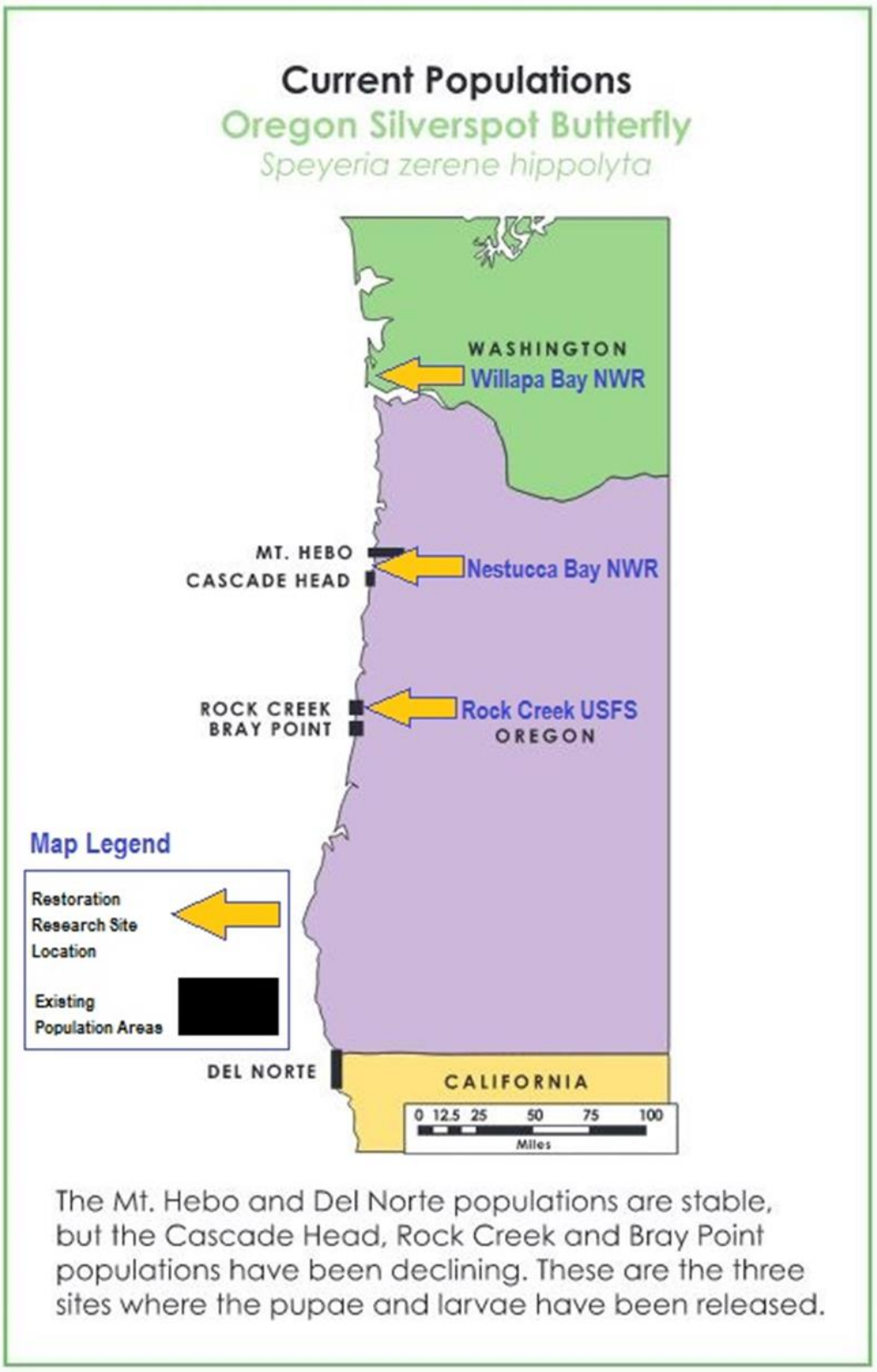


Figure 8: Map of Oregon silverspot habitat, populations and restoration research site locations; source map from: (Andersen et al. 2010)

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.

My data analysis will utilize a MANCOVA test to determine whether there is an interaction effect between explanatory variables on the experiments' response variables by comparing the continuous relationship of the studies response variables to analyses whether a two-way interaction effect exists between the restoration treatment types and planting types. The analysis will aim to understand if there is an interaction between the two independent variables on the dependent variables. I will use an R software package to analyze the data collected. The results of the MANCOVA test will generate a coefficient of determination (an R^2 value) assuming the collected data is normally distributed an R^2 value greater than 0.5 and close to 1 for the vegetative mats vs. control plugs will respect to increased Early blue violet, native plant and bare ground aerial cover will illustrate the strength of the mats interaction with respect to non-native invasive plant aerial cover. Additionally, I will incorporate an ordination test across the three restoration research sites to explore the influence of site location on the dataset.

9) Address the ethical issues 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), and specific permits or permissions you need to obtain before you begin collecting data (e.g. landowner permissions, agency permits).

My research aims to address many ethical issues revolving around the use of herbicide and the effects it has on plant and animal life. While my thesis research will be to explore how coastal prairie vegetative mats work in comparison to traditional plug plantings and restoration maintenance centered around the use of herbicide, I recognize that the introduction of a new material--in this case coconut coir--into an environment could also raise other ethical issues. Of concern to the research project would be the introduction of an unknown pathogen, fungus or other organism that would negatively affect the ecosystem and insect I'm looking to provide habitat enhancement for. On top of these concerns, the weed suppression that the vegetative mats will provide may also inhibit other native species though not present or possibly dormant at the time of planting from growing.

Stakeholders that will benefit from the results of the research work

- The Sustainability in Prisons Project who has contributed the Early blue violet seed, the mats, plugs labor and hoop house space to grow the material
- The US Forest Service
- The US Fish and Wildlife Service, who along with the Forest Service are providing an in-kind donation to the project by providing habitat restoration treatment types
- Landowners of the surrounding area may whose lands are proximal to the study areas
- The Confederated Tribes of the Siletz Indians whose land I have asked for permission to work with are supportive of the project and have been involved in the project from the beginning. The Siletz have an interest in improving ecological function without creating archaeological disturbances to their sensitive sites. Traditional ecological knowledge of land use practices shared by Robert Kenta will help frame the traditional human ecology within the western concept of restoration ecology.

While the benefits of the project may seem apparent, a clear understanding of the permitting requirements for the research have been obtained through both the US Forest Service and the US Fish and Wildlife Service. The project's research installation implementation is covered under the umbrella of the current NEPA process, already put forth by the agencies who's land the project will be taking place in. My research project dovetails into current restoration experimentation already occurring at each site and, which will allow for a single research permit to be granted from the agencies involved.

10) Reflect on how your positionality as a researcher could affect your results and how you will account for this in the research process[4].

I must consider my positionality as a researcher due to the adaptive management goal of my research and the community stakeholder concerns; I'm looking to address from the research results. Working in restoration ecology for the past decade, I have witnessed unsuccessful attempts to restore and enhance prairie plant communities solely through plug planting. These trials have led me the idea that there is a need for research to be conducted that develops new methods to restore low growing prairie plant communities. Because of this, I have an inherent bias toward seeing new method that works more successfully than traditional plug planting.

Over time, I have developed a relationship with the ecosystems, plants, animals and people I'm working with, both personally and professionally. In the 1990s I observed and volunteered with some of the Oregon silverspot butterfly research conducted at Cascade Head. From 2014 to 2017, I worked for the Salmon Drift Creek Watershed Council as an Education Coordinator. As part of my responsibilities, I worked with the Siuslaw National Forest on a contract to conduct community outreach and gather recommendation for a charrette process portion of their NEPA process.

The outcome of the charrette process for coastal prairie restoration in the Cascade Head Scenic research area illustrated that the community wanted to see habitat restoration occur for the butterfly and other animals but without the proposed use of herbicide. This led to my decision to investigate ways of establishing the Oregon silverspot butterflies host plant without the uses of herbicide, and the use of new materials such as coconut coir mats. Ultimately, my education in ecological conservation and my experiences with the environments being researched affect my understanding and interest in researching this topic. I must address through my wealth of experiences however slight my sentimental attachment to the recovery of the Oregon silverspot butterfly and its ecosystem.

My thesis research is not oriented in the traditional basic research question model. The habitat restoration goal setting put forth by my research project is positioned with an experience-based biased hypothesis on the experimental outcome. As I move through my thesis process, I will continue to examine the experimental and adaptive management-oriented nature of my work as an important factor for me to constantly consider in the positionality of my decision making.

11) 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.

Project Budget

Itemize projected costs under each of the following categories:	**Unit Number**	**Unit Cost**	**Requested MES Thesis Funds**	**In-Kind**
CONTRACTED SERVICES				
Restoration Site Prep and Installation	200 hours	$20 per hour		$ 4,000
Travel to Research Sites: Mileage	$.57 per mile 4 x 560 miles per trip (from TESC to southern most site Rock	2,240 miles $1,277	**$1000**	$ 277
MATERIALS/SUPPLIES				
Coconut coir mats growing *Viola adunca, Festuca romeri and Fragaria chiloensis*	36 1x1 meter mats	$50 each		$1,800
C-7 plugs growing *Viola adunca, Festuca romeri and Fragaria chiloensis*	VIOADU 288 FESROE 108 FRACHIL 24 **Per site 420**	$1.5 each $630 per site 3 sites		$1,890
Stakes	200 stakes	$15		$15
Monitoring materials (i.e. drone imaging and time lapsed camera)				$400
TOTALS			**$1000**	$8,382

12) Provide a detailed working outline of your thesis.

Introduction

Historic Coastal Prairie Environment

- Paleoclimate and biogeography (Walsh et al. 2010)

Indigenous Prairie Practitioners

- Historic coastal prairie landscape (Zald, 2009)

- Historic burning regumes (Van Geel et al. 2010)

Early Blue Violet Evolution and Biology

- Violet Evolution (Botanical & Press, 2016)
- Violet biology of other species (Freitas & Sazima, 2003)

Early Blue Violet Life History

- Early blue violet germination (Almasi & Kollmann, 2007)
- Early blue violet biology (Juncus, 1998)

Oregon Silverspot Butterfly Biology/ Ecology

- Modeling caterpillar movement to guide habitat enhancement the Oregon silverspot butterfly (Bierzychudek & Warner, 2015)
- Captive rearing of the Oregon silverspot butterfly (Crone, Pickering, & Schultz, 2007; McHugh et al., 2013)
- Oregon silverspot butterfly conservation in the Oregon and Washington (Hays & Stinson, 2019; Hixon et al., 2010, US Fish and Wildlife Service. 2001)
- Conservation of the Oregon silverspot butterfly genus *Speyeria* (Sims, 2017)
- Limiting habitat factors of *Speyeria* butterfly survival (Hill, Rush, & Mayberry, 2018)
- Oregon silverspot butterfly biology/ ecology (McCorkle D.V. & Hammond P.C. 1988, McCorkle et al. 1980)
- Habitat connectivity for insects (Dover & Settele, 2009; Schtickzelle, Joiris, Van Dyck, & Baguette, 2007)

Historical Prairie Conversion to Agriculture

- Noss, R., Laroe III, E., & Scott, J. (1995)

Modern Habitat Restoration Ecology

- Pacific Northwest Coastal Prairie Ecological Restoration (Petix, Bahm, & Kaye, 2018; Service, 2017)
- Habitat restoration goal setting (Coulter, Voelke, & Rilea, 2010; Schultz, 2008; Schultz et al., 2011; Thorpe & Stanley, 2011; Zielin, Littlejohn, de Rivera, Smith, & Jacobson, 2016)
- Habitat restoration techniques (Bennett et al. 2011, Dunwiddie & Martin, 2016; Kaye, Bush, Naugle, & LeRoy, 2015; Shuey et al., 2016; Sims, 2017)
- Human made disturbance (Buisson et al., 2006; Russell & Schultz, 2010; Zielin et al., 2016)
- Soil restoration and the use of coconut coir (Sivakumar et al. 2008)

Methods

- Considerations for study and data collection design.
- The use of remote sensing and NDVI drone imaging

Results

- Analysis of MANCOVA test
- The use of ordination in analysis of sites

Discussion

- Cost feasibility study of results as related to other coastal prairie restoration projects.
- Addressing the overall loss of historic prairie extent due to forest encroachment, land use and development.
- ArcGIS map of idea coastal prairie patch size habitat connectivity based on modern constraints.

Conclusion

- Future research for other host plant species
- Next steps and stakeholder funding for future mat production

13) 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.

Date	***Nov. 2019***	***Dec. 2019***	***Feb. 2020***	***Apr. 2020***
Research Action	Restoration treatments to study sites	Mat and control plug planting	Monitoring of study areas	Monitoring of study areas
Thesis	Complete lit review draft	Begin writing thesis	Complete introduction	Complete lit review
Jun. 2020	***Aug. 2020***	***Oct. 2020***	***Dec. 2020***	***Jan. 2021***
Monitoring of study areas	Monitoring of study areas	Monitoring of study areas	Removal of mat stakes	Reporting to project stakeholders
Complete methods/ mapping	Begin data analysis	Complete analysis and results/ discussion	Complete conclusion/ formatting	Binding presenting and celebrating

14) 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.

The Evergreen State College

From within the Evergreen State College Staff I have support from *Sarah Hammond* with the Center for Natural Lands Management. I have taken a restoration ecology elective from Sarah where she was introduced to my research project. Sarah is involved in other prairie restoration projects in the Salish Lowlands and is working with the enhancement of Early blue violets within her professional restoration projects. I'm hoping that Sarah could be a supplemental reader to my thesis and provide me feedback on my study design and data analysis.

U.S. Fish and Wildlife Service

Anne Walker is the biological and management lead for the Oregon silverspot butterfly recovery plan and provides full support to my project via permitting approval and resource allocation for project implementation.

Rebecca Chuck is the project manager for prairie restoration at Nestucca National Wildlife Refuge and provides access and restoration treatments for the projects study areas.

William Ritchie is the project manager for prairie restoration at Willapa National Wildlife Refuge and provides access and restoration treatments for the projects study areas.

U.S. Forest Service

Doug Glavich is a Zone 1 ecologist for the Siuslaw National Forest and provides the biological field data on existing Oregon silverspot butterfly habitat at Mt. Hebo and provides support to my project via permitting approval and resource allocation for project implementation at Rock Creek.

Each of my project partners expect to receive a copy of my thesis and a presentation to their agencies. There is also a desire to see the work published with agency approval and input.

15) List the 3-5 most important references you have used to a) identify the specific questions and context of your topic, b) help with issues of research design and analysis, and c) provide a basis for interpretation. For each reference, explain how your project specifically connects to the source by extending, challenging, or responding to the conclusions, methods, or implications.

Bierzychudek P., Warner K. Modeling caterpillar movement to guide habitat enhancement for *Speyeria zerene hippolyta*, the Oregon silverspot butterfly. J. Insect Conserv. 2015;19:45–54. doi: 10.1007/s10841-014-9741-6

This article is this most paramount piece of literature to my research. The article provides the field observations in combination with the computer modeling of caterpillar movements that will guide the role and value of my thesis research in relation to the insect conservation. As my research seeks to communicate the role of the Early blue violet in relation to larval development and survivorship, this article lays out the specific contributions my research may provide to the life history of the Oregon silverspot butterfly.

McCorkle, David Vernon, Paul C. Hammond, and Glory Penington. *Ecological investigation report: Oregon silverspot butterfly (Speyeria zerene hippolyta)*. Forest Service USDA, Pacific Northwest Region, Siuslaw National Forest, 1980.

This article provides one of the earliest archives of the Oregon silverspot butterfly's ecology right before the specie was listed as threatened. Information from the article will provide important insights into habitat restoration goal setting for the results of my thesis beyond my study areas.

McCorkle D.V., Hammond P.C. Biology of *Speyeria zerene hippolyta* (Nymphalidae) in a marine-modified environment. J. Lepidopterists Soc. 1988; 42:184–195.

This article provides one of the earliest archives of the Oregon silverspot butterfly's biology right after the specie was listed as threatened. Information from the article will provide important insights into how to best facilitate the biological needs of the insect and what historical conditions were utilized by the specie.

Meaghan I. Petix, Matt A. Bahm, & Thomas N. Kaye. (2018). Development of Techniques to Improve Coastal Prairie Restoration on the Clatsop Plains, Oregon. Natural Areas Journal, 38(4), 268–274. https://doi.org/10.3375/043.038.0407

This article provides an overview of what habitat restoration treatments have occurred throughout the Oregon silverspot butterflys' historic range and the role various experimental restoration types have played in developing landscape practitioners ability to achieve desired outcomes. The article also highlights the challenges and limitations to achieving habitat goals through certain treatments and provides a good foundation for my thesis research as a next step in the development of techniques.

---

[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.

[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.

[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.

[4] 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).

Bibliography

Almasi, K., & Kollmann, F. (2007). Germination Requirements of the Early-Blue Violet. *The Michigan Botanist*, *46*(1), 14–24. http://hdl.handle.net/2027/spo.0497763.0046.102

Andersen, M.J., M. Arnold, M. Barclay, L. Myers, D. Shepherdson and E. Sullivan. 2010. Oregon Silverspot Butterfly Husbandry Manual. Oregon Zoo, Portland, Oregon. 36 pp.

Bennett, A. E., Thomsen, M., & Strauss, S. Y. (2011). Multiple mechanisms enable invasive species to suppress native species1. *American Journal of Botany*, *98*(7), 1086–1094. https://doi.org/10.3732/ajb.1000177

Bierzychudek, P., & Warner, K. (2015). Modeling caterpillar movement to guide habitat enhancement for Speyeria zerene hippolyta, the Oregon silverspot butterfly. *Journal of Insect Conservation*, *19*(1), 45–54. https://doi.org/10.1007/s10841-014-9741-6

Botanical, M., & Press, G. (2016). *Floral Evolution in Viola Author (s): Andrew J . Beattie Source : Annals of the Missouri Botanical Garden , Vol . 61 , No . 3 (1974), pp . 781-793 Published by : Missouri Botanical Garden Press Stable URL : http://www.jstor.org/stable/2395029*. *61*(3), 781–793.

Buisson, E., Holl, K. D., Anderson, S., Corcket, E., Hayes, G. F., Torre, F., … Dutoit, T. (2006). Effect of seed source, topsoil removal, and plant neighbor removal on restoring California coastal prairies. *Restoration Ecology*, *14*(4), 569–577. https://doi.org/10.1111/j.1526-100X.2006.00168.x

Cockcroft, D. W., Faaaai, F., Nair, P., Frcpc, F., Nair, P., & Frcpc, F. (2012). Reproduced with permission of the copyright owner . Further reproduction prohibited without. *Journal of Allergy and Clinical Immunology*, *130*(2), 556. https://doi.org/10.1016/j.jaci.2012.05.050

Coulter, C., Voelke, K., & Rilea, W. V. C. (2010). *Legacy Resource Management Program in Coastal Meadow Habitat , a Critically Imperiled Ecosystem*. (January).

Crone, E. E., Pickering, D., & Schultz, C. B. (2007). Can captive rearing promote recovery of endangered butterflies? An assessment in the face of uncertainty. *Biological Conservation*, *139*(1–2), 103–112. https://doi.org/10.1016/j.biocon.2007.06.007

Dover, J., & Settele, J. (2009). The influences of landscape structure on butterfly distribution and movement: A review. *Journal of Insect Conservation*, *13*(1), 3–27. https://doi.org/10.1007/s10841-008-9135-8

Dunwiddie, P. W., & Martin, R. A. (2016). Microsites Matter: Improving the success of rare species reintroductions. *PLoS ONE*, *11*(3), 1–17. https://doi.org/10.1371/journal.pone.0150417

Freitas, L., & Sazima, M. (2003). Floral biology and pollination mechanisms in two Viola species - From nectar to pollen flowers? *Annals of Botany*, *91*(3), 311–317. https://doi.org/10.1093/aob/mcg025

Gillam, C. (2017). Whitewash : The story of a weed killer, cancer, and the corruption of science. Washington, DC: Island Press.

Hammond, Paul C., and D. V. McCorkle. "The decline and extinction of Speyeria populations resulting from human environmental disturbances." *J Res. Lepid* 22 (1983): 217-224.

Hays, D. W., & Stinson, D. W. (2019). *STATE OF WASHINGTON Oregon Silverspot*. (February).

Hill, R. I., Rush, C. E., & Mayberry, J. (2018). Larval food limitation in a speyeria butterfly (Nymphalidae): How many butterflies can be supported? *Insects*, *9*(4), 1–16. https://doi.org/10.3390/insects9040179

Hixon, M. A., Gregory, S. V, Robinson, W. D., Baker, C. S., Batchelder, H. P., Epps, C., … White, A. E. (2010). *Case Study 7: Oregon's Fish and Wildlife in a Changing Climate. In: The Oregon Climate Change Assessment Report.* 1–88. https://pdxscholar.library.pdx.edu/centerforlakes_pub/29/

Jones, K., & Hanna, E. (2004). Design and implementation of an ecological engineering approach to coastal restoration at Loyola Beach, Kleberg County, Texas. *Ecological Engineering*, *22*(4–5), 249–261. https://doi.org/10.1016/j.ecoleng.2004.05.006

Juncus, L. (1998). *Plant Guide*. (Figure 3), 5–8.

Jutila, H. M., & Grace, J. B. (2002). Effects of disturbance on germination and seedling establishment in a coastal prairie grassland: A test of the competitive release hypothesis. *Journal of Ecology*, *90*(2), 291–302. https://doi.org/10.1046/j.1365-2745.2001.00665.x

Kaye, T. N., Bush, K., Naugle, C., & LeRoy, C. J. (2015). Conservation Projects in Prison: The Case for Engaging Incarcerated Populations in Conservation and Science. *Natural Areas Journal*, *35*(1), 90–97. https://doi.org/10.3375/043.035.0113

Kocher, S. D., & Williams, E. H. (2000). The diversity and abundance of North American butterflies vary with habitat disturbance and geography. *Journal of Biogeography*, *27*(4), 785–794. https://doi.org/10.1046/j.1365-2699.2000.00454.x

Littlejohn, R. J. (2012). *Connecting Habitat Across Roads: Field Testing Mitigation Strategies for Reducing Road Mortality of an Imperiled Butterfly C onnecting Habitat Across Roads : Field testing mitigation strategies for reducing road mortality of an imperiled butterfly Master*.

Maiti, S. K., & Maiti, D. (2015). Ecological restoration of waste dumps by topsoil blanketing, coir-matting and seeding with grass-legume mixture. *Ecological Engineering*, *77*, 74–84. https://doi.org/10.1016/j.ecoleng.2015.01.003

McCorkle D.V., Hammond P.C. Biology of *Speyeria zerene hippolyta* (Nymphalidae) in a marine-modified environment. J. Lepidopterists Soc. 1988;42:184–195.

McCorkle, David Vernon, Paul C. Hammond, and Glory Penington. *Ecological investigation report: Oregon silverspot butterfly (Speyeria zerene hippolyta)*. Forest Service USDA, Pacific Northwest Region, Siuslaw National Forest, 1980.

McHugh, A., Bierzychudek, P., Greever, C., Marzulla, T., Van Buskirk, R., & Binford, G. (2013). A molecular phylogenetic analysis of Speyeria and its implications for the management of the threatened Speyeria zerene hippolyta. *Journal of Insect Conservation*, *17*(6), 1237–1253. https://doi.org/10.1007/s10841-013-9605-5

Noss, R., Laroe III, E., & Scott, J. (1995). Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. *Biological Report - US Department of the Interior, National Biological Service, 28*, https://www.fwspubs.org/doi/suppl/10.3996/022015-JFWM-008/suppl_file/022015-jfwm-008.s5.pdf

Petix, M. I., Bahm, M. A., & Kaye, T. N. (2018). Development of Techniques to Improve Coastal Prairie Restoration on the Clatsop Plains, Oregon. *Natural Areas Journal*, *38*(4), 268–274. https://doi.org/10.3375/043.038.0407

Russell, C., & Schultz, C. B. (2010). Effects of grass-specific herbicides on butterflies: An experimental investigation to advance conservation efforts. *Journal of Insect Conservation*, *14*(1), 53–63. https://doi.org/10.1007/s10841-009-9224-3

Schtickzelle, N., Joiris, A., Van Dyck, H., & Baguette, M. (2007). Quantitative analysis of changes in movement behavior within and outside habitat in a specialist butterfly. *BMC Evolutionary Biology*, *7*, 1–15. https://doi.org/10.1186/1471-2148-7-4

Schultz, C. B. (2008). Dispersal Behavior and Its Implications for Reserve Design in a Rare Oregon Butterfly. *Conservation Biology*, *12*(2), 284–292. https://doi.org/10.1111/j.1523-1739.1998.96266.x

Schultz, C. B., Henry, E., Carleton, A., Hicks, T., Thomas, R., Potter, A., … Reader, B. (2011). Conservation of Prairie-Oak Butterflies in Oregon, Washington, and British Columbia. *Northwest Science*, *85*(2), 361–388. https://doi.org/10.3955/046.085.0221

Service, W. (2017). *Clatsop Plains – Long Beach Peninsula Coastal Prairie Restoration*. https://appliedeco.org/wp-content/uploads/Clatsop-Plains-Restoration-2017_Final.pdf

Sivakumar Babu, G., Vasudevan, A., & Sayida, M. (2008). Use of Coir Fibers for Improving the Engineering Properties of Expansive Soils. Journal of Natural Fibers, 5(1), 61-75. https://doi.org/10.1080/15440470801901522

Shuey, J., Jacquart, E., Orr, S., Becker, F., Nyberg, A., Littiken, R., … Luchik, D. (2016). Landscape-scale response to local habitat restoration in the regal fritillary butterfly (Speyeria idalia) (Lepidoptera: Nymphalidae). *Journal of Insect Conservation*, *20*(5), 773–780. https://doi.org/10.1007/s10841-016-9908-4

Sims, S. R. (2017). Speyeria (Lepidoptera: Nymphalidae) conservation. *Insects*, *8*(2). https://doi.org/10.3390/insects8020045

Thompson, E., Baumsteiger, J., & Hill, R. I. (2019). Phylogenomic Analyses Clarify True Species within the Butterfly Genus Speyeria despite Evidence of a Recent Adaptive Radiation. *Insects*, *10*(7), 209. https://doi.org/10.3390/insects10070209

Thorpe, A. S., & Stanley, A. G. (2011). Determining appropriate goals for restoration of imperiled communities and species. *Journal of Applied Ecology*, *48*(2), 275–279. https://doi.org/10.1111/j.1365-2664.2011.01972.x

US Fish and Wildlife Service. 2001. Revised recovery plan for the Oregon silverspot butterfly (*Speyeria zerene hippolyta*). US Fish and Wildlife Service, Portland, Oregon, USA.

Van Geel, B., Raspopov, O. M., Renssen, H., Van der Plicht, J., Dergachev, V. A., & Meijer, H. A. J. (1999). The role of solar forcing upon climate change. *Quaternary Science Reviews*. https://doi.org/10.1016/S0277-3791(98)00088-2

Walsh, M. K., Pearl, C. A., Whitlock, C., Bartlein, P. J., & Worona, M. A. (2010). An 11 000-year-long record of fire and vegetation history at Beaver Lake, Oregon, central Willamette Valley. *Quaternary Science Reviews*, *29*(9–10), 1093–1106. https://doi.org/10.1016/j.quascirev.2010.02.011

Zald, H. S. J. (2009). Extent and spatial patterns of grass bald land cover change (1948-2000), Oregon Coast Range, USA. *Herbaceous Plant Ecology: Recent Advances in Plant Ecology*, 153–165. https://doi.org/10.1007/978-90-481-2798-6_13

Zielin, S. B., Littlejohn, J., de Rivera, C. E., Smith, W. P., & Jacobson, S. L. (2016). Ecological investigations to select mitigation options to reduce vehicle-caused mortality of a threatened butterfly. *Journal of Insect Conservation*, *20*(5), 845–854. https://doi.org/10.1007/s10841-016-9916-4