January 2, 2020

MES Thesis Fund Committee

The Evergreen State College

Olympia, WA 98505

To the MES Thesis Fund Committee,

Please accept the attached materials as my application for a MES Thesis Fund award for 2019. I received credit for Case Studies and Thesis Design in Fall 2019. I have started gathering and organizing data for thesis work described in my thesis prospectus, and I am on track to graduate in Spring 2020.

This thesis aims to provide an assessment of riparian corridor conservation and landowner restoration outreach opportunities in the south Puget Sound. Guided by climate refugia data and riparian corridor characteristics, this thesis will give conservation options for riparian areas locally, while the approach can be applied to riparian conservation at a regional scale. Because of current and projected landscape impacts in the south Puget Sound, an approach of proactive, adaptive management, rather than ad hoc recovery is a best management strategy to mitigate landscape fragmentation and protect against the uncertainties of changing climate (Ardron et al., 2010; Monahan & Theobald, 2018).

For my analysis, I will use GIS together with Marxan conservation planning software. Marxan uses an algorithm that works with comprehensive conservation target data and then outputs scores of best options for strategic conservation. Outputs can by analyzed by looking at the sum solutions and best solution of each unit. Each time a unit fits a set of requirements from the Marxan inputs, the unit gets a score. The final sum of these scores, minus any associated penalty such as boundary length of the unit, will show the sum solution. Thus, the scenarios with the best scores can be considered as priority habitats for conservation.

To become a Marxan practitioner, I attended a 1-week training course in Victoria, BC, in November 2019. The course, which instructed on the complete set up of input files and output analysis of Marxan, was facilitated by the leading practitioners of this conservation planning software, PacMARA. The Marxan training course was integral to my understanding of how to compile data for my thesis into a strategic conservation plan using Marxan, for riparian areas in the south Puget Sound.

I have already received partial funding of $250 from MESA for the Marxan course fee. I am requesting $817 to cover the remaining course fee and travel costs to and from the Marxan training in Victoria, BC, including mileage expenses, ferry tolls and lodging. The required software for the analysis is open source and thus requires no funding.

Thank you,

Christine Davis

MES Graduate student, The Evergreen State College

**Thesis Itemized Budget**

****

**Budget Justification for Thesis Funding request from Christine Davis**

**Expense type:**

**Travel**

* **Mileage round trip by car to Port Angeles ferry from Olympia, WA**

I drove my car from Olympia, Washington to the Port Angeles, Washington ferry terminal round trip, yet did not drive while in Victoria. In order to save gas, I rode my bike to the training and to other activities such as going to the grocery store. Thus, the mileage represented here is only the direct and necessary route to and from Olympia, WA.

* **Lodging**

I chose to stay at an Airbnb near the Marxan training. At $95 per night, the cost of the Airbnb was much lower than other hotels in the area. Additionally, staying with a family near the training rather than at a hotel downtown was a safer option for me as a single traveler.

* **Ferry fee**

The ferry fee to travel internationally from Port Angeles to Vicotria is $149 roundtrip. This fee does not have any discount for students. The Marxan course is only offered once per year and it is often located in other parts of the country, such as West Virginia. I was lucky to be able to participate in this course at such a convenient location to Olympia, despite the extra fees necessary for travel to Canada.

**Marxan training**

* **Course fee of $400, $250 of which has been funded by MESA in November 2019**

In addition to travel costs to attend the Marxan training, I am requesting funding for the remaining portion Marxan course fee. Marxan is the most widely used conservation planning software in the world. Understanding how to use Marxan software is essential to my thesis analysis. Using Marxan, I will analyze large amounts of data that span multiple watersheds in Washington. I will use Marxan to analyze biological and physical data on riparian corridors in the south Puget Sound and recommend target areas for further conservation status. I am essentially building a workflow that can be used locally with the data I am incorporating for the study yet can be applied at a regional scale by multiple management agencies. Marxan provides an excellent framework with which to analyze large biological and conservation cost data sets over complex landscapes. Without the Marxan course, I would not have been able to use this essential tool for my thesis analysis.

MES Thesis Fund Application Checklist for (*student name*): Christine Davis

Please check **any and all** boxes that are applicable to your intended thesis research, and complete any required subsequent information.

* **My thesis research involves working with human subjects**. I submitted my Human Subjects Review Application to the Academic Deans Office on the following date: ­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **My thesis research will involve the use of Evergreen’s Science Support Center and laboratory spaces**. I have completed the required forms to begin using these spaces and have been assigned a Scientific Instructional Technician (SIT). **My assigned SIT is** (if you do not currently have an assigned SIT, please explain): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **My thesis research requires that I have obtained special permits and/or permissions in order to collect data.** The required permits/permissions I need, and the status of my requests and approvals is detailed below. Please attach electronic copies of any permits already obtained. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **I am requesting reimbursement for the purchase of software and/or licensing** for technology needed to complete my research and analysis. I have spoken with the following staff or faculty member(s) at Evergreen and am assured this is not available on campus: ­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**X I have requested funding for my thesis from other sources.** If checked, please list the source of funding (e.g., Evergreen Clean Energy Committee), and the status of your request (funded/not funded/in review).

Request of $250 for partial reimbursement for the Marxan course fee has been funded by MESA.

* **None of the above apply to my research plans**

**The Evergreen State College**

**Graduate Program on the Environment**

### Thesis Prospectus

Christine Davis A00265429

5720 40th Ave SW

Olympia, WA 98512

xtinedavis@gmail.com

360-359-0499

**STUDENT AGREEMENT:**

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

**FACULTY READER APPROVAL:**

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

**MES DIRECTOR APPROVAL:**

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

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

Identifying conservation opportunities in riparian climate corridors of the Puget Lowlands

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

Riparian areas are the resource and movement conduits for plants and animals in protected and unprotected areas, yet they are often fragmented by different types of land use (Fremier et al., 2015). Habitat fragmentation and associated patch isolation within a landscape can cause habitat degradation which ultimately leads to a reduction of species richness (Fletcher et al., 2018; Haddad et al., 2015, 2017). This is particularly true for riparian areas where vegetation intactness and topography are the primary influence on species richness (Stein et al., 2014). To minimize further fragmentation, strategically identifying conservation suitability within riparian ecosystems can result in protection of threatened biodiversity at a landscape level (Krosby et al., 2015).

The effects of disturbances such as habitat fragmentation are amplified with the added stressors of climate change. This can push the landscape beyond its recovery threshold, minimizing its role as climate refugia (Beisner et al., 2003; Dunn & Angermeier, 2019; Wade et al., 2013). Because riparian corridors are natural climate refugia, conservation and restoration actions within watersheds are climate-risk mitigation strategy (Carroll et al., 2016; Zavaleta & Heller, 2009).

Along with the Columbia Plateau, the area of the Puget lowlands has been identified by landscape ecologists as an area of high importance for protecting riparian areas in the Pacific Northwest (Krosby et al., 2018; Wade et al., 2013). The low, fertile plateaus are experiencing rapid population growth (Hepenstall-Cymerman et al., 2013), yet do not have adequate protections in place to preserve climate refugia and corridor connectivity within riparian areas (Krosby et al., 2018).

**State your research question.**

 Where are the remaining areas of conservation suitability in riparian areas of the south Puget Sound? What are the estimated conservation costs if riparian protection is implemented?

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

Practical framework

Lowlands are under-represented in conservation planning because of their accessibility to humans for development and farming (Pressey et al., 1993, Soule & Terborgh 1999, Krosby et al, 2018). The Puget lowlands in Washington have been identified as an area of importance for conservation due to human impacts of urban development and rural sprawl (Hepenstall-Cymerman et al., 2013; Krosby et al., 2018). The protection of riparian areas in proximity to both urban development and established natural areas is a strategic approach that can mitigate the landscape pressures of land clearing and climate change (Carroll et al., 2016; Theobald et al., 2011).

 Studies concerning ecological integrity are biased towards larger species with wide ranges. Small species with less range movement tend to be underrepresented (Krosby et al., 2015). Although the riparian corridors of Thurston County do not connect contiguously with established wildlife corridors (Singleton et al., 2001), they do provide important habitat locally.

Theoretical framework

Conservation targets and belief systems

Conservation targets are created by humans so there is a possibility that data informing conservation targets may be flawed or led by interpretation weighted in belief systems rather than science. When applying targets to conservation strategy, we must assess whether conservation implementation will affect the landscape and species negatively or positively. (Pressey et al., 2017). Having good intentions in setting conservation targets does not equate to practicing sound science.

**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?**

Many habitat corridor analyses in Pacific Northwest are species driven. In contrast, our question: Where are the remaining areas for conservation? may be answered by examining habitat quality on a landscape level. We incorporate riparian climate-corridor habitat data with spatial data of conservation features such as endangered and endemic species ranges to show where new protected areas could benefit landscape habitat quality. The analysis will result in multiple options, displayed spatially, for conservation opportunities and landscape suitability within watersheds of Thurston County.

Protecting connectivity among fragmented landscapes improves ecological resilience (McRae et al., 2012). The need for conservation of riparian areas increases as plants and animals have fewer places to move due to disturbance caused by urban development and climate change (Fremier et al., 2015; Krosby et al., 2015; Tilman et al., 2017). This is especially true on flat, developed lowland areas where humans have historically been more likely to access and develop the landscape for their resource needs (Alberti et al., 2006; Krosby et al., 2018).

Protected areas along riparian corridors in Thurston County are managed by various state agencies and land trusts with individual conservation targets loosely based on guidelines of the Clean Water and Endangered Species Acts. Considering this, conservation or restoration of riparian parcels that have not yet been protected must be applicable to various agencies with their respective agendas. The proposed analysis and reassessment of watershed health in Thurston County incorporates data and expert knowledge from the most current and applicable science available. In gathering this data, we acknowledge the need for ecological policy to be based in biological priority rather than politics (Hagen & Hodges, 2006).

Land managers in Thurston County do not currently have a tool to assess riparian conservation targets at local scales (conversation with Andrea Thorpe, October 10, 2019). This research addresses the inherent disconnect of multiple land management agencies with different management goals by producing a tool in GIS that joins protected area parcels to maps and provides specific information on habitat quality. The tool can then be used to initiate dialogue among stakeholders regarding habitat suitability for newly acquired protected areas or landowner restoration incentives.

A landscape study informed by climate refugia and corridor movement characteristics such as this, can help guide proactive conservation management of riparian areas in Thurston County. Because of current and projected landscape impacts, an approach of proactive, adaptive management, rather than ad hoc recovery is a best management strategy to mitigate landscape fragmentation and protect against the uncertainties of changing climate (Ardron et al., 2010; Monahan & Theobald, 2018).

**6) 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)?**

The proposed study will use methods of spatial analysis using GIS and Marxan conservation planning software. With these tools, I will identify conservation opportunities and provide recommendations for conservation suitability. Marxan uses an algorithm that works with input of user set conservation targets and then outputs scores of best options for strategic conservation (Possingham & Watts, 2011).

From a map of ranked climate corridors (90 m cells) (Theobald et al., 2013) I will create a buffered GIS layer of my study area watershed boundary along rivers in Thurston County, WA.

I will then create a layer of merged protected area polygons including, federal protected areas, private conservation easements and land trusts within my study area.

Within the clipped boundary of potential riparian area, I will analyze the intactness of vegetation and other conservation targets in the unprotected riparian areas by creating inputs for analysis in Marxan conservation planning software.

Marxan outputs can by analyzed by looking at the sum solutions and best solution of each unit. Each time a unit fits a set of requirements from the Marxan inputs, the unit gets a score. The final sum of these scores, minus any associated penalty such as boundary length of the unit, will show the sum solution. Thus, the scenarios with the best scores can be considered as priority habitats for conservation. The best solution output shows the unit with the highest efficiency. These will be the units with the highest sum solution in addition to having the least cost associated with the area of the unit. Creating a series of maps using GIS, I can spatially display conservation suitability for watersheds of Thurston County.

 Units of measure: 30 - 90 m grid over the study area or parcel layers

**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]](#endnote-3).**

I will use existing data for inputs to Marxan conservation planning software.

 Marxan inputs:

* Canopy Cover from NLCD 2016 Land Cover (CONUS) at 30m
* Ranked riparian climate-corridor habitat quality at 90 m cells. These data are created from mean of canopy cover, mean annual temperature, stream width, solar radiation and human interference as established by Krosby et al, 2018.
* Conservation target options: 10, 20 and 30% intact habitat for species diversity
* Presence/absence of rare, threatened or endangered species (IUCN and DNR Natural Heritage Program)
* Fish passage data – the water typing data set from WA DNR shows whether fish passage is available or not through an area.

<https://data-wadnr.opendata.arcgis.com/search?groupIds=f4ec961e570146fd8cc47baf291f895c>

* Presence of riparian and wetland bird rookeries
* Proximity to protected areas
* Estimated cost of individual parcel conservation (data set from Cristoph Nolte, Boston University)
* Null costs (costs set to “1” or using area for costs)

**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 identify priorities for biodiversity conservation for three riparian areas in Thurston and Pierce Counties, WA. Based on the biological and topographical data I input to Marxan, Marxan connectivity analysis will show options for habitat conservation prioritization. Goals of the analysis are to identify the suitability for land acquisition of new natural areas and land stewardship on private land.

The data for this research are spatial. They will be gathered from online sources and added to a GIS analysis that plugs into Marxan software. By using the Zonae Cojito software interface, Marxan outputs can be viewd and analyzed for their effectiveness as conservation planning support data.

**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).**

 The research will need to present a balanced framework from which to approach different

 perspectives of land use, property value and ownership. While riparian areas and their adjacent forests are important habitat and potential climate refugia for multiple animal and plant species, they also provide resources and aesthetic value to humans. The concept of protecting remaining high-quality habitat and prioritizing those areas for conservation might not be the best management option for all areas of high-quality habitat. Landowners can potentially participate in conservation easements or be involved in an incentive program for riparian restoration. However, these come with both costs in the form of giving up land rights to build and benefits such as tax incentives. Multi-use among humans, animals and plants can provide valuable riparian connectivity in the landscape.

People who may benefit: Employees of land trust or government agencies that may gain more

work if new natural areas are created

People that may be harmed: If the results of this work generate policy change for land use around high quality riparian areas, landowners could feel imposed upon by zoning rules for sensitive habitat they live on or near. Future landowners may have negative cost impacts associated with building restrictions on their land.

**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]](#endnote-4).**

My positionality is that I do not personally need to use riparian forest resources for

survival. My basic needs are already met by a societal framework that provides options

such as having a job, going to the grocery store to buy food and easily heating my home.

 This research focuses on local watersheds. However, the resulting could be applied to forest systems in other areas of the world where people rely heavily on forest resources for survival. Creating new natural areas in these places could displace people or their resources.

Additionally, I would like to acknowledge Native American influence, presence and historic use of riparian areas in the south Puget Sound. I will attempt to obtain a data layer with traditional ecological knowledge (TEK) within my study area. This data layer can then be added after the Marxan scenarios as an overlay in GIS to show indigenous land use, historic and/or present day.

I will approach my positionality of place by suggesting in my research that this is

scenario meant to be used with the permission and active involvement in decision making

of all parties involved, rather than a command and control approach.

**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.**

Tuition for Marxan training at PacMARA, University of Victoria 400

Ferry from Port Angeles to Victoria, BC 149

Lodging in Victoria, BC 380

Gas/mileage 240 miles @ $0.575 /mile 138

Total: $1067

$250 of the $1067 total has been funded by MESA, November 2019.

The remaining $817 will be requested from the MES thesis fund January 2020.

**12) Provide a detailed working outline of your thesis.**

**Introduction**

Thesis statement

Global biodiversity loss, internal pressure on 1/3 of natural areas, landscape processes, disturbance and population growth

Importance of riparian areas

Necessity of habitat for animal movement, human resources

Puget lowlands – why this study site has important habitat for protection

* Climate refugia
* Riparian ranked climate corridors

Effects of disturbance

* Fragmentation, urban development
* Climate change
* Threshold changes

**Background**

**Historic background**

* Historic land use
* Riparian areas not viewed as ecosystem whole
* Buffers and resource extraction
* Fish, bird and mammal passage
* Cut off from major habitats of Rainier and Olympics – fracture zone of Puget lowlands
* Development in flat, fertile valley areas
	+ Floodplain changes, scouring and dwd removal in streams
* Riparian areas protected as part of ESA and Water Protection acts – minimal protection,
	+ Various agencies
	+ Ad hoc recovery
	+ Connectivity can be restored
		- Value of such action provides exponential return for riparian areas in Puget Lowlands

**Contemporary context**

Proactive adaptive management

* Biodiversity value
* Strategic conservation management
* Island biogeography
	+ Reserves in isolation
	+ Impacts of roads
	+ Fragmentation continued
	+ Source-sink dynamics of fragmented habitat, species persistence not prioritized
* Identify refugia
	+ Build on the work that’s already been done (Krosby et al., 2018; Theobald, 2013)
* Urban growth boundary
* Barriers to pathways (McRae et al., )
* Riparian connectivity to build on and within
* Gene flow limitations and expressions (Battin, 2004)
	+ Genes and climate impacts – climate velocity (Carwardine et al., )
* Global protected area targets – adapt, and use local data
* Multi-faceted, multi-spatial approach
* Naturalness and habitat quality
* Umbrella theory
* Trophic cascades
* Conservation targets
	+ Room for improvement
	+ Theory of arbitrary conservation targets
		- Use expert opinions and rely on strong data, explain where data derives from

**Manuscript chapter**

**Abstract**

**Introduction**

**Methods**

**Results**

**TBD**

**Discussion**

**Additional thesis discussion**

**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.**

Writing, section drafts to be turned in as completed\*:

Literature review – 3 weeks

Introduction – 1 week

Results, methods, graphs, graphics, tables 1 month

Discussion – 2 weeks

Bibliography – 2 days

Begin in November/December:

Building layers for analysis basis in GIS – 4 weeks

Creating other features in GIS – 1 week

Designing the input files for Marxan - 3 weeks

Inputting, learning, running and troubleshooting Marxan – 2 weeks

Creating Maps of study areas in GIS – 3 weeks

1st complete draft April 1, 2019

\*I will turn in thesis sections for review as soon as possible. However, the GIS and Marxan analysis tasks will likely continue throughout the winter quarter.

**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.**

I am working loosely with the DNR Natural Heritage Program. They have supported me in establishing my research question and are available to provide spatial data if I need it. However, my contact at the agency no longer works at DNR so their involvement moving forward will be minimal.

Mike Ruth has helped me with some basic GIS advice for my study design.

**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.**

Ardron, J.A., Possingham, H.P., and Klein, C.J. (eds). 2010. Marxan Good Practices Handbook, Version 2. Pacific Marine Analysis and Research Association, Victoria, BC, Canada. 165 pages. [www.pacmara.org](http://www.pacmara.org).

 This exhaustive resource for using Marxan in strategic conservation planning will be a primary source for the analysis of my thesis. This document discusses data limitations and how to approach data for Marxan inputs. Additionally it explains how to set up and run Marxan followed with how to analyze Marxan prioritization outputs.

Krosby, M., Theobald, D. M., Norheim, R., & Mcrae, B. H. (2018). *Identifying riparian climate corridors to inform climate adaptation planning*. <https://doi.org/10.1371/journal.pone.0205156>

The authors describe riparian corridors as dispersal corridors because of their inherent microclimate refugia. Elements which facilitate these microclimates are temperature gradient, canopy cover, width, solar radiation and human interference. They used these variables to rank the habitat quality of riparian areas across the Pacific Northwest region on a scale of 1-5 with a score of 1 being the most natural state. From their analysis, mountainous regions had the highest scores, while lowland areas such as the Columbia Basin and Puget Lowlands had the lowest scores. They recommend focusing riparian restoration and conservation strategy in these two lowland areas to provide resource protection where it is most needed in the Pacific Northwest. Considering this recommendation, I use their habitat ranking as a boundary for study sites applied to 3 local watersheds in Thurston County.

At the large-scale application of the variables analyzed for the whole Pacific Northwest it is understandable, that by comparison, the low, flatlands would be assigned a lower rank of climate refugia due to human interference of roads, development and industry. This study isolates an area of the south Puget Sound while using the variables previously used at a regional scale, to closely examine climate refugia ranking locally. The local ranking can inform decisions for conservation opportunity along riparian corridors in Thurston County.

Tilman, D., M. Clark, D.R. Williams, K. Kimmel, S. Polasky & C. Packer. (2017) Future threats to biodiversity and pathways to their prevention. *Nature* *546*, 73-81.

 The research found that extinction risks accelerate with per capita growth and agriculture land conversion as correlated directly with individual country size. They looked at biodiversity presence and projected growth and assigned rankings in order to quantify the extinction risks for every country. Their findings suggest that the most biodiverse areas of the world are currently under the highest threats from land use changes. They assert that improved land use planning will be the most important element to proactively address biodiversity loss.

Venter, O., Fuller, R. A., Segan, D. B., Carwardine, J., Brooks, T., Butchart, S. H. M., Watson, J. E. M. (2014). Targeting global protected area expansion for imperiled biodiversity. *PLoS Biology 12*(6), 1-7.

 In this study, the authors use the 2012 World Database on Protected Areas and Marxan software to model scenarios for best management of biodiversity in order to achieve conservation targets committed by nations in the 2010 Convention of Biological Diversity (CBD) for application by the year 2020. They focus on least cost management by avoiding conflicts of management options that would impede agricultural production. They found that only 15% of endangered species are protected at a level in which they will persist. Vegetation communities should be protected to support more habitats. Additionally, the least cost approach to conservation is not the best approach. The return on species conservation to money spent is so minimal that steps forward cannot be achieved. Species with small range of movement are highest at risk.

References cited:

Balmford, A., Bennun, L., Ten Brink, B., Cooper, D., Côté, I. M., Crane, P., … Walther, B. A. (2005, January 14). The convention on biological diversity’s 2010 target. *Science*, Vol. 307, pp. 212–213. https://doi.org/10.1126/science.1106281

Beisner, B. E., Haydon, D. T., & Cuddington, K. (2003). Alternative stable states in ecology. *Frontiers in Ecology and the Environment*, *1*(7), 376–382. https://doi.org/10.1890/1540-9295(2003)001[0376:ASSIE]2.0.CO;2

Dale, Virginia H., and Haeuber, R. A. A. (2001). *Ecological Principles to Land Management*. Springer Science and Business Media.

Donald, P. F., & Evans, A. D. (2006). Habitat connectivity and matrix restoration: the wider implications of agri-environment schemes. *Journal of Applied Ecology*, *43*(2), 209–218. https://doi.org/10.1111/j.1365-2664.2006.01146.x

Dunn, C. G., & Angermeier, P. L. (2019). Remaining populations of an upland stream fish persist in refugia defined by habitat features at multiple scales. *Diversity and Distributions*, *25*(3), 385–399. https://doi.org/10.1111/ddi.12866

Fletcher, R. J., Didham, R. K., Banks-Leite, C., Barlow, J., Ewers, R. M., Rosindell, J., … Haddad, N. M. (2018). *Is habitat fragmentation good for biodiversity?* https://doi.org/10.1016/j.biocon.2018.07.022

Fremier, A. K., Kiparsky, M., Gmur, S., Aycrigg, J., Craig, R. K., Svancara, L. K., … Scott, J. M. (2015). A riparian conservation network for ecological resilience. *Biological Conservation*, *191*, 29–37. https://doi.org/10.1016/j.biocon.2015.06.029

Haddad, N. M., Gonzalez, A., Brudvig, L. A., Burt, M. A., Levey, D. J., & Damschen, E. I. (2017). Experimental evidence does not support the Habitat Amount Hypothesis. *Ecography*, *40*(1), 48–55. https://doi.org/10.1111/ecog.02535

Hagen, A., & E. H. (2006). Resolving Critical Habitat Designation Failures: Reconciling Law, Policy, and Biology. *Conservation Biology*, *20*(2), 399–405.

Heinrichs, J. A., Lawler, J. J., Schumaker, N. H., Wilsey, C. B., Monroe, K. C., & Aldridge, C. L. (2018). A multispecies test of source–sink indicators to prioritize habitat for declining populations. *Conservation Biology*, *32*(3), 648–659. https://doi.org/10.1111/cobi.13058

Heller, N. E., & Zavaleta, E. S. (2009, January). Biodiversity management in the face of climate change: A review of 22 years of recommendations. *Biological Conservation*, Vol. 142, pp. 14–32. https://doi.org/10.1016/j.biocon.2008.10.006

Hepinstall-Cymerman, J., Coe, S., & Hutyra, L. R. (2013a). Urban growth patterns and growth management boundaries in the Central Puget Sound, Washington, 1986-2007. *Urban Ecosystems*, *16*(1), 109–129. https://doi.org/10.1007/s11252-011-0206-3

Keppel, G., Van Niel, K. P., Wardell-Johnson, G. W., Yates, C. J., Byrne, M., Mucina, L., … Franklin, S. E. (2012). Refugia: identifying and understanding safe havens for biodiversity under climate changeg eb\_686 393..404. *Global Ecology and Biogeography*, *21*, 393–404. https://doi.org/10.1111/j.1466-8238.2011.00686.x

Krosby, M., Norheim, R., & Theobald, D. M. (2015). *Riparian Climate Corridors-Identifying Priority Areas for Conservation in a Changing Climate Riparian Climate-Corridors: Analysis Extension, Improvements, and Validation*.

Krosby, M., Theobald, D. M., Norheim, R., & Mcrae, B. H. (2018). *Identifying riparian climate corridors to inform climate adaptation planning*. https://doi.org/10.1371/journal.pone.0205156

Monahan, W. B., & Theobald, D. M. (2018). Climate change adaptation benefits of potential conservation partnerships. *PLoS ONE*, *13*(2). https://doi.org/10.1371/journal.pone.0191468

Possingham, H. P., & Watts, M. E. (2011). *Marxan and relatives: Software for spatial conservation prioritization Conservation Planning View project Managing fire-dependent landscapes View project*. Retrieved from www.ecology.uq.edu.au/marxan

Pressey, R. L., Weeks, R., & Gurney, G. G. (2017a). *From displacement activities to evidence-informed decisions in conservation*. https://doi.org/10.1016/j.biocon.2017.06.009

Rosenzweig, M. L. (37AD). Reconciliation ecology and the future of species diversity. *Oryx*, 194–205.

Singleton, P. H., Lehmkuhl, J. F., & Org, E. (2001). *Using weighted distance and least-cost corridor analysis to evaluate regional-scale large carnivore habitat connectivity in Washington Publication Date ICOET 2001 Proceedings 583 A Time for Action* Retrieved from https://escholarship.org/uc/item/526536d6

Stein, A., Gerstner, K., & Kreft, H. (2014). Environmental heterogeneity as a universal driver of species richness across taxa, biomes and spatial scales. *Ecology Letters*, *17*(7), 866–880. https://doi.org/10.1111/ele.12277

Theobald, D. M., Reed, S. E., Fields, K., & Soulé, M. (2012). Connecting natural landscapes using a landscape permeability model to prioritize conservation activities in the United States. *Conservation Letters*, *5*(2), 123–133. https://doi.org/10.1111/j.1755-263X.2011.00218.x

Wade, A. A., Beechie, T. J., Fleishman, E., Mantua, N. J., Wu, H., Kimball, J. S., … Stanford, J. A. (2013). Steelhead vulnerability to climate change in the Pacific Northwest. *Journal of Applied Ecology*, *50*(5), 1093–1104. https://doi.org/10.1111/1365-2664.12137

Whittaker, R. J., Araújo, M. B., Jepson, P., Ladle, R. J., Watson, J. E. M., & Willis, K. J. (2005). Conservation Biogeography: assessment and prospect. In *Diversity and Distributions* (Vol. 11). Retrieved from www.blackwellpublishing.com/ddi

Zavaleta, E., & Heller, N. (2009). Chapter III.18: Responses of Communities and Ecosystems to Global Changes.: EBSCOhost. Retrieved October 11, 2019, from Princeton Guide to Ecology Princeton University Press. website: http://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=28&sid=a74fb43d-977b-4e88-b40e-dc9e3bc1bdff%40pdc-v-sessmgr01

Zielinski, W. J., Tucker, J. M., & Rennie, K. M. (2017). Niche overlap of competing carnivores across climatic gradients and the conservation implications of climate change at geographic range margins. *Biological Conservation*, *209*, 533–545. https://doi.org/10.1016/j.biocon.2017.03.016

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. 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-4)