**The Evergreen State College**

**Graduate Program on the Environment**

### Thesis Prospectus

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**STUDENT AGREEMENT:**

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

**FACULTY READER APPROVAL:**

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

**MES DIRECTOR APPROVAL:**

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

1. Provide the working title of your thesis[[1]](#endnote-2).

Culvert inventory strategies for fish passage in intertidal streams

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

Salmon are a keystone species in Washington state, providing cultural, economic, and ecological importance. However, salmon populations have been in steady decline since the early 1900s. The Boldt Decision in 1974 recognized treaty rights of Native Americans to claim half of the yearly salmon harvest in their “usual and accustomed grounds and stations”. Since salmon runs have been in such decline, even half of the harvest has drastically fallen. This led to the culvert case injunction, which ruled that culverts (specifically state owned) are a large contributor to the declining salmon runs. The culvert case requires all state-owned fish barrier culverts to be replaced within an allotted time.

Washington Department of Fish and Wildlife (WDFW) has developed the fish passage barrier assessment protocol to locate and prioritize man-made barrier culverts. However, this protocol does not work for intertidal culverts, leaving many culverts along the coast and Puget Sound as barrier status “unknown”. Intertidal culverts are the first possible barrier that salmon encounter as they migrate back from the ocean, or the last point at which juveniles rest before they move into the ocean.

Since intertidal culverts are so important to fish barrier removal prioritization, and they are so difficult to assess, my goal is to find correlations between physical measurements that can be taken during a rapid assessment and the barrier status of engineer reviewed intertidal culverts. These correlations will be assessed in hopes of finding an easier and faster method for intertidal culvert assessments.

1. State your research question.

Are physical measurements taken at intertidal fish passage structures in western Washington a good surrogate for more-extensive habitat measurements, to help determine fish barrier status?

Subquestions

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

The practical framework of my research problem is the importance of fish passage for salmon in the Pacific Northwest. Pacific salmon are a keystone species in Washington state, providing cultural, economic, and ecological growth for people and the environment. Since human growth and development in the state, roads and railroads have crossed many salmon streams, causing disconnections and blockages for salmon migrations (Turner & Lewis, 1996). As a result, research into culvert assessments and replacements for fish passage, and implications for management has been conducted by a variety of investigators and agencies (Greene & Hall, 2017). However, there is still limited knowledge of the effects of tidally influenced restrict culverts on fish passage and specifically juvenile behavior in intertidal rearing systems(Greene & Hall, 2017).

Work is currently being done by WDFW to assess the barrier status of stream culverts. The theoretical framework consists of methods developed by Washington Department of Fish and Wildlife, Fish Passage and Surface Water Diversion Screening Assessment and Prioritization Manual. These methods were developed by using models, such as FishXing, and surrogate physical culvert measurements to predict velocity and depth of water through the culverts, as well as culvert water outfalls that are known barriers to salmon. Research in alluvial riverine systems has found that water crossing structures, such as culverts, can inhibit fish passage by creating vertical drops, shallow water, and/or increased velocity around the structure (R. Barnard, Yokers, Nagygyor, & Quinn, 2013). Structure length, slope, texture, and volume capacity can increase stream velocity, reduce water depth, (Dane, 1978; Kemp & O’Hanley, 2010; Larinier, 2002), and inhibit fish migration through the structure (Larinier, 2002). A structures physical dimensions and roughness can create habitat disconnection and inhibit fish movement through the structure; thus Washington state has design guidelines for culvert design to improve fish passage (R. J. Barnard, Yokers, Nagygyor, & Quinn, 2015; Kemp & O’Hanley, 2010).

Velocity, depth, and surface water drop measurements through structures are compared against salmon swimming and leaping capabilities (Slaney, P.A; Zaldokas, 1997) to determine passability of the structure. Salmon swimming and leaping capabilities have been measured by snorkel surveys, pit tagging and tracking salmon movement, and mark and recapture (R. J. Barnard et al., 2015; Connor & Pflug, 2004; Hoffman & Dunham, n.d.; Kahler & Quinn, 1998). Habitat assessments are performed above and below culverts to determine the habitat type and quality for salmonid use to prioritize removing any culvert barriers that are keeping salmon from migrating to these habitats.

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?

Many salmon runs in Washington state are listed as threatened or endangered. Culvert passage barriers have been found to be a large contributor to salmon run declines because they block salmon from migrating to spawning and rearing grounds (Greene & Hall, 2017). Washington Department of Fish and Wildlife (WDFW) has developed the fish passage barrier assessment protocol to locate and prioritize man-made barrier culverts to salmonid migration. However, this protocol does not work for intertidal culverts, leaving many culverts along the coast and Puget Sound as barrier status “unknown”. Intertidal culverts are the first possible barrier that salmon encounter as they migrate back from the ocean, or the last point at which juveniles rest before they move into the ocean. My work could help resource managers prioritize intertidal culverts, by being able to inventory culverts quicker and less costly than previous methods.

1. Summarize your study design[[2]](#endnote-3). 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)?

About 20 intertidal culverts will be selected for analysis in my study. I will take physical measurements on culverts and relate them to engineer reviewed culverts, such as scour depth, width, and length of pool inlet and outlet, vegetation line, velocity at time in relation to tide, depth of culvert at time in relation to tide and mean high water mark, size of culvert in relation to mean might water mark and stream basin size/bankfull width. All of these variables are going to be compared against each other and against culverts already assessed by engineers to find any correlations between measurements and known structure passability. I could also be taking physical measurements of the habitat as response variables around a culvert in response to the independent culvert size/gradient/relation to mean high water/ variables.

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-4).

I will be using existing data and gathering new data. I will work with the Fish Passage Division of WDFW to get a list of inventoried tidal culverts with their barrier status. I will take X number of engineer reviewed culverts, hopefully within a range of passable and non passable, and then X number of unknown passability culverts waiting engineer review.

The data that I will be collecting will be physical measurements of culverts (and habitat around them) that I found that have been previously inventoried. I haven’t located these culverts yet, but they will most likely be highway culverts along the coast line or Puget Sound in Wa.

1. 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.

After I complete my data collection, I am planning on analyzing my data using statistical analysis in JMP, since that is what I am familiar with from RDQM class. I will be comparing multiple variables independent and dependent to see if there are statistical correlations. I may be using a one-way ANOVA, but I still need to research the best analysis strategy.

1. 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).

For my research, I will only be taking physical measurements of culverts and habitat around them. I will not be interacting with animals or people, except to get permission to access property of the culvert locations that I will be surveying. Most culverts will be state owned or privately owned. My results may benefit WDFW if I find that tidal culverts’ barrier status can be determined by rapid physical surveys, rather than time consuming engineer review. This work could have future implications for landowners that have culverts on their property that are found out to be barriers to fish passage. However, these culverts will be or are currently listed on WDFW’s fish passage barrier list, so these culverts barrier status will be eventually found out.

1. 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-5).

My background over the last ten years has focused on the conservation and restoration of natural lands ecology. I chose this background, because I have always had a passion for the outdoors. I grew up fishing with my dad and hiking with friends. I have fond memories of these experiences and want to preserve the natural environment for myself and future generations to enjoy. With this in mind, I understand that there are human limitations to restoration and conservation, but I believe that if people strive towards restoration and conservation of natural ecosystems, we will all benefit.

I chose my research question, because it is a question that I’ve been curious about over the past 5 years of working as a fish passage technician for WDFW. The state and private sector has invested so much time and funds into surveying, prioritizing, and replacing man made barrier culverts, that it is a shame that there aren’t accepted methods to efficiently survey intertidal culverts. This question is close to me, because I have struggled with it in my career for the past 5 years. This curiosity and drive that I have to find the answer may be difficult to bear if I am not successful. Even though I want to develop methods to efficiently survey intertidal culverts, I understand the importance of good and accurate data. Even if I am not able to find methods, the questions that I will answer will still further scientific understanding of fish passage.

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

Stadia rod (loan)

Rotary laser (loan)

Impulse laser (loan)

Write in the rain notebook ($15)

Gas to drive to sites around 500 miles ($100)

1. Provide a detailed working outline of your thesis.

**Introduction**

Salmon are a keystone species in Washington state, providing cultural, economic, and ecological importance. However, salmon populations have been in steady decline since the early 1900s. The Boldt Decision in 1974 recognized treaty rights of Native Americans to claim half of the yearly salmon harvest in their “usual and accustomed grounds and stations”. Since salmon runs have been in such decline, even half of the harvest has drastically fallen. This led to the culvert case injunction, which ruled that culverts (specifically state owned) are a large contributor to the declining salmon runs. The culvert case requires all state-owned fish barrier culverts to be replaced within an allotted time.

Washington Department of Fish and Wildlife (WDFW) has developed the fish passage barrier assessment protocol to locate and prioritize man-made barrier culverts. However, this protocol does not work for intertidal culverts, leaving many culverts along the coast and Puget Sound as barrier status “unknown”. Intertidal culverts are the first possible barrier that salmon encounter as they migrate back from the ocean, or the last point at which juveniles rest before they move into the ocean.

Since intertidal culverts are so important to fish barrier removal prioritization, and they are so difficult to assess, my goal is to find correlations between physical measurements that can be taken during a rapid assessment and the barrier status of engineer reviewed intertidal culverts. These correlations will be assessed in hopes of finding an easier and faster method for intertidal culvert assessments. Are physical measurements taken at intertidal fish passage structures in western Washington a good surrogate for more-extensive habitat measurements, to help determine fish barrier status?

**Literature Review**

Pacific salmon are a keystone species in Washington state, providing cultural, economic, and ecological growth for people and the environment. Since human growth and development in the state, roads and railroads have crossed many salmon streams, causing disconnections and blockages for salmon migrations (Turner & Lewis, 1996). As a result, research into culvert assessments and replacements for fish passage, and implications for management has been conducted by a variety of investigators and agencies (Greene & Hall, 2017). However, there is still limited knowledge of the effects of tidally influenced restrict culverts on fish passage and specifically juvenile behavior in intertidal rearing systems(Greene & Hall, 2017).

Work is currently being done in Washington State to assess the barrier status of stream culverts using methods developed by (Washington State Department of Fish and Wildlife, 2009). Fish Passage and Surface Water Diversion Screening Assessment and Prioritization Manual. Washington Department of Fish and Wildlife. Olympia, Washington. These methods were developed by using models, such as FishXing, and surrogate physical culvert measurements to predict velocity and depth of water through the culverts, as well as culvert water outfalls that are known barriers to salmon. Velocity, depth, and surface water drop measurements are compared against salmon swimming and leaping capabilities (Slaney, P.A; Zaldokas, 1997) ). Salmon swimming and leaping capabilities have been measured by snorkel surveys, pit tagging and tracking salmon movement, and mark and recapture (cite). Habitat assessments are done above and below culverts to determine the habitat type and quality for salmonid use to prioritize removing any culvert barriers that are keeping salmon from migrating to these habitats.

**Methods**

A number of intertidal culverts will be selected for analysis in my study. I will take physical measurements on culverts and relate them to engineer reviewed culverts, such as scour depth, width, and length of pool inlet and outlet, vegetation line, velocity at time in relation to tide, depth of culvert at time in relation to tide and mean high water mark, size of culvert in relation to mean might water mark and stream basin size/bankfull width. All of these variables are going to be compared against engineer review. I could also be taking physical measurements of the habitat as response variables around a culvert in response to the independent culvert size/gradient/relation to mean high water/ variables.

I will work with the Fish Passage Division of WDFW to get a list of inventoried tidal culverts with their barrier status. I will take X number of engineer reviewed culverts, hopefully within a range of passable and non passable, and then X number of unknown passability culverts waiting engineer review.

The data that I will be collecting will be physical measurements of culverts (and habitat around them) that I found that have been previously inventoried. I haven’t located these culverts yet, but they will most likely be highway culverts along the coast line or Puget Sound in Wa.

**Results**

After I complete my data collection, I am planning on analyzing my data using statistical analysis in JMP, since that is what I am familiar with from RDQM class. I will be comparing multiple variables independent and dependent to see if there are statistical correlations. I may be using a one-way ANOVA, but I still need to research the best analysis strategy.

X# Passable culverts X# nonpassable culverts

Does relation of culvert position to mean high matter?

Does location of tidal flux matter? Coast vs north Puget sound vs south Puget sound

Does basin size of stream matter?

Does slope over stream US and DS matter?

**Discussion & Conclusion**

**Literature Cited**

Barnard, R. J., Yokers, S., Nagygyor, A., & Quinn, T. (2015). An Evaluation of the Stream Simulation Culvert Design Method in Washington State. *River Research and Applications*. https://doi.org/10.1002/rra.2837

Barnard, R., Yokers, S., Nagygyor, A., & Quinn, T. (2013). Concurrent Sessions A: Passage Effectiveness Monitoring in Small Streams II - An Evaluation of the Stream Simulation Culvert Design Method in Washington State. *International Conference on Engineering and Ecohydrology for Fish Passage*. Retrieved from https://scholarworks.umass.edu/fishpassage\_conference/2013/June27/47

Connor, E. J., & Pflug, D. E. (2004). Changes in the Distribution and Density of Pink, Chum, and Chinook Salmon Spawning in the Upper Skagit River in Response to Flow Management Measures. *North American Journal of Fisheries Management*. https://doi.org/10.1577/m03-066.1

Dane, B. G. (Fish. and M. S. . 1090 W. P. S. . V. B. V. 2P1 (Canada)). (1978). A review and resolution of fish passage problems at culvert sites in British Columbia. *Technical Report. Fisheries and Marine Service of Canada (Canada)*.

Greene, C. M., & Hall, J. (2017). *Effects of intertidal water crossing structures on estuarine fish and their habitat: a literature review and synthesis*.

Hoffman, R., & Dunham. (n.d.). *Fish-Movement Ecology in High-Gradient Headwater Streams: Its Relevance to Fish Passage Restoration Through Stream Culvert Barriers Open-File Report 2007-1140*. Retrieved from http://www.usgs.gov/pubprod

Kahler, T. H., & Quinn, T. P. (1998, July 1). *Juvenile and resident salmonid movement and passage through culverts*. Washington (State). Dept. of Transportation.

Kemp, P. S., & O’Hanley, J. R. (2010). Procedures for evaluating and prioritising the removal of fish passage barriers: a synthesis. *Fisheries Management and Ecology*, no-no. https://doi.org/10.1111/j.1365-2400.2010.00751.x

Larinier, M. (2002). FISH PASSAGE THROUGH CULVERTS, ROCK WEIRS AND ESTUARINE OBSTRUCTIONS. *Bulletin Francais de La Peche et de La Pisciculture*, *364*, 119–134. https://doi.org/10.1051/kmae/2002097

Slaney, P.A; Zaldokas, D. (Watershed R. P. (1997). *Fish Habitat Rehabilitation Procedures*.

Turner, R. E., & Lewis, R. R. (1996). Hydrologic restoration of coastal wetlands. *Wetlands Ecology and Management*, *4*(2), 65–72. https://doi.org/10.1007/BF01876229

Washington State Department of Fish and Wildlife. (2009). *Fish Passage and Surface Water Diversion Screening Assessment and Prioritization Manual*.

1. 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.

Work on methods and study design for culvert surveys and analysis. This includes permissions to survey culverts, the number of culverts I will survey and each variable I will be recording. I am currently working on these now but am planning to have my design complete by December 1st.

Work on thesis outline. First draft of introduction and methods done by December 15th.

Prospectus complete Fall quarter.

Working draft of literature review complete fall quarter.

Start surveying culverts after December 1st. My goal is to survey 2 culverts per week. I will survey 10-20 culverts within the Puget Sound and/or Washington coast. My goal is to have all of my culvert surveys complete and ready to analyze by March 1st.

Final draft of methods written by March 1st.

First draft of analysis March 15th

Working draft of conclusions by March 15th.

I will begin analyzing my results on March 1st using statistical analysis.

I will be done with my research by April 1st, and working on my final thesis paper drafts.

My final thesis draft will be done by May 15th.

1. Who, beyond your MES faculty reader, will support your thesis? Indicate support both within and outside of Evergreen. Be specific about who they are and in what capacity they will support your thesis. If you are working with an outside agency or expert, be specific about their expectations for your data analysis or publication of results.

Christy Rains and Dan Barrett from the Fish Passage division of WDFW will be supporting me in reviewing my thesis method designs. I will be coordinating with them to survey specific culverts and to get landowner permissions.

1. 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.
   1. Greene, C. M., & Hall, J. (2017). Effects of intertidal water crossing structures on estuarine fish and their habitat: a literature review and synthesis.

This reference provides the overview and identifies questions in my topic. It expands on current research strengths and flaws in intertidal culvert passage. This article also covers an in-depth literature review on general fish passage in intertidal systems that I will use as a base for my literature review.

* 1. Bourne, C. M., D. G. Kehler, Y. F. Wiersma and D. Cote (2011). Barriers to fish passage and barriers to fish passage assessments: the impact of assessment methods and assumptions on barrier identification and quantification of watershed connectivity. Aquatic Ecology 45: 389-403.

This article points out the need and lack of research on intertidal passage assessments in Western Washington. I will use this article to help with my research methods for intertidal assessments and possibly analysis.

* 1. David, A., C. Simenstad, J. Cordell, J. Toft, C. Ellings, A. Gray and H. Berge (2015). Wetland Loss, Juvenile Salmon Foraging Performance, and Density Dependence in Pacific Northwest Estuaries. Estuaries and Coasts 39: 767-780.

This article will provide a scientific background for the importance and need for my research.

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-2)
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-3)
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-4)
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-5)