### Thesis Prospectus 2023-24

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**Student Final Submission (date):**

**Faculty Reader Approval (date):**

**MES Director Approval (date):**

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

Bell or Barrier? How road noise impacts two mesocarnivores in Washington State

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

Roadways are an inevitable part of human expansion and with the movement of synanthropic predators into urban environments, contact between the two is only increasing. Synanthropic scavengers are scavengers/predators that benefit from being in close proximity to humans but are not domesticated. Use of anthropogenic resources brings synanthropic predators out of their natural habitats and into close proximity to human development which increases animal-human interactions.

Both raccoons and coyotes have become well adapted to urban life, showing changes down to a genetic level in some populations, as well as changes in behavior, diet, and home ranges. There is significant overlap between the two species in concerns to both diet and habitat, as well as becoming increasingly more familiar with humans, resulting in increased contact events between wildlife and humans, including vehicles.

The Biological Assessment Manual (BA) from WSDOT states that road and construction noise disrupts the natural behavior of wildlife. In most cases, this disruption in natural behavior is considered detrimental to the species but in the case of coyotes, they have been shown to have a positive benefit from the presence of roadways due to the amount of roadkill available.

There is a correlation between coyote size and the size of the prey they consume. Washington State coyotes are limited in their size due to the presence of larger carnivores such as cougars and wolves, this results in individuals that are unable to take down a deer and they may be turning to the abundance of ungulate roadkill present.

1. State your research question(s).

How does road noise impact coyotes (*Canis latrans*) and raccoons (*Procyon lotor*) on Washington State Highways?

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

It is known that scavengers consume roadkill but currently the framework for biological assessments considers road noise a deterrent to the presence of animals or otherwise disruptive to their normal behavior (WSDOT BA Manual Ch. 7, 2020). If scavengers are consuming roadkill it may mean that they are not deterred by road noise.

It is documented that coyotes consume roadkill but the extent of which requires further investigation (Jensen et al., 2022; Lange, 2011). As discussed in Jensen et al. in 2022, the size of coyote prey is dictated by the size of the coyote, with larger coyotes being able to take down larger prey items, such as full-sized ungulates, more specifically deer. They also discussed that while coyotes are the largest carnivore in most of the Eastern United States, their size is limited by the presence of larger carnivores.

In Washington state, this size is limited mainly by the presence of wolves and cougars, resulting in smaller coyotes. However, scat and roadkill analysis has shown that ungulates make up a portion of the diet of coyotes in Washington State (Quinn, 1997), this leads me to question if they are consuming roadkill deer, as deer make up the majority of roadkill aside from raccoons collected by WSDOT (WSDOT carcass removal database). Raccoons are also a portion of the diet of urban coyote populations (Jensen et al., 2022).

With urban populations of both coyotes and raccoons showing habituation to humans and the urban environment to the extent of showing genetic differences between populations, it is likely they are accessing roads as a food source as both species have generalist diets.

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?

Currently, it is assumed that road noise adversely impacts wildlife and can deter wildlife from going near or crossing roadways, unless they are forced to do so to find new habitat, food, etc. or otherwise changes their natural behavior. However, mesocarnivores such as coyotes and raccoons have been shown to consume roadkill and have become accustomed to human generated noises (urban dwelling populations) to the point of being genetically different in the context of urban and nonurban coyote populations (Adducci et al., 2020) and changes in behavior and home ranges in the context of raccoons (Bozek et al., 2007).

This research is important as both coyotes and raccoons are developing urban-specific populations and behaviors, bringing them ever closer to roadways and increasing the risk of road strikes. How we currently perform biological assessments for projects does not account for a species that may be drawn to high traffic areas and often times considers noise to be a deterrent to species. This is also not taken into account during project proposals, with a majority of cases for road crossing structures being made for fish passage structures or endangered or threatened species.

If this research shows that these mesocarnivores are drawn to or otherwise unimpacted by road noise, how we preform biological assessments for road projects and construction will need to change to account for the presence of these species. It can also add weight to needing to remove food sources from roadways in order to lessen animal-vehicle collisions.

Based on my own research using WSDOT carcass removal data, raccoons, deer, and coyote make up a majority of the roadkill collected by WSDOT. By removing deer from the equation by increasing permeability of highways through crossing structures as well as limiting the ability for animals to enter roadways, the amount of roadkill should decrease.

1. Summarize your study design[[2]](#endnote-2). If applicable, identify the key variables in your study. What is their relationship to each other? For example, which variables are you considering as independent (explanatory) and dependent (response)?

Using the road noise calculator (WSDOT) paired with WSDOT traffic volume (http://www.wsdot.wa.gov/mapsdata/roadway/statehighwaylog.htm) I will be creating a sound map of Washington state routes and highways using Python, putting that into GIS and then overlaying carcass removal data for deer (food source), coyotes, and raccoons (coyotes and raccoons making up a majority of roadkill removed from roads with the exclusion of deer).

Then I will run a series of multi-variant regression analysis, MANOVA, and various other statistical tests looking at the relationship between road noise, presence of food source (deer carcasses/raccoon carcasses/overall roadkill), coyote/raccoon roadkill, as well as habitat corridors, urban centers, crossing structures, etc.

1. Describe the data that will be the foundation of your thesis. Will you use existing data, or gather new data (or both)? Describe the process of acquiring or collecting data[[3]](#endnote-3).

WSDOT:

 Carcass removal data (2015-2020 and 2009-2020)

 Traffic volume data (same years as carcass removal)

 Crossing structure data

 Road noise calculator

Multi Resolution Land Characteristics Consortium (MRLC): [https://www.mrlc.gov/](https://nam02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.mrlc.gov%2F&data=05%7C01%7Csanash06%40evergreen.edu%7C56174aef005243258e1908dbf50a1322%7C22adcff7c06f49a68f2050711c40ddaa%7C0%7C0%7C638373195858191955%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=DCsBGPLZ7C%2BPmUaps1hFj4MZ0%2BFAk2jhhde0Erewfxc%3D&reserved=0)

1. **Land cover** – Conterminous U.S. land cover at a 30-meter spatial resolution with a 16-class legend based on a modified Anderson Level II classification system
2. **Land cover change index** – Provides a simple and comprehensive way to visualize change that occurred across all the NLCD epochs of land cover
3. **Urban imperviousness** – Indicates urban impervious surfaces as a percentage of developed surface over every 30-meter pixel in the Conterminous U.S.
4. **Urban impervious descriptor** – Classifies specific types of roads, wind tower sites, building locations, and energy production sites to allow a deeper analysis of developed features
5. **NLCD Science Products**
	1. **Land Cover Change Disturbance Date** – Identifies the first land cover classification change event between any two adjacent target years across all NLCD epochs at the 30-meter pixel level
	2. **Forest Disturbance Date** – Identifies the most recent year of forest disturbance between the years 1984–2021
	3. **Land Cover Change Count** – Calculates an integer count total of any change recorded between two consecutive epochs
	4. **Land Cover with additional Forest Transition Classes** – Delineates spectrally stable grass and shrub areas from those that are transitional forest classes, which tend to be represented by forest harvest, burns, regrowth, and other disturbances
	5. **U.S. Forest Service Science Tree Canopy Cover** – The original, unmasked Tree Cover Canopy data produced by the U.S. Forest Service, an MRLC partner
6. Summarize your methods of data analysis. If applicable, discuss any specific techniques, tests, or approaches that you will use to answer your research question.

Will bin data into NOISE (loud, moderate, quiet), HABITAT (good, better, best), URBAN (rural, exurban, urban), CROSSING (Yes/No crossing structure within 1 mile)

\*Addition of raccoon carcass data as an independent variable when running coyote carcass presence as a dependent variable

Multi-variant regression analysis: determine the relationship between dependent variable and independent variables (run twice, once with coyotes and once with raccoons. Possible third test to determine why deer are being struck in that area)

* Dependent variable
	+ 1. Raccoon carcasses
	+ 2. Coyote carcasses
* Independent variables
	+ Noise
	+ Habitat
	+ Urban
	+ Crossing
	+ Deer carcasses
	+ Total roadkill
	+ \*Raccoon carcasses

MANOVA: determine if combination of independent variables has an effect on independent variables

* Dependent variable
	+ 1. Raccoon carcasses
	+ 2. Coyote carcasses
* Independent variables
	+ Noise
	+ Habitat
	+ Urban
	+ Crossing
	+ Deer carcasses
	+ Total roadkill
	+ \*Raccoon carcasses

Correlation Coefficient: determining whether a relationship exists between variables and determining magnitude and action of the relationship. This test includes number of cars/trucks per mile per hour to determine road strike probability outside of noise

* Dependent variable
	+ 1. Raccoon carcasses
	+ 2. Coyote carcasses
* Independent variables
	+ Noise
	+ Habitat
	+ Urban
	+ Crossing
	+ Deer carcasses
	+ Total roadkill
	+ \*Raccoon carcasses
	+ Total cars per mile per hour
1. Address the ethical issues[[4]](#endnote-4) raised by your thesis work. Include issues such as risks to anyone involved in the research, as well as specific people or groups that might benefit from or be harmed by your thesis work, perhaps depending on your results. List any specific reviews you must complete first (e.g., Human Subjects Review or Animal Use Protocol Form).

I don’t believe there are any ethical issues concerning my thesis work, all animals are already dead, removed by WSDOT maintenance team, and recorded in database.

1. List specific research permits[[5]](#endnote-5) or permissions you need to obtain before you begin collecting data (e.g. landowner permissions, agency permits).

Permission to use WSDOT data, this has been obtained through verbal discussion and email from the head of the ESO branch.

WSDOT is interested in my thesis and also components such as the sound map of the state for biological assessments. I have been asked to present my findings to the ESO biology branch of the department.

1. Reflect on how your positionality as a researcher could affect your results and how you will account for this in the research process[[6]](#endnote-6).

I have been a WSDOT intern since March 2022.

WSDOT is interested in my work and would like me to present any findings to the ESO branch.

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

There are no costs associated with conducting my research as all data has been made available to me and I do not need to collect more. Also through WSDOT and Evergreen I already have access to statistical programs as well as GIS programs.

1. Provide a detailed working outline of your thesis.
2. Introduction
* Thesis Statement:

 It is known that scavengers consume roadkill but currently the framework for biological assessments considers road noise a deterrent to the presence of animals. If scavengers are consuming roadkill it may mean that they are not deterred by road noise.

1. Background Information
* Scavengers
	+ Coyotes and Raccoons
		- Diet
		- Scavenging behavior
* Roadways
	+ Dangers to animals
	+ Impacts of roadways
		- Methods to prevent collisions
			* Crossing structures
			* Barriers
	+ Habitat corridors
	+ Urbanization
* Current understanding of road noise as a deterrent
* WSDOT tools
1. Methodology
	* GIS
		1. Sound map
			+ Road noise calculator
				1. Traffic volume (trucks/cars per hour per mile)
				2. Background noise level

Determined using GIS and primary literature on background noise

* + - * 1. Attenuation

Environmental matrix of thru-ways

Determine how far noise travels before reaching background levels

* + Carcass removal database
		1. Deer
		2. Coyote
		3. Raccoons
		4. 2015-2019
		5. 2019-2023
			- Comparing pre and post pandemic levels
	+ Multivariate Regression Analysis/Correlation analysis/MANOV on binned data
		1. Road noise
		2. Habitat corridors
		3. Urban zones
		4. Deer carcasses
		5. Coyote carcasses
		6. Raccoon carcasses
1. Results
2. Discussion
3. Provide a specific work plan and a timeline for each of the major tasks in the work plan. Be as realistic and specific as you can at this point, including the deadlines for Spring quarter.
4. Map out carcass removals of deer, raccoons, and coyotes across Washington State
	1. Creates Carcass Layers

                                                               i.      Deer (prey)

                                                             ii.      Coyote

                                                           iii.      Raccoon

                                                           iv.      Combined Scavenger

* 1. Use Kernel Density function to find Carcass “Hotspots”
1. Use WSDOT GIS highway map to define the areas to create a sound map
2. Create a supervised classification raster OR MRLC classification data of thru-ways along highways (limiting area defined by step above)
	1. Creates hard/soft site and background noise inputs for sound calculator
3. Input classification raster data, traffic volume data, and highway data into BA sound calculator to create a sound matrix of highways (will use python to automate)
4. Input sound matrix into GIS, overlay with highway map
	1. Creates Base Sound Map
5. Add Urban centers and growth area to GIS map
	1. Creates Urban layer
6. Add Habitat Corridors to GIS map
	1. Creates Habitat layer
7. Add Crossing Structure locations
	1. Creates Crossing Structure Layer
8. Overlay layers on to map and make it look pretty
9. \*Use data processed above to run multi-variate regression analysis to determine relationships (currently discussing this aspect with data analyst)
10. Who (if anyone), beyond your MES thesis reader, will support your thesis (in or outside of Evergreen)? Be specific about who they are and in what capacity they will support your thesis. If you are working with an outside agency or expert, be specific about their expectations for your data analysis or publication of results.

\*Glen Kalisz, WSDOT Habitat Connectivity Biologist

\*Jeff Dreier, WSDOT Fish and Wildlife Program Manager

 \*Both will be available to answer questions and provide additional information and details concerning biological assessments, WSDOT tools, and access to data.

Mike Ruth, GIS assistance

Robin Vance, GIS assistance

Harry George, statistics and python

1. Provide the 5 most important references you have used to identify the specific questions and context of your topic, help with issues of research design and analysis, and/or provide a basis for interpretation. Annotate these references with notes on how they relate to/will be helpful for your thesis. For any other sources cited in your prospectus in other answers, provide a complete bibliographic citation here as well.

Bateman, Philip W., and Patricia A. Fleming. "Big city life: carnivores in urban environments." *Journal of Zoology* 287.1 (2012): 1-23.

Discusses implications of coyotes consuming anthropogenic food sources such as roadkill.

Lange, Karen E. "Coyotes Among Us." *Serial-All Animals 2009-15* 14.3 (2011): 5.

Discusses coyote diets in urban setting.

Reid, Rachel EB, and Paul L. Koch. "Isotopic ecology of coyotes from scat and road kill carcasses: a complementary approach to feeding experiments." *PLoS One* 12.4 (2017): e0174897.

Discusses coyote as roadkill

Henger, Carol S., et al. "DNA metabarcoding reveals that coyotes in New York City consume wide variety of native prey species and human food." *PeerJ* 10 (2022): e13788.

Discusses coyote diet, including roadkill

Additional References:

1. Adducci, Anthony, et al. "Urban coyotes are genetically distinct from coyotes in natural habitats." *Journal of Urban Ecology* 6.1 (2020): juaa010.
2. Bozek, Clare K., Suzanne Prange, and Stanley D. Gehrt. "The influence of anthropogenic resources on multi-scale habitat selection by raccoons." *Urban Ecosystems* 10 (2007): 413-425.
3. Jensen, Alex J., et al. "Coyote diet in North America: geographic and ecological patterns during range expansion." *Mammal Review* 52.4 (2022): 480-496.
4. Lange, Karen E. (2011) "Coyotes Among Us," Serial - All Animals 2009-15: Vol. 14: Iss. 3, Article 5.
5. Quinn, Timothy. "Coyote (Canis latrans) habitat selection in urban areas of western Washington via analysis of routine movements." *Northwest science.* 71.4 (1997): 289-297.
6. Washington State Department of Transportation. “7.0 Construction Noise Impact Assessment” *Biological Assessment Preparation Manual* (2020).
1. You are not locked into this title; we want you to identify the main point or topic of your thesis. [↑](#endnote-ref-1)
2. You might discuss a selection of case studies, sampling methods, experimental design, and/or specific hypotheses you will test. You should also address any specialized knowledge or skills that are necessary to complete the research. [↑](#endnote-ref-2)
3. If you are planning to use existing data, explain the specific source, contact information, arrangement with collaborating agencies, and expectations about use of data and final products of your research. If you are planning to gather new data, describe specific methods, time, place, and equipment that will be required. [↑](#endnote-ref-3)
4. If you’re not sure where to start, consult a ‘Code of Ethics’ or other similar document from an academic society in an applicable field of study. [↑](#endnote-ref-4)
5. If you are collecting ANY samples or data, even observational data, on public lands (city, county, state and/or federal) it is your responsibility to find out the permit requirements BEFORE you collect data. Conducting research with tribal members/on tribal lands will have different and additional requirements. [↑](#endnote-ref-5)
6. Your *positionality as a researcher* refers to the fact that one’s “…beliefs, values systems, and moral stances are as fundamentally present and inseparable from the research process as [one]’s physical, virtual, or metaphorical presence when facilitating, participating and/or leading the research project…” (The Weingarten Blog 2017). [↑](#endnote-ref-6)