
Habitat suitability modelling for mink passage activity
A cautionary tale
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Thank you!
Introduction
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Roads
Fragmentation
Ecological effects
Habitat loss
Barrier to movement
Reduced gene flow
Limited access to resources
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Introduction

Roads

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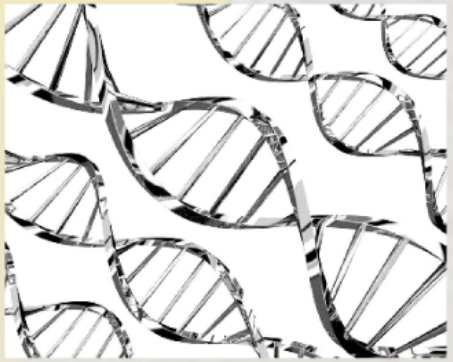
Barrier to movement



Reduced gene flow

Limited access to resources

Introduction

Transportation agencies have begun **constructing wildlife passages** in an attempt to offset the ecological consequences.

Placement is often based on economic considerations.

Few have examined the influence of the pre-construction landscape on post-construction use of wildlife passages.

Target species: Mink

- semi-aquatic & generalists
- habitat use mirrors prey
- survival depends on persistent water bodies and vegetative cover
- tolerant of human disturbance


Dals Wildlife Site

Habitat characteristics

Passage activity should depend on:

- **distance to water and cover**
- **land use**
- **cover density**
- **forest age**

Passage characteristics

Passage activity should depend on:

- **passage type* & age**
- **water**
- **vegetated median**
- **elevation**
- **approaching slope**

dimensions do not affect activity

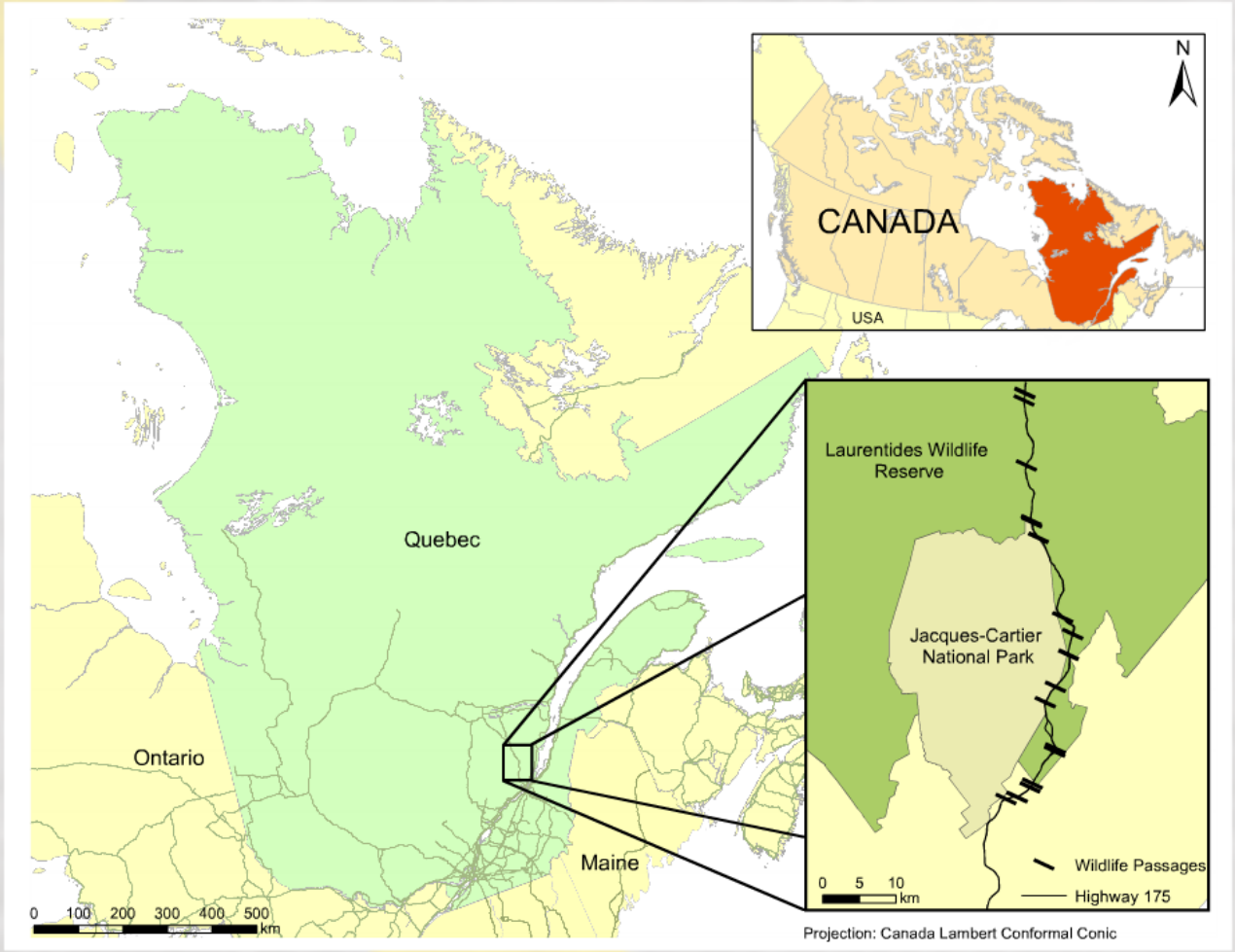
Research questions

(1) Can HSI modelling be used to determine passage activity for mink?

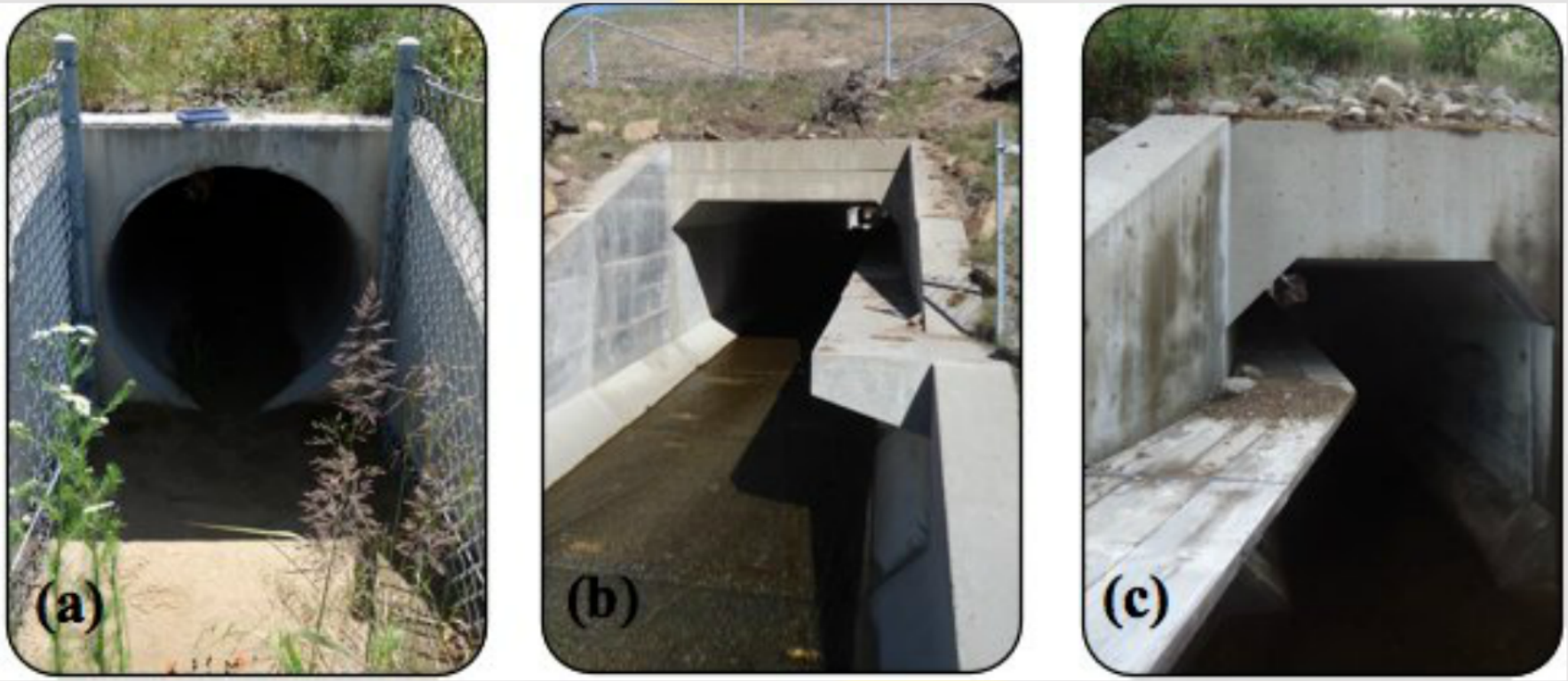
(2) How sensitive are the models to different parametrizations?

Methods

- Highway 175
- Laurentides Wildlife Reserve
- forest dominated
- between Québec City and Saguenay
- 17 passages
- remotely triggered cameras
- monitored year round (2012 to 2015)



Passage types



(a) Pipe culvert (PC) (n=6)
(b) Box culvert with dry concrete ledge (DCC) (n=7)
(c) Box culvert with dry wooden ledge (DWC) (n=4)

Analysis and models

GIS Analysis

- forest survey June 2011, 1 km buffer along road
- weighted linear combination (**multi-criteria decision analysis**)
- HSI = aA + bB + cC + dD + eE
- 3 buffers: 500 m, 100 m, 50 m

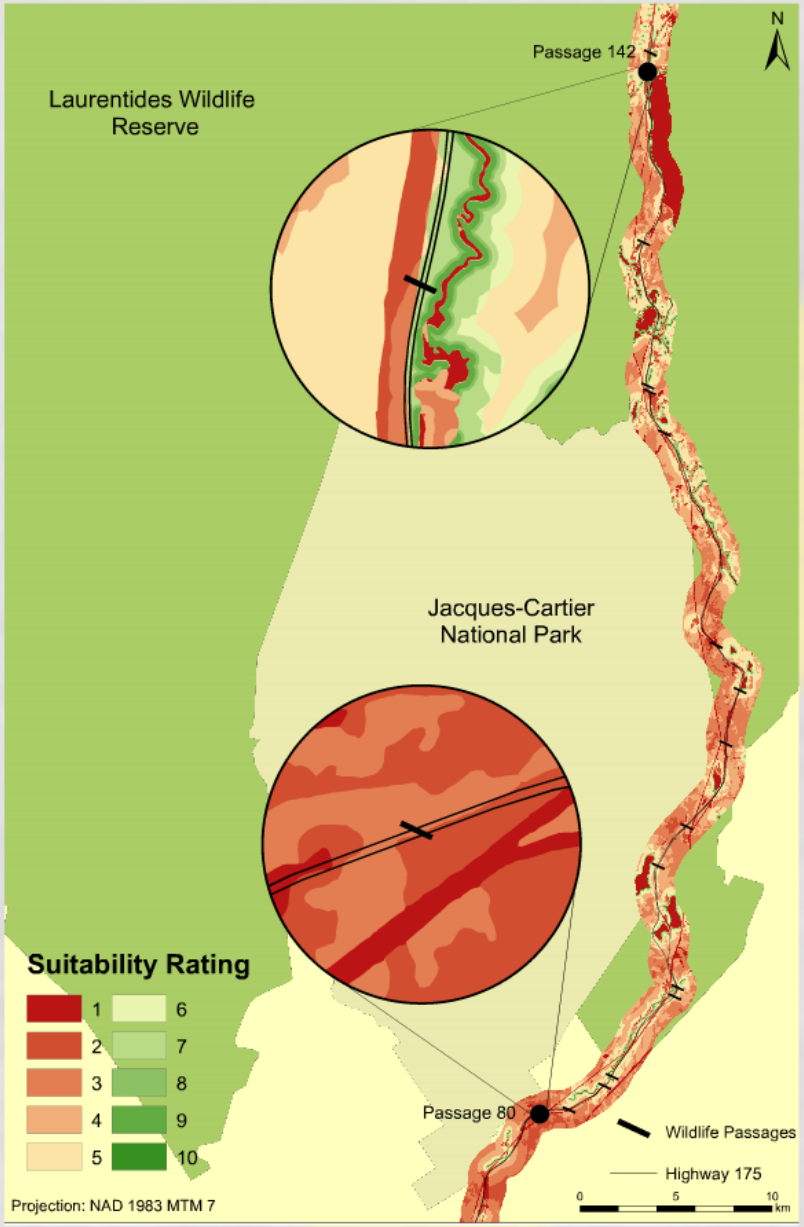
Uncertainty Analysis

- tested 23 alternative models
- varied weights and scores
- compared ranked output to original HSI model
  - Model 4 (extreme changes in weights), 23 (100m buffer), & 24 (50 m buffer)

Data Analysis

- generalized linear model
- **response**: count data (mink passage activity)
- compared HSI to HSI+passage characteristics

Suitability map

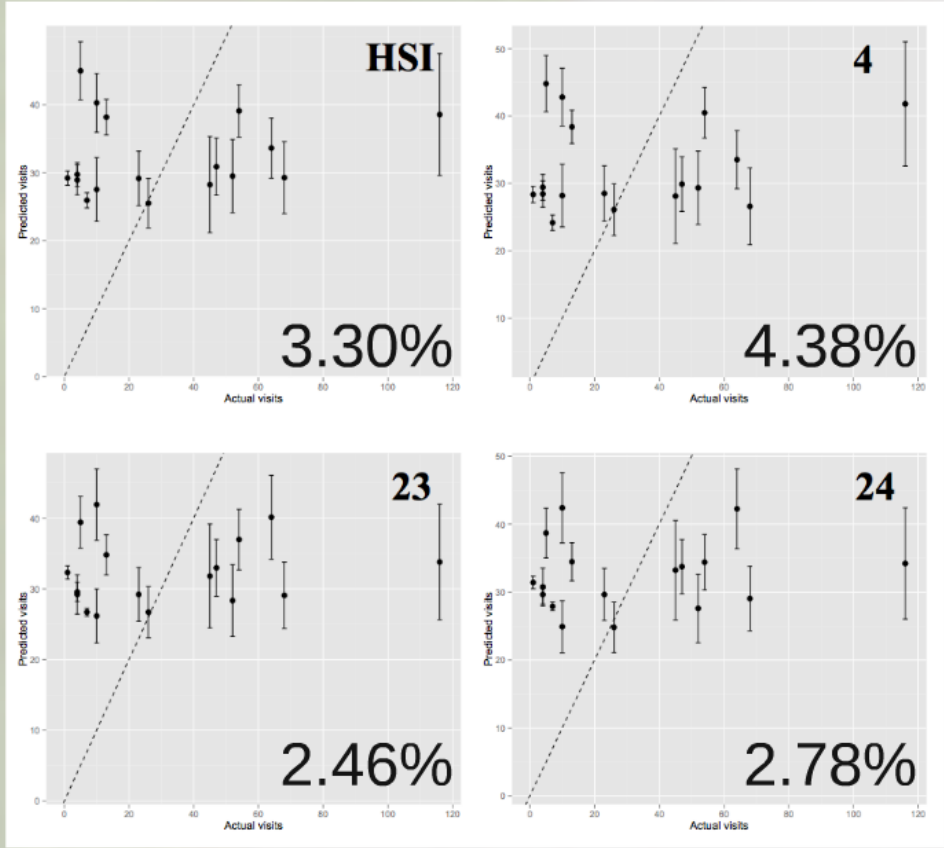


Score range: 2.27-5.13

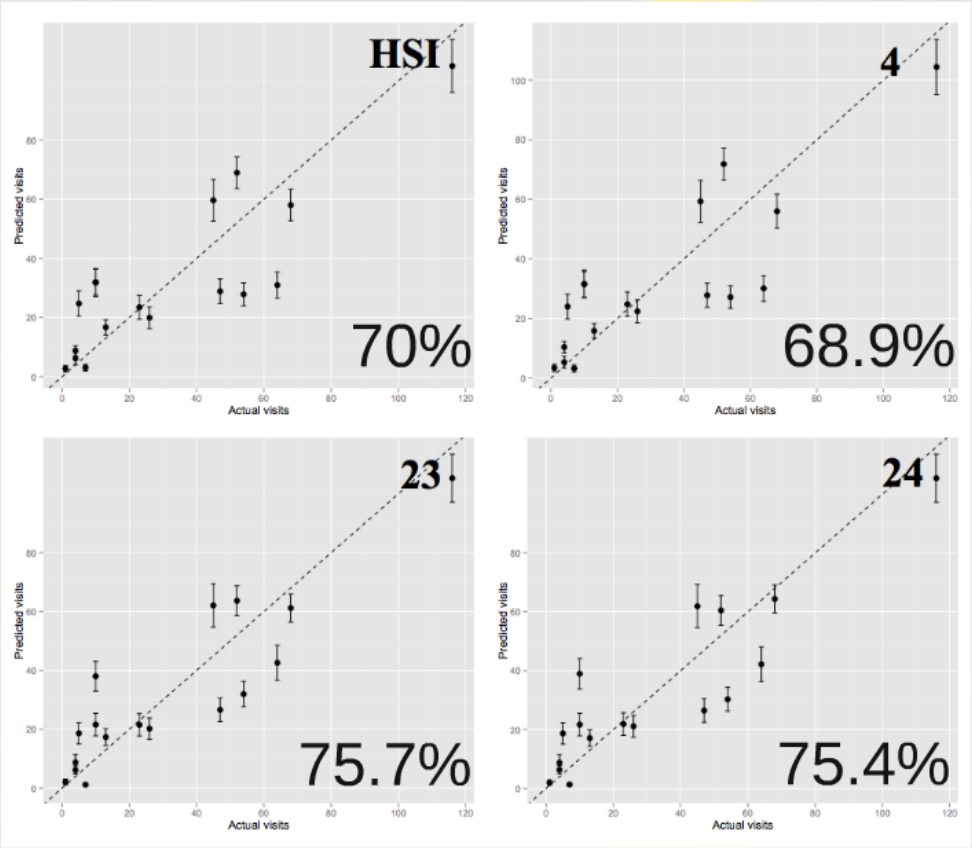
Average: 4.02

All models: suitable = less activity

Habitat characteristics only



Habitat + passage characteristics



predictive power increased →

Passage characteristics

median = less activity

passage + water
= more activity

less activity on
steep slopes

concrete ledge
used less

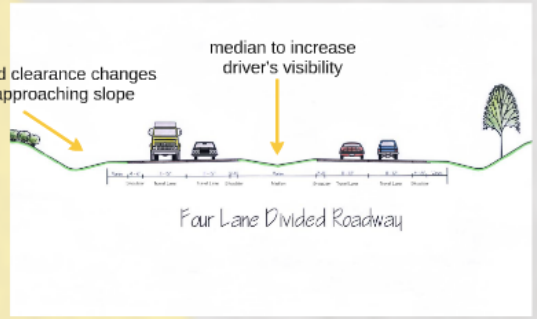
Discussion

Missing variables = poor model fit?

prey abundance and distribution

aquatic factors

Microhabitat preferences



topography changed during road construction

What about passage type?

dry ledges versus wet ledges

Population depression

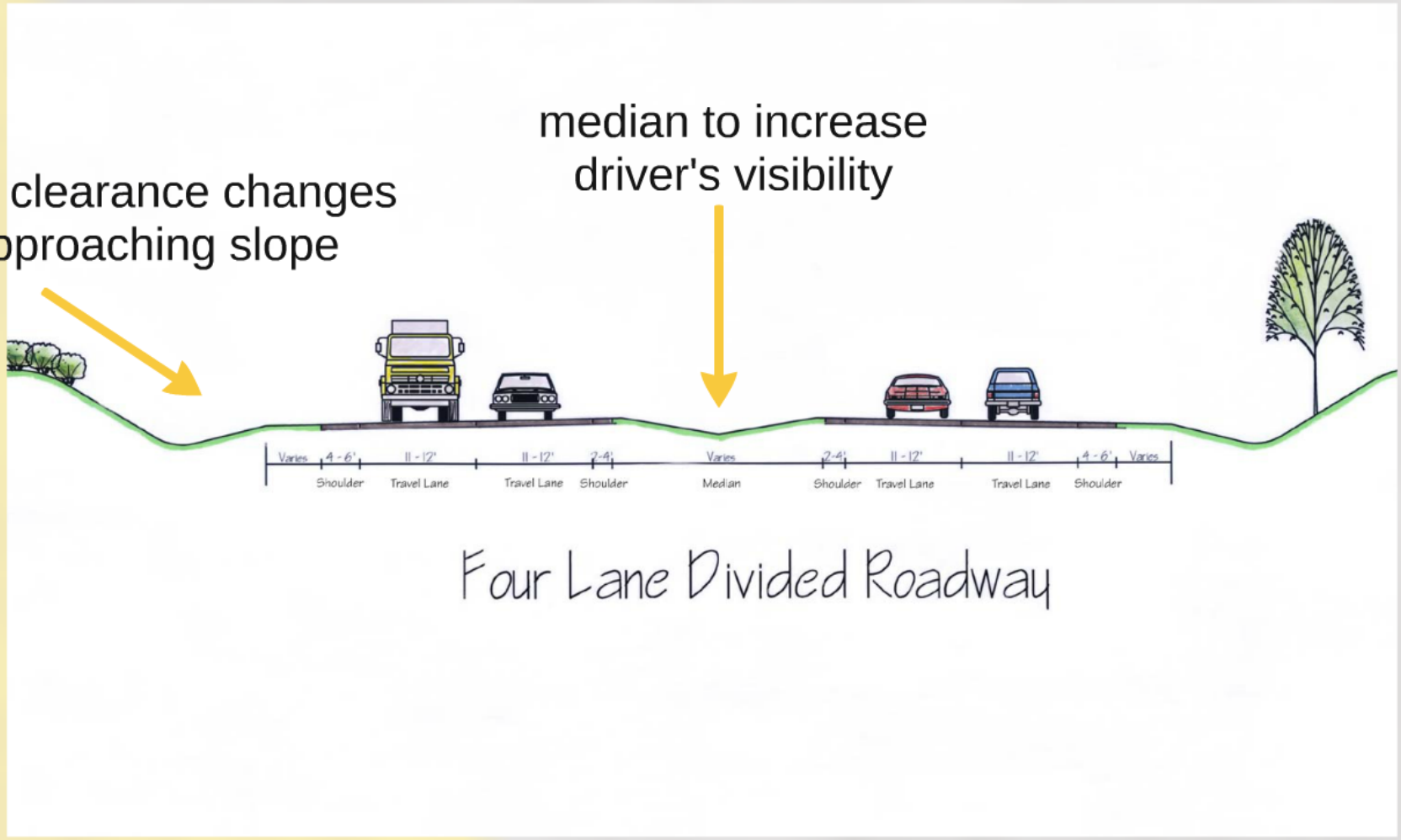
Previously **high mortality** results in **low current abundance**.
Low passage activity despite high suitability.

Missing variables = poor model fit?

prey abundance and distribution

aquatic factors

Microhabitat preferences



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Management recommendations for mink

(1) prioritize building **appropriately** designed passages
(2) maintain a **variety** of passage types
(3) build **more** passages in less costly locations

Conclusions

These results are site- and community-specific, but they suggest that so long as we build passages, they will come.

Université Concordia University

Transports Québec

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Seasonality

- tested for seasonal effects
- restricted passage activity to mid-April to mid-November (82% of visits)
- did not change HSI model results

Sensitivity Results

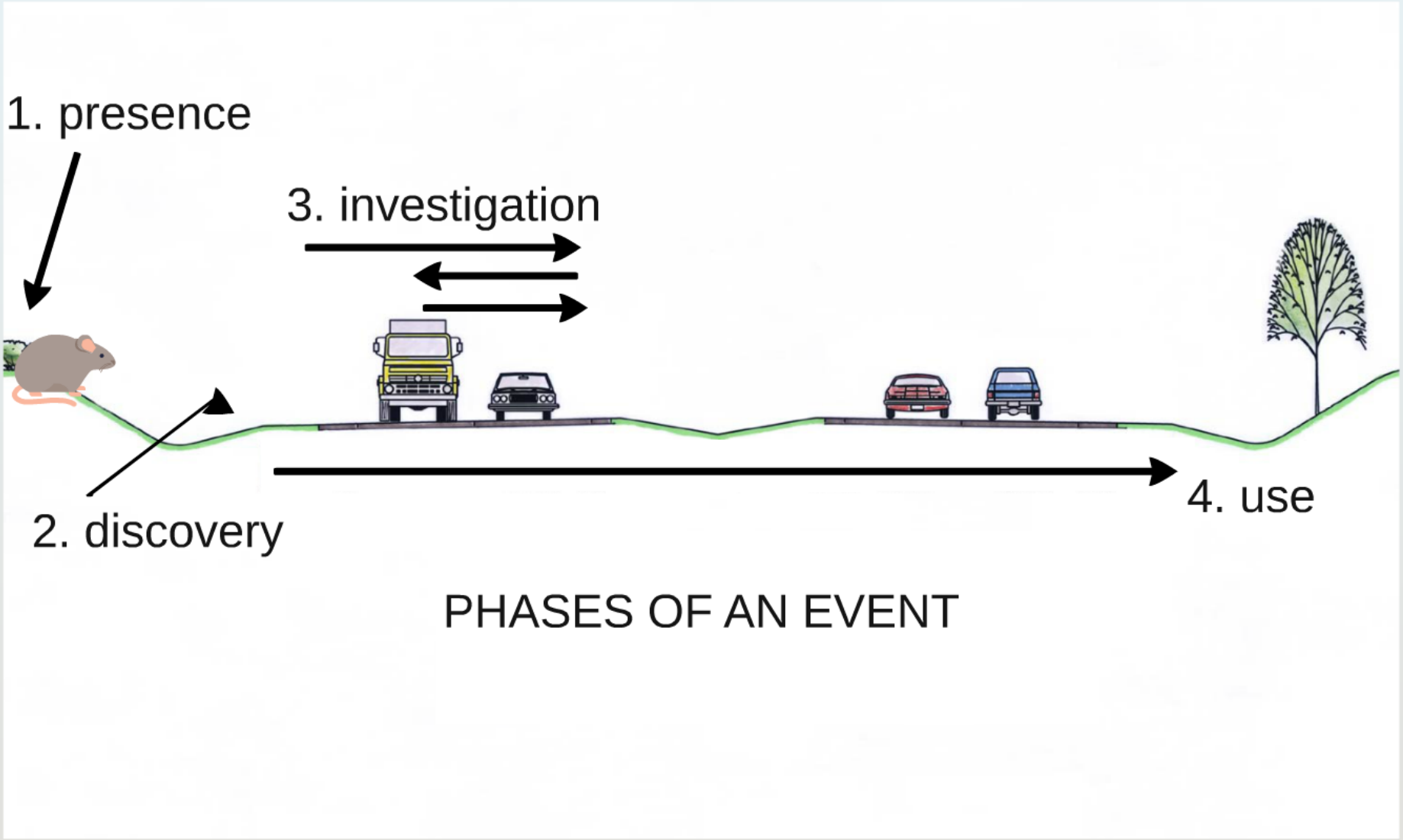
- HSI model: 2.27-5.13 avg: 4.02
- factor weights: 2.27-5.89 avg: 4.29
- factor scores: 2.27-5.42 avg: 3.99
- buffers: 1.10-6.94 avg: 4.20

Passage Data

Total photos: 227,720
Total independent events: 14,344
20 species observed

- mink accounted for 549 records (4%)

Phases of an event



Passage Variables

Attribute	Definition	Range
STRUCTURAL		
Passage type	Pipe culvert (PC) Box culvert with dry concrete ledge (DCC) Box culvert with dry wooden ledge (DWC)	n=6 n=7 n=4
Width[a]	Culvert width (m)	0.61-7.1
Height[a]	Culvert height (m)	0.52-3.3
Length[a]	Culvert length (m)	46-91
Openness	Culvert width x culvert height/culvert length[b] (m)	0.004-0.50
Ledge[a]	Presence, Yes (1) / No (0)	0-1
HABITAT & ROAD		
Road width[a]	Total width (m) of road from furthest East and West outer pavement edges	27.9-121.11
Road clearance[a]	Total distance (m) between forest margins	66-198
Median	Presence, Yes (1) / No (0)	0-1
Total length[a]	Total length from each entrance, including median when passage is divided (m)	46-182
Distance to cover	Average distance (m) to nearest continuous forest from passage entrance	6-105
Wildlife fence[ac]	0=small fauna fence, 1=large & small fauna fence	0-1
Road lighting	Presence, Yes (1) / No (0)	0-1
Location	Location of passage (km)	80-144
Year of construction	When construction was completed (year)	2007-2011
FUNCTIONAL TRAITS[d]		
Body Mass[ac]	Log_{10} of average body mass (g)	1.98-3.78
Open Areas	Use (1) or avoidance (0) of open areas	0-1
Water Obligate	Association with (1) or avoidance of (0) water	0-1

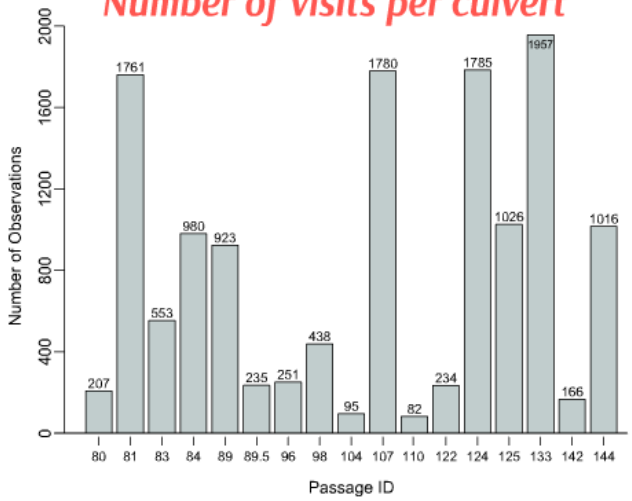
[a] Removed from analysis due to multicollinearity (Pearson's r > 0.70)
[b] Reed & Ward 1985
[c] Correlated with *Loca*
[d] Naughton 2012
[e] Correlated with *Open*

Common Name	Scientific Name	Species Code
American beaver	*Castor canadensis*	CACA
Porcupine	*Erethizon dorsatum*	ERDO[a]
Snowshoe hare	*Lepus americanus*	LEAM[a]
River otter	*Lontra canadensis*	LOCA
American Marten	*Martes americana*	MAAM
Marmot/Groundhog	*Marmota monax*	MAMO[ab]
Striped skunk	*Mephitis mephitis*	MEME[a]
White-footed mouse	*Peromyscus leucopus*	
Jumping mouse	*Zapus sp*	
Vole and bog lemming	Family: *Cricetidae*	MICRO[b]
Shrew	*Sorex sp*	
Star-nosed Mole	*Condylura cristata*	
American mink	*Neovison vison*	MUVI[ab]
Ermine	*Mustela erminea*	MUXX[ab]
Long-tailed Weasel	*Mustela frenata*	
Common muskrat	*Ondatra zibethicus*	ONZI[a]
Racoon	*Procyon lotor*	PRLO
Red squirrel	*Tamiasciurus hudsonicus*	TAHU[ab]
Eastern chipmunk	*Tamias striatus*	TAST[a]
Black bear	*Ursus americanus*	URAM
Unknown animal	-	UNKN
Red fox	*Vulpes vulpes*	VUVU

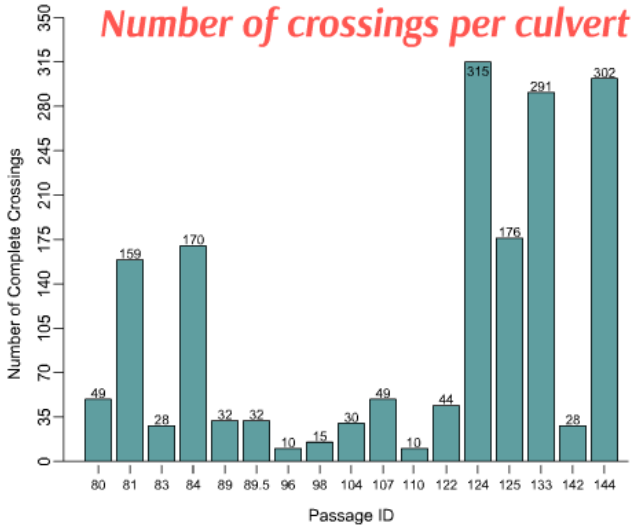
[a] In global models

[b] Has own species-specific model

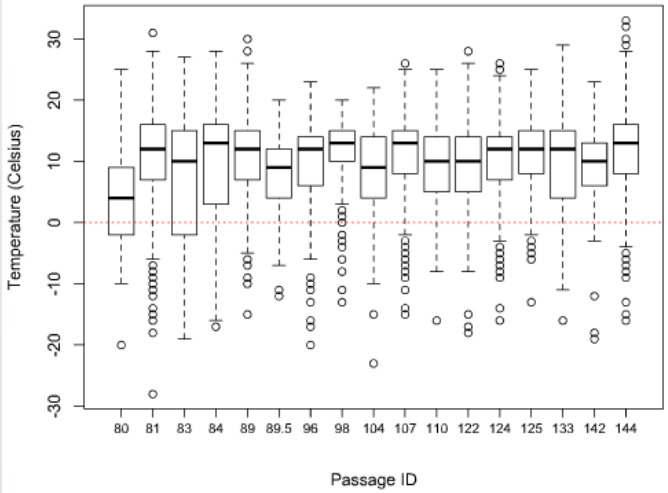
Number of visits per culvert



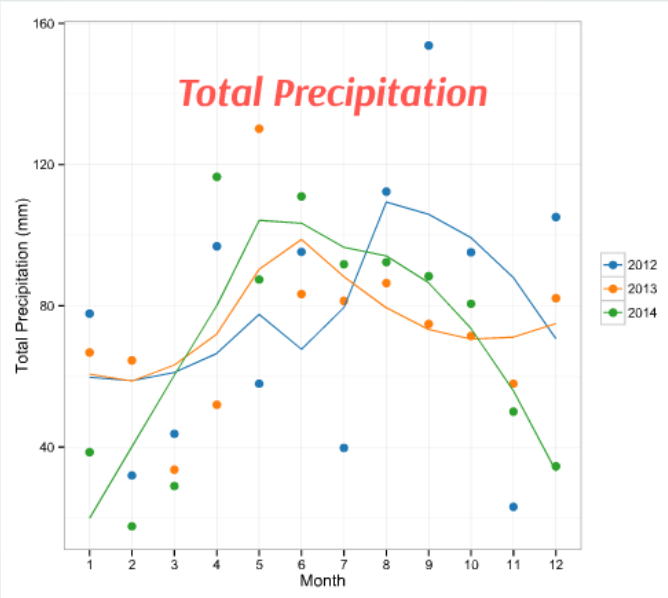
Number of crossings per culvert



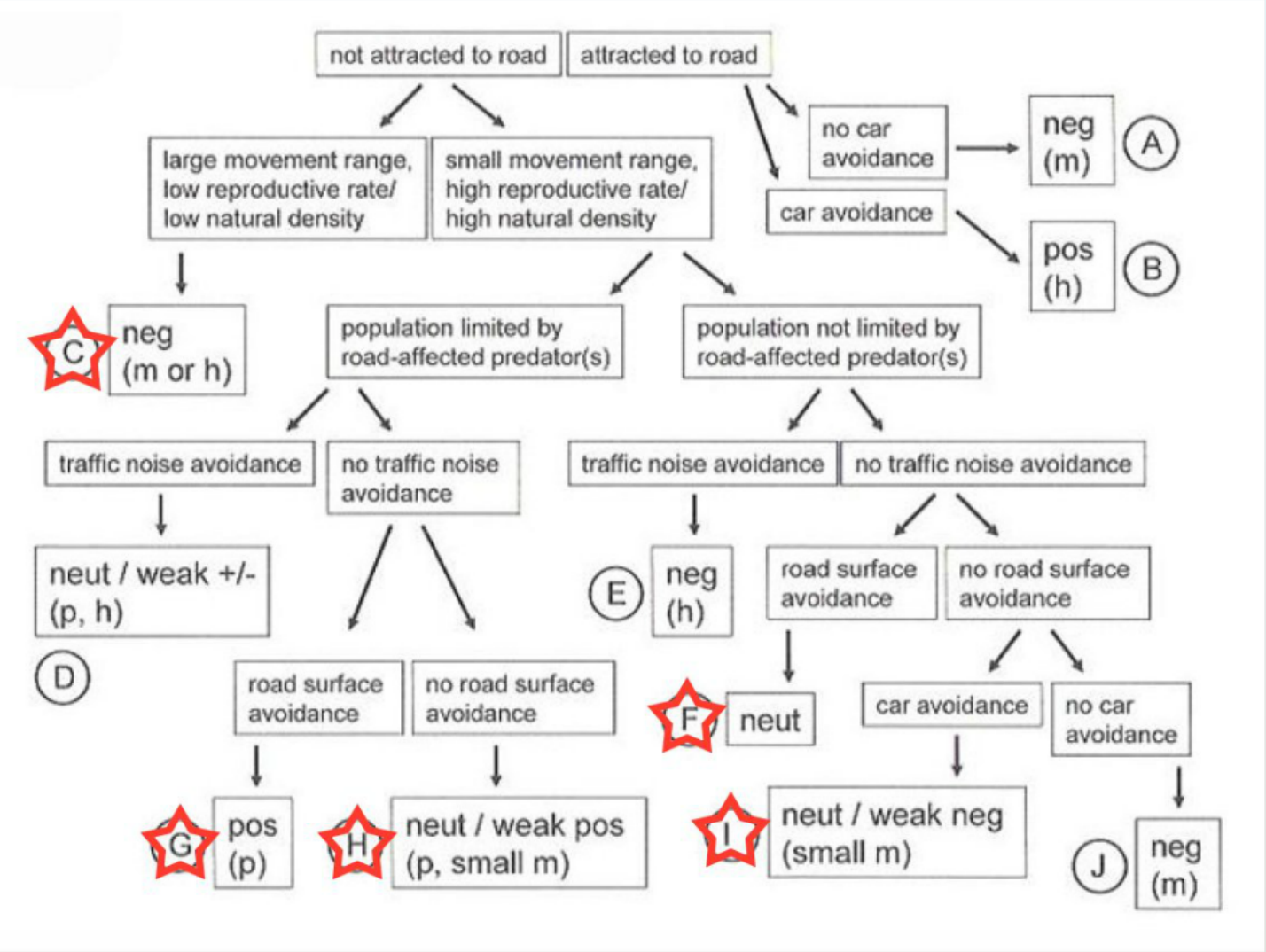
Temperature range per culvert



Total Precipitation

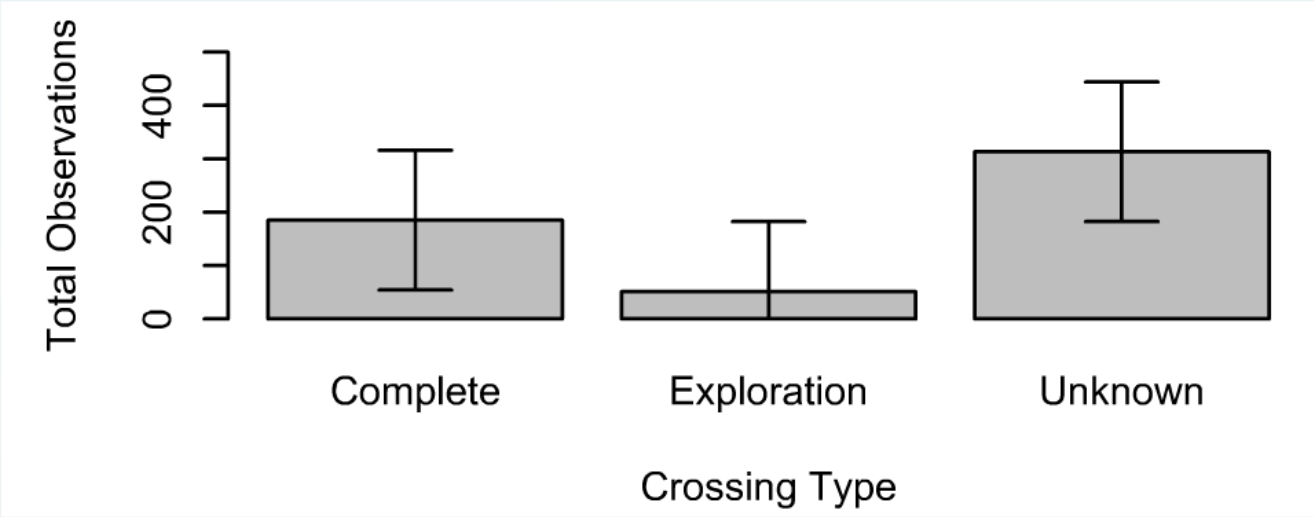


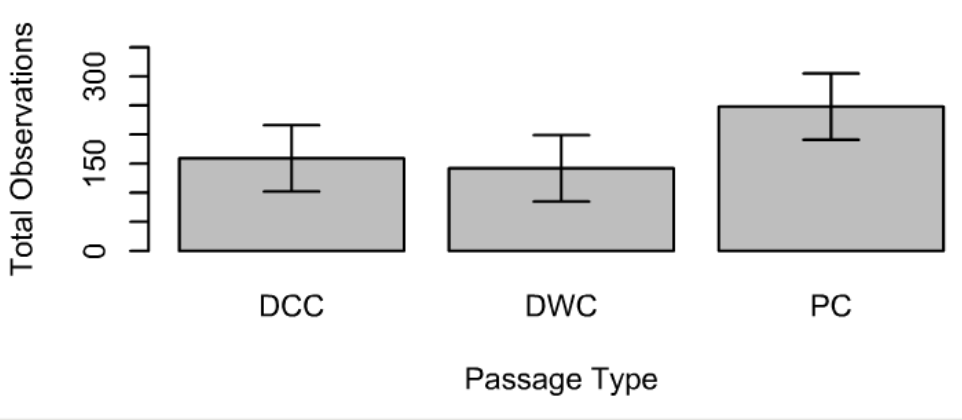
Review: Effects of roads on animal abundance

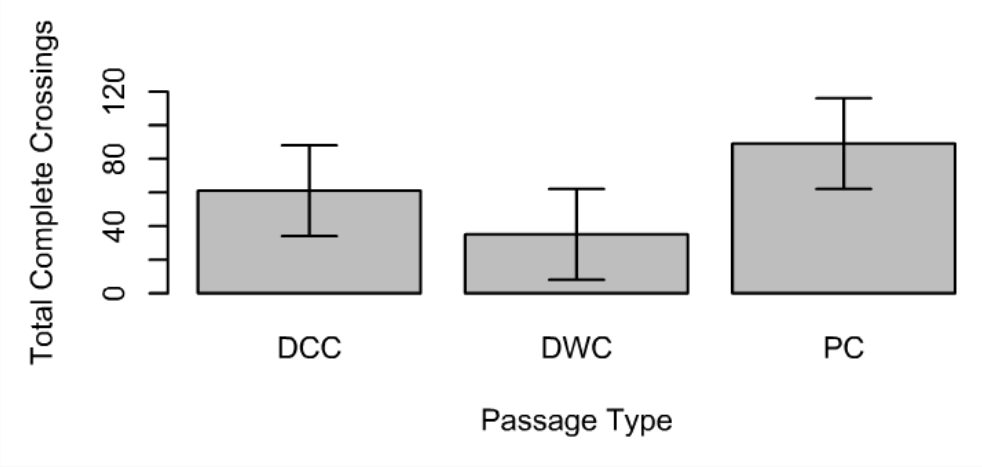


Fahrig & Rytwinski 2009

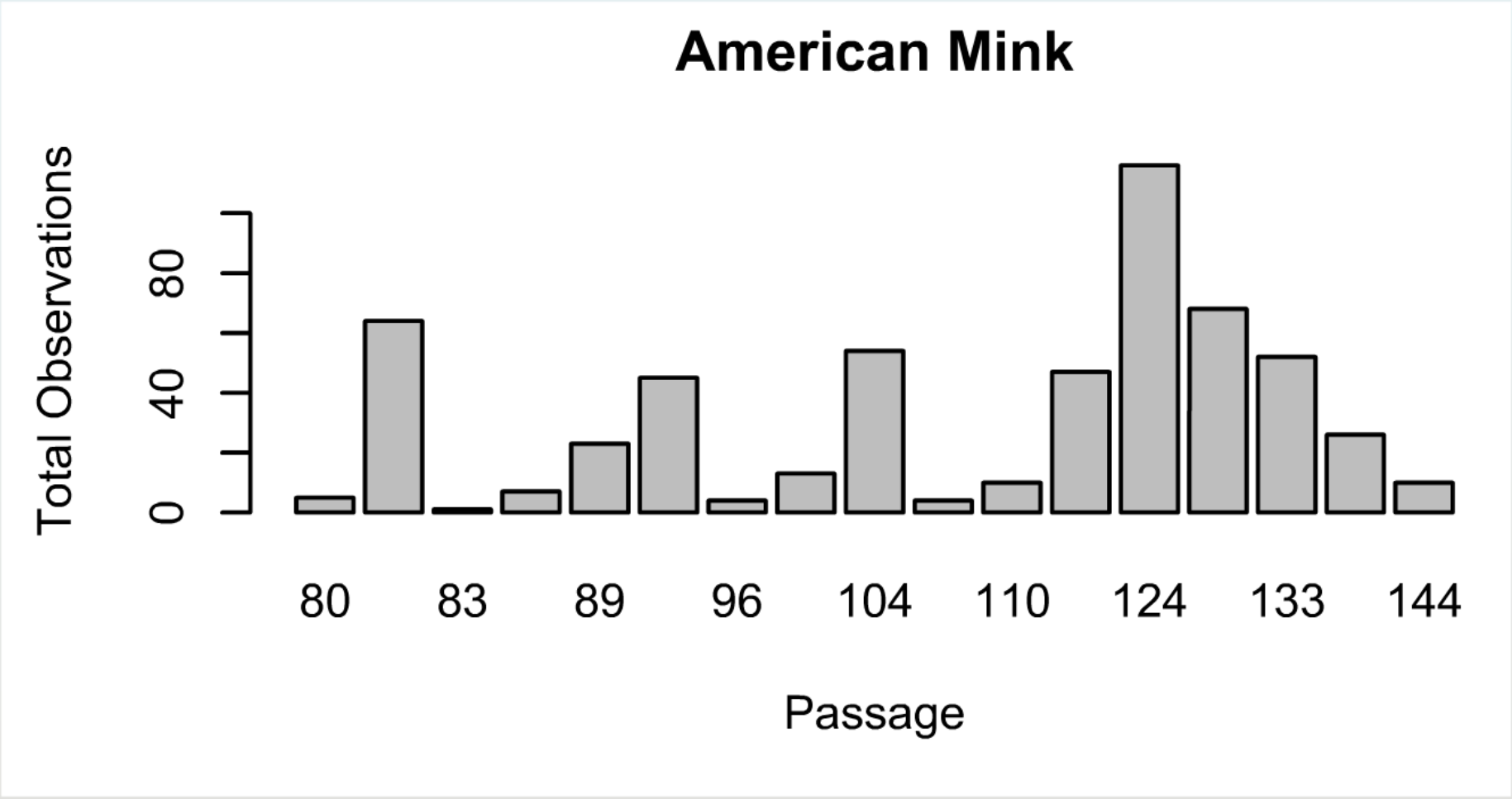
Observations by Passage Type & Crossing Type and Complete Crossings by Passage Type for Mink







Observations by Culvert



Issues with the track data: ***some highlights***

- **track ID uncertainty**: limits precision of results
  - not confident in the classifications for most species or taxonomic groups
  - rodents could include everything from micromammals to chipmunks and squirrels because of overlap in track sizes (of single feet) of the largest micro's (voles/mice) and smallest chipmunks (juveniles)
- **observer effect**: differences in interpretation of tracks between myself, Katrina, and our volunteers
  - observer effect adds (observer=introduced) variability to our already highly variable dataset
- **temporal variability**: making inferences about the whole year from only one season (summer)
  - literature has shown that abundances vary across seasons and years
- **assume tracks = passage use**: cannot assume that a species detected in the forest can use passages.
  - species with small home ranges may not be able to travel from the furthest box to the passage for boxes placed across rivers and >100 m into the forest
- **habitat specialization**: placing boxes only in forest introduced a habitat effect (biases abundances towards primarily terrestrial, forest dwelling species)
  - not preferred habitat for many species present in study area
  - specifically water obligate species (beavers, otters, muskrats, mink) or open habitat users (marmots)
- **site fidelity**: sampling same individual(s) due to site fidelity (nest or territory), thereby inflating abundance estimates during sampling periods if the animal revisits the box over the season
- **oversampling**: species with small home ranges may be oversampled, inflating abundance estimates
- **site fidelity + oversampling = index of activity**: sampling something more akin to an index of activity, rather than abundance index
  - here, activity means animals that only occasionally visited the box would leave fewer tracks than those whose home range are centered on the box
- **box shyness**: differences in behaviour mean not all species are equally inclined to use the boxes (ex. foxes)
- **false negatives**: boxes only detected (at most) 14 taxonomic groups - unable to account for common (marmots, muskrats, mink) and less common species (foxes, beavers, otters)
  - *differences in detection probability reflect our ability to find the species more than its actual abundance and can be attributed to physical, biological, and anthropogenic factors (topography, habituation threshold, home range size, sampling methods, experimental design, technician error, etc.)*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