Wildlife Movement Through Culverts and Bridges in Vermont: Influences of Structure and Site Characteristics

UVM Transportation Research Center
National Wildlife Federation

The Nature Conservancy
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Vermont Chapter

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  - Vermont Agency of Transportation (University of Vermont Transportation Research Center)

Study Design:

- ***<u>Structure-focused</u>*** monitoring with 80 cameras (Reconyx PC 900) at **25 sites**
  - Sites representative of range of structure sizes/types
- Winter tracking

13 “focal” species

- Black bear
- Bobcat
- Coyote
- Deer
- Fisher
- Grey fox
- Moose
- Otter
- Red fox
- Skunk
- “small weasels” (mink, ermine, long tailed weasel)

<u>Also detected:</u>
raccoon, domestic cat, domestic dog, snowshoe hare, muskrat, opossum, porcupine, woodchuck

<u>Birds:</u> grouse, great blue heron, turkey, woodcock, wood duck, mergansers

Phase 1: Spring 2014 – Fall 2016

- Assess wildlife use of transportation structures across various structure sizes/types.
  - “Movement Guild” species groupings (VTRANS BMP manual - Cramer 2011): patterns and structure size/wildlife use relationships?
- Other site/structural factors that might explain variation in site use

Phase 1 take-homes:

- Wildlife use drainage structures to occasionally move under roads
  - However, 11 of 23 “cherry picked” sites were low or zero use.

- Local-scale structural connectivity important (pinched/diffuse vs. discontinuous)

- Structure design attributes probably matter, but few consistent broad patterns detected

- Modified PAS movement guild/size class framework useful for identifying potential species use of the ability of drainage culverts to move wildlife under roadways

Working hypothesis: structure size and width; Wildlife species “movement guilds” (Kintsch and Cramer 2011)

Structures with width >x and <y

Species a, b, c, d

Structures with width >y and <z

Species a, b, c, d, e, f, g

Vermont Species/movement guilds

structure	species	
Small underpass	small weasel, fox, otter, fisher, skunk bobcat, bear, lynx	**< 8 – 10' high**
Medium/Large underpass	small weasel, fox, otter, fisher, skunk bobcat, bear, lynx deer, moose **coyote, catamount, wolf**	**> 8 – 10' high**

“ideal” site characteristics structures from Phase 1 insights:

1. No PAS “fatal flaws”
2. Structural connectivity site characteristics

“Diffuse”

~~“Fragmented”~~

“Pinched”

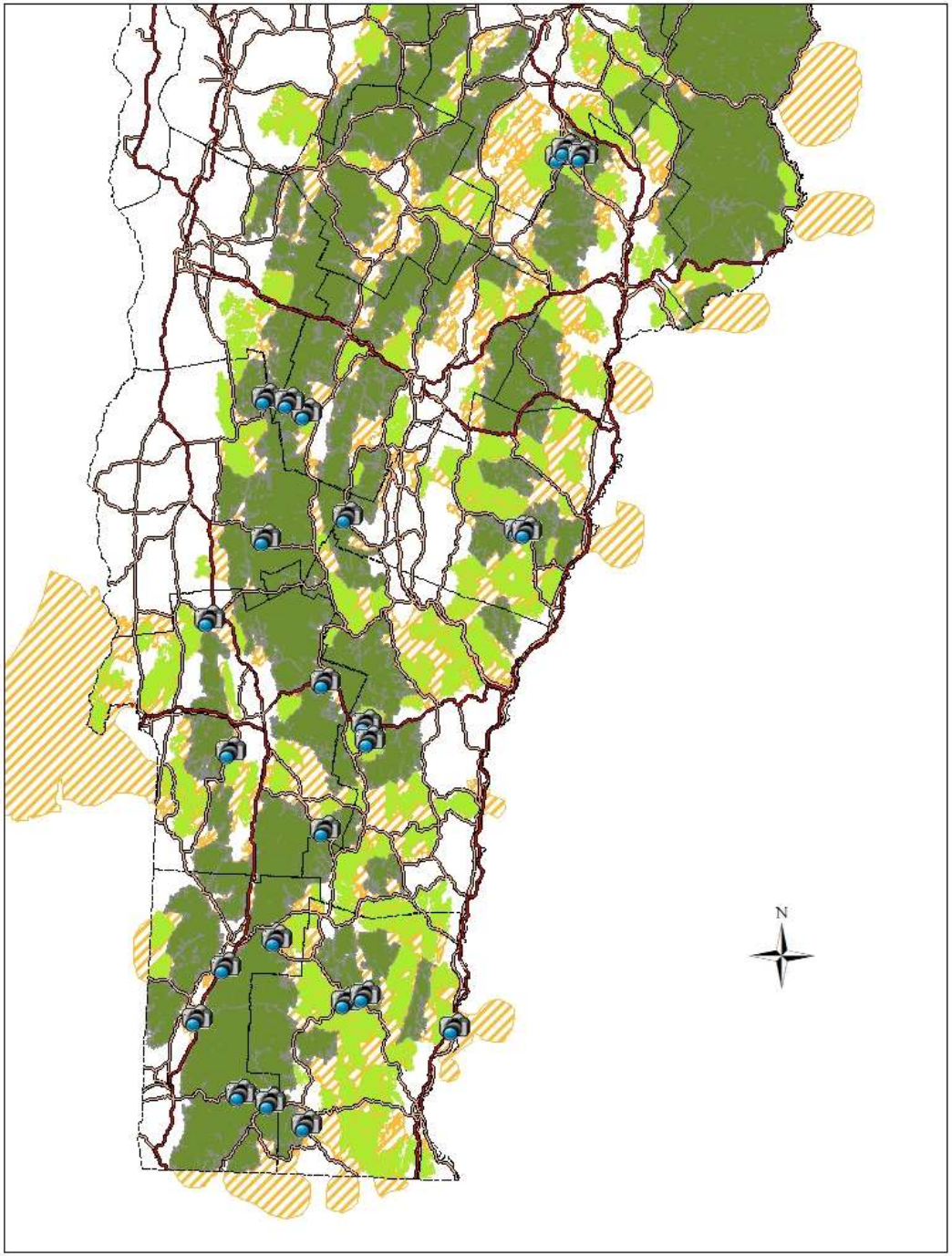
Potentially important structure attributes

- High structure width/bankful width ratio
- “Shelf” (exposed concrete footing)

Phase 2: Assess effects of structural characteristics

- All structures >3’ diameter/height on *state highways and within network of connected lands*
- Use structures that are best suited for wildlife movement
  - Insights on ideal site characteristics from Phase 1
  - ***Identify and represent*** range of different structural characteristics that facilitate wildlife structure use

- Hundreds (> 400) of structures assessed for suitability in December 2016 on state highways



- Spring 2017
- 25 sites
- 19 new sites
  - <u>6 modern post-Irene designs</u>
- 6 established in 2014 for previous phase

Structure design attributes that promote wildlife use:

- contributes or detracts from usable movement surfaces
  - Dry or wet (right-sized structures have more “dry”)
  - Substrate: natural or concrete/metal/riprap

  - “usable movement surface” can be species specific
    - Natural, dry, even, substrate most universally beneficial
    - Dry concrete
    - Dry riprap
    - wet shallow streambed
    - wet sheet flow on flat concrete

Arch Culverts

large underpass	small underpass	Grand Total
1	0	1

Concrete Box Culverts

	Large	Small	Grand Total
"V" bottom	1		1
even streambank	1		1
accumulated debris	3		3
wet flat concrete		2	2

Large = New post-Irene pre-cast boxes

"V" bottom

Small = older box culverts

Pipe culverts

	Large	Small	Total
Round pipe			
round pipebottom	0	5	5
Squash pipe			
flat pipebottom	0	2	2

Spans

	Large
dry streambed	4 (2)
even bank	1
level floodplain	2
riprap bank	3
footing "shelf"	1

New Post-Irene structures (6 of 25)

- In most respects ideal: “built to modern right – sized” stream crossing specifications

- 4 large pre-cast box culverts; 2 spans

- lots of dry room for movement, many have mostly favorable site characteristics for wildlife use

Bridge 100a-8
Plymouth, VT

Construction footprint of temporary bridge

The elusiveness of perfection:

- Searched for best combinations of site characteristics across all design attributes/structure types

- Almost no "ideal" sites/structures exists. Nearly all have at least minor site or structure-related (*sub-fatal*) issues.

  - High human visitation
  - Steep gradient in structure
  - Residences maybe too close
  - Lack of sufficient cover around structure ends
  - > ideal length
  - Stream channel parallel to highway in steep/confined valleys

Results thus far: Focal Species Through - passages

- 19 of 25 sites used

- 4 of 6 post-Irene structures used:
  - Otter (2 sites); fox (1 site); coyote/skunk (1 site)

- 15 of 18 sites with pre-Irene structures have been used.

New pre-cast boxes:

- Interior accumulation of substrate on top of concrete (“rock hop”)

- Large enough to allow for development of “even banks”

Squash pipes

Bears:

- 6 passage events at 5 sites
  - 4 under large spans (4 different sites)
  - 2 under large natural-bottom arch culvert (same site)
  - All “large” structures
  - No or few repeated passages

Bear non-use:

chooses road over squash pipe

4 hours between detections

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2017-08-09 6:30:51 AM M 2/3
50°F
60
RECONYX


2017-07-14 5:30:49 PM M 3/3
68°F
PC900 PROFESSIONAL
RECONYX


2017-12-08 1:39:37 PM M 3/3
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C123
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2017-05-28 7:07:46 PM M 1/3
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C73
RECONYX

Plenty of weasels in pipes

Anticipated conclusions:

- Design features that maximize availability of dry "natural" movement surfaces in structures
  - Dry streambeds and even banks (right sized structure)
  - Grubbing over riprap banks (bridge spans)
- Flat concrete bottom box culverts don't perform well (best for weasels but bobcats prefer pipes)
- Replacements that use temporary bridges degrade site usefulness (large construction footprint)
  - Consider site restoration plantings

Anticipated conclusions (2)

- “ideal” settings on busy corridors where enhancement work can entirely be focused on structure modification/ replacement appear to be rare.

- Site restoration/protection work will be needed to increase wildlife permeability across problematic road corridors (network of connected lands)

Next steps:

- Effects of human visitation frequency? Invasive species?
- GIS Terrestrial passage screening tool to prioritize transportation structures for conservation investments related to wildlife passage.


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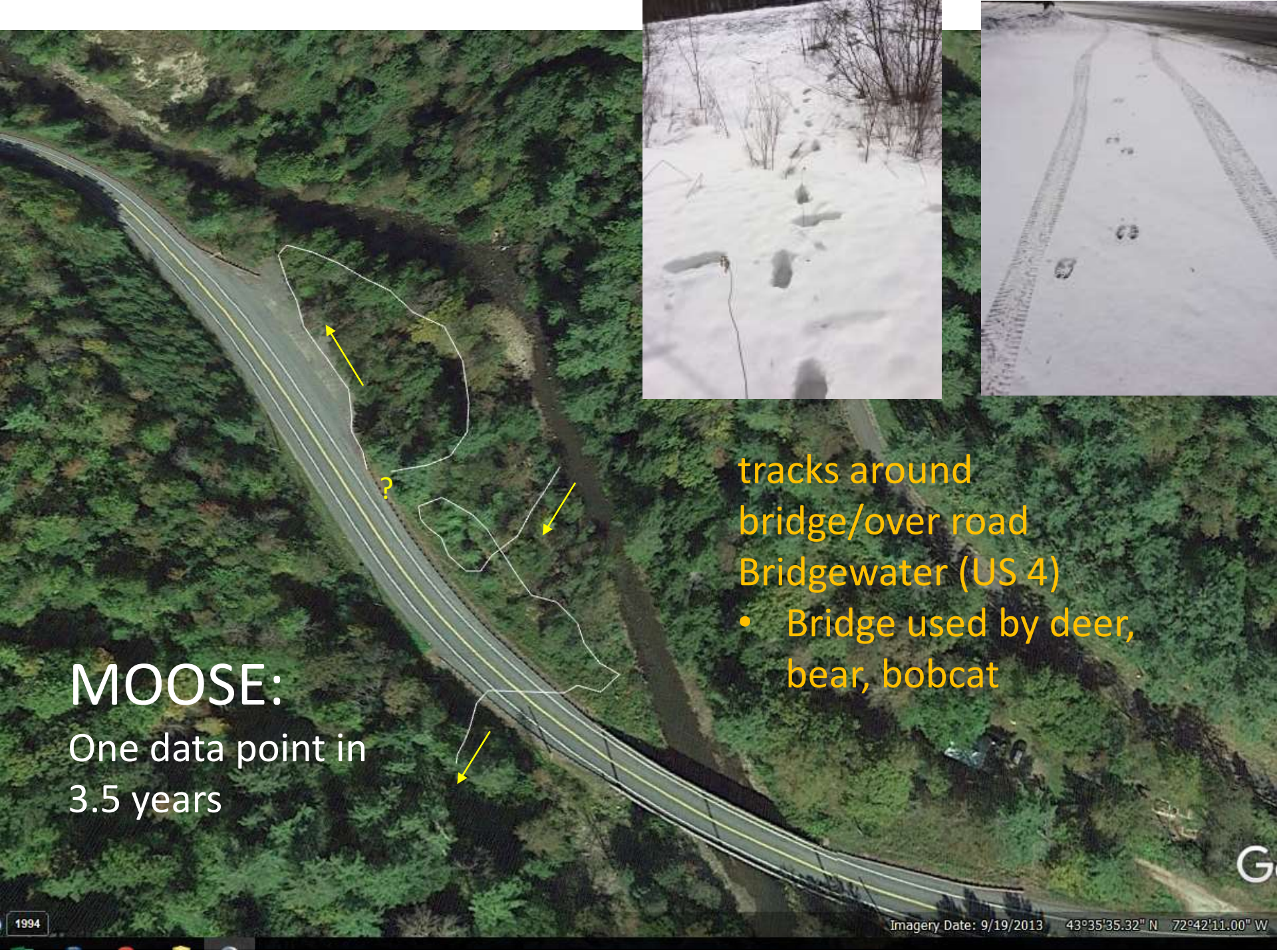

MOOSE:

One data point in 3.5 years

tracks around bridge/over road Bridgewater (US 4)

- Bridge used by deer, bear, bobcat


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Project amplification/publicity

Wildlife crossing enhancement need assessment

1. Road corridors where connectivity is important

2. ID presently suitable existing structures based on understanding of ideal site and structure characteristics

3. ID Structure enhancement opportunities
   i. Structures not suitable but good site characteristics

4. Structure-centered site restoration opportunities
   i. Structures suitable but site restoration needed

Prioritize road corridors

Example of possible Tier 1 list:
US 7 Brandon/Pittsford
US 7 Manchester/Dorset/Sunderland
US 4 Ira/Hubbardton
US 4 Killington/Mendon/Bridgewater
22a West Haven
I89/US 2 Bolton/Waterbury
VT 15 Morrisville/Wolcott/Hardwick
VT 15 Johnson/Cambridge
US 2 Cabot/Marshfield
VT 103 Shrewsbury/Mt Holly
VT 9 Searsburg/Woodford

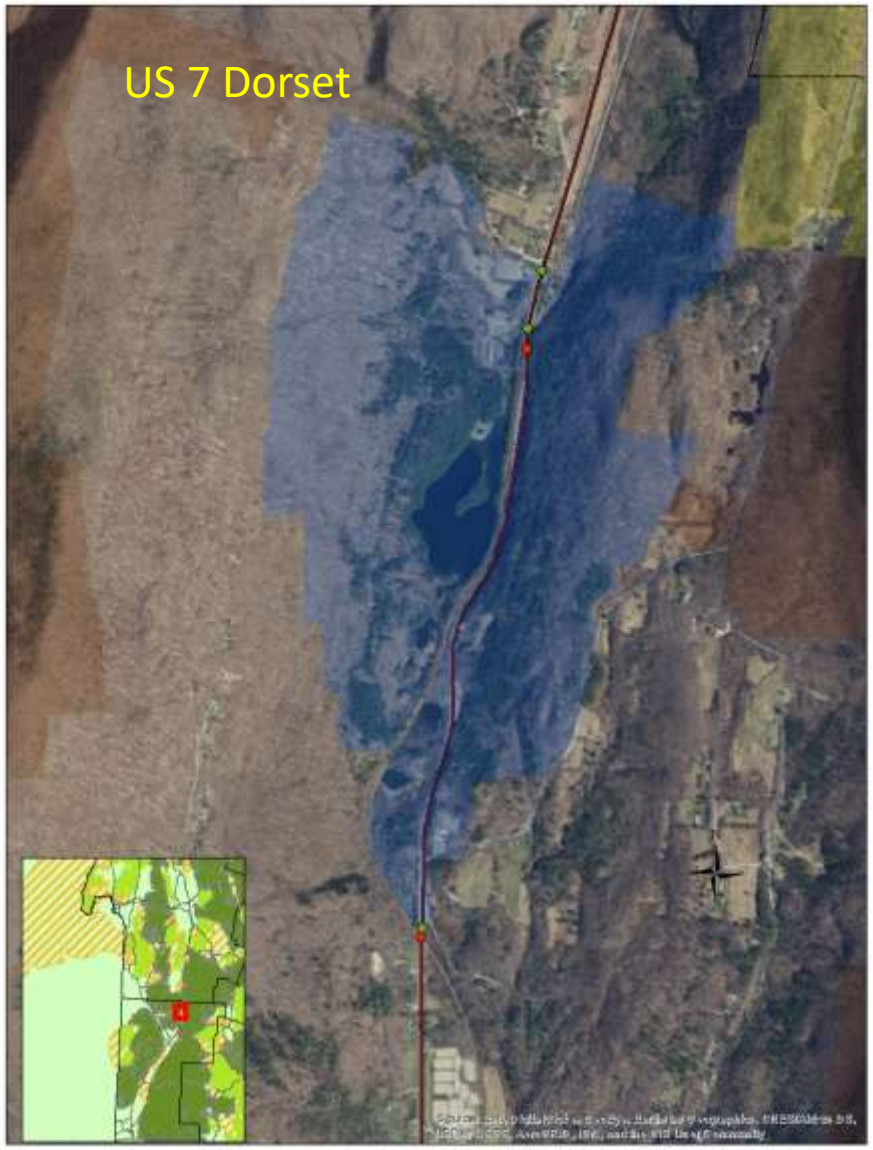
Prioritize road corridors:
Tier 1
Tier 2
Tier 3

Framework:

- List of existing (potentially) high-use structures based on camera research conclusions
- Identify structure replacement-oriented opportunities
- Identify site restoration need-oriented opportunities
- Identify structure replacement and site restoration-oriented opportunities

Deer using a secondary movement surface VT 113 Vershire

Examples:



US 4 Ira/Hubbardton opportunities:

Bobcat I91 slideshow

Project schedule

- End data collection in December 2018.
- Winter tracking underway – no results yet.
- Analyze data and prepare report for May 2019.
- Project publicity/amplification

Coyote repel large span VT 133 Ira

Concrete baffles in high-gradient boxes

30-22 West Townshend:

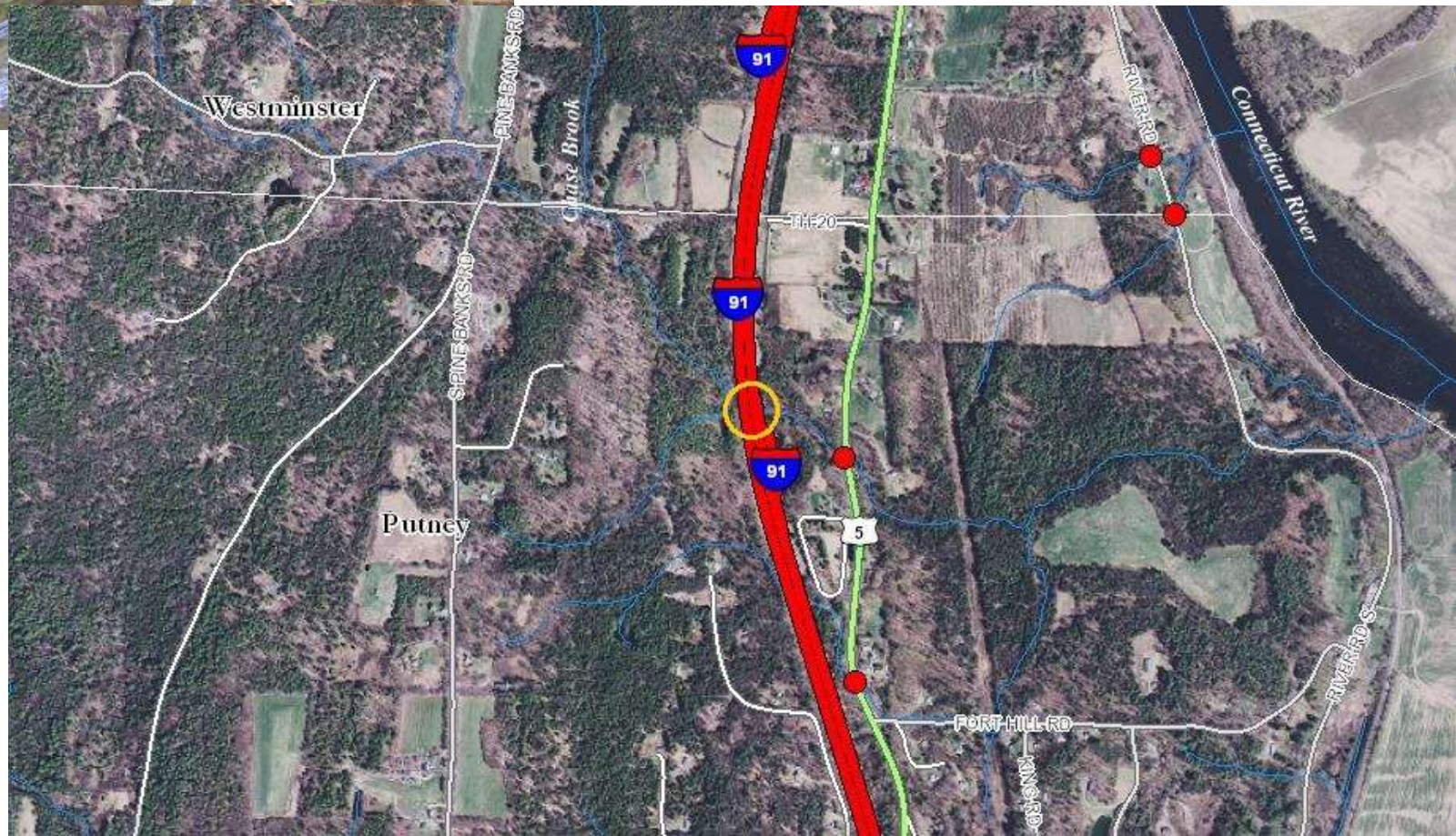
Pinched structural connectivity;
under lots of road fill;
no houses nearby;
downstream west river flood control lands

VT 113 Vershire – rare coyote passage event

I 91 – Putney: Rare "V" bottomed box culvert

- Interstate exclusion fencing funnels to culvert
- Poor downstream landscape context
- Too long (298 ft) for deer? Multiple detections/approaches, no passages

Site Landscape context fragmented; impassable downstream culvert



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Project analysis

- Effects of structure characteristics
  - 12 categories of structures over 25 sites – too many
  - Some categories will be under-represented in the dataset because few suitable structures exist
- Which structure characteristics benefit the most species (within structure size classes)?
- Use existing Movement Guild framework to refine relationships between species and size classes
- Temporal variance of use at 4 sites with 4.5 years of monitoring data (Spring 2014 – end of 2018)