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TRANSPORTATION RESEARCH BOARD

Road Passages and Barriers for Small Terrestrial Wildlife

August 12, 2021

@NASEMTRB
#TRBwebinar

PDH Certification Information:

- 1.5 Professional Development Hour (PDH) – see follow-up email for instructions
- You must attend the entire webinar to be eligible to receive PDH credits
- Questions? Contact TRBWebinars@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

REGISTERED CONTINUING EDUCATION PROGRAM

#TRBwebinar

Learning Objective

Identify successful implementations of road passages and barriers to prevent impeding wildlife

This webinar

1. TRB synthesis Small Terrestrial Wildlife

Marcel Huijser, *Western Transportation Institute – Montana State University*

2. Case study turtles Ontario

Kari Gunson, *Eco-Kare International*

3. Experiments and case study Yosemite toad

Cheryl Brehme, *United States Geological Survey*

4. Q&A session

Facilitated by Kris Gade *Arizona DOT*

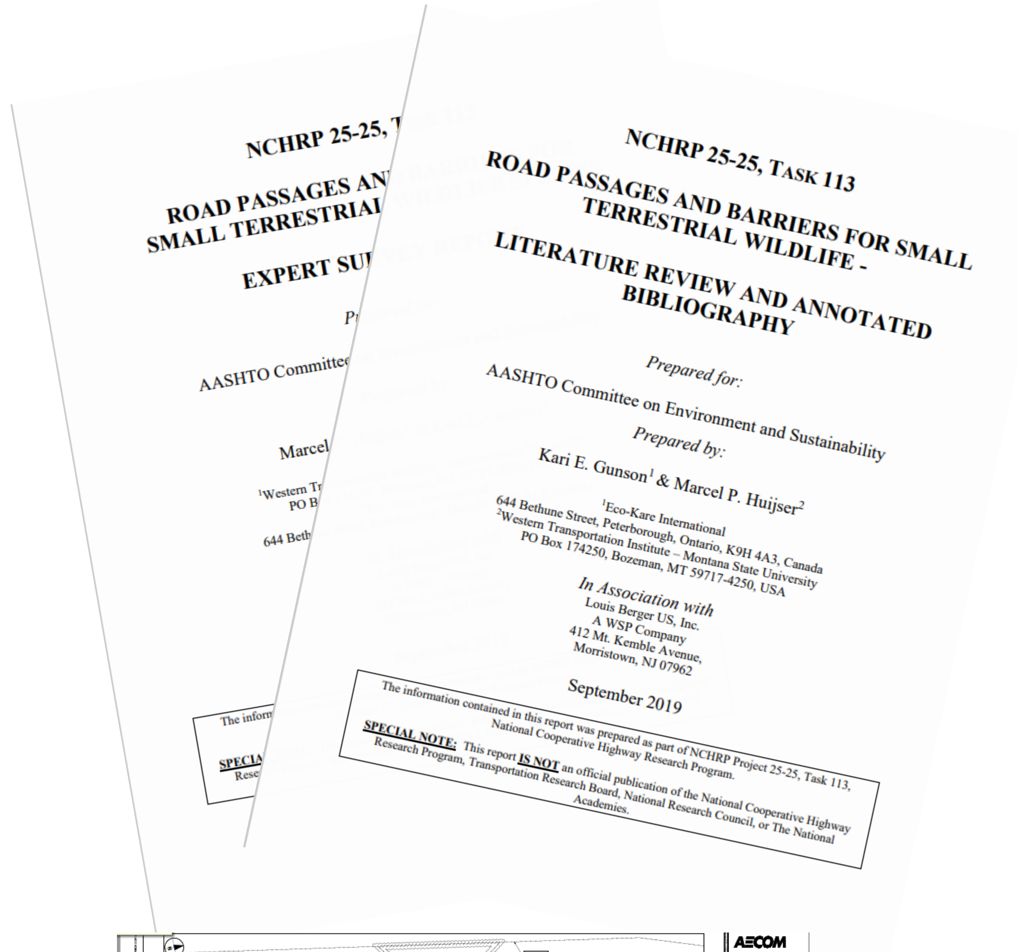
Marcel Huijser

TRB SYNTHESIS 2019

Small, terrestrial species

Reports

- Literature review
- Expert survey
- Considerations
- Case studies
- Summary report



NCHRP 25-25, TASK 113

ROAD PASSAGES AND BARRIERS FOR SMALL TERRESTRIAL WILDLIFE - LITERATURE REVIEW AND ANNOTATED BIBLIOGRAPHY

Prepared for:

AASHTO Committee on Environment and Sustainability

Prepared by:

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September 2019

The information contained in this report was prepared as part of NCHRP Project 25-25, Task 113, National Cooperative Highway Research Program.

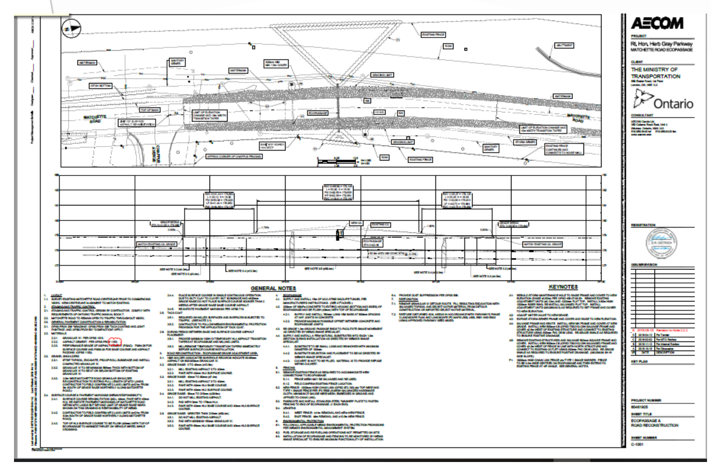
SPECIAL NOTE: This report **IS NOT** an official publication of the National Cooperative Highway Research Program, Transportation Research Board, National Research Council, or The National Academies.

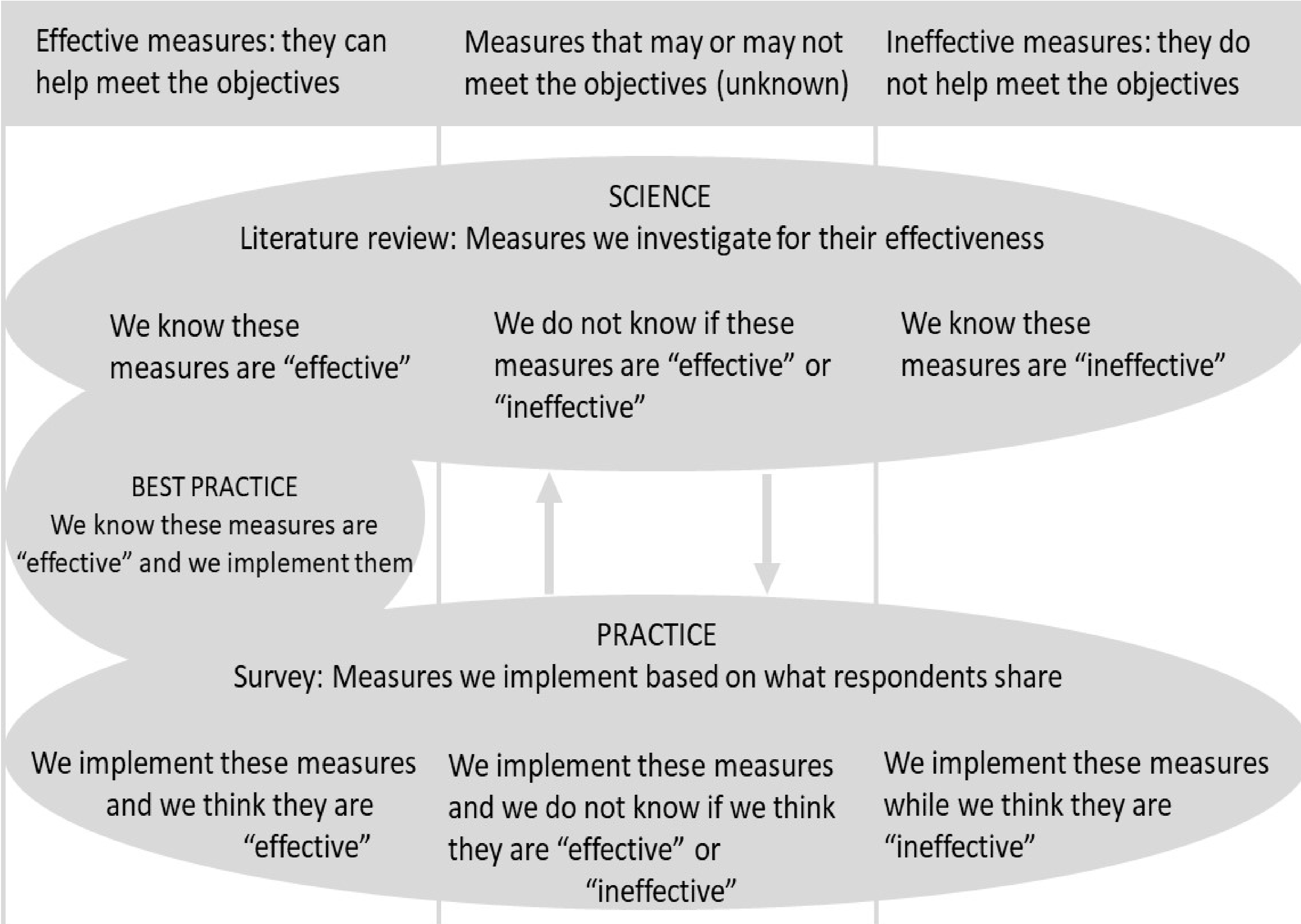
Repository

Web-based

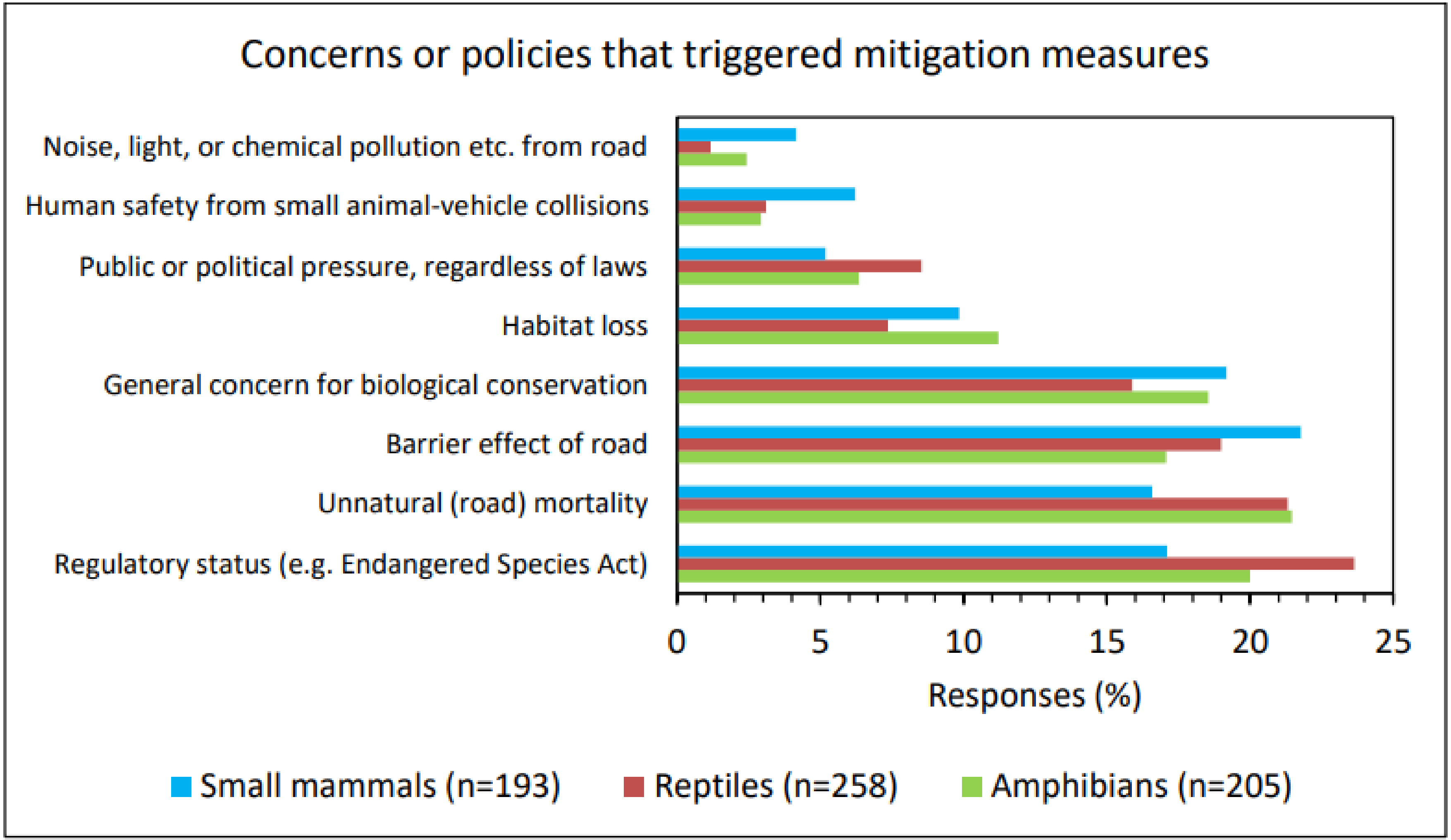
Technical drawings

Photos



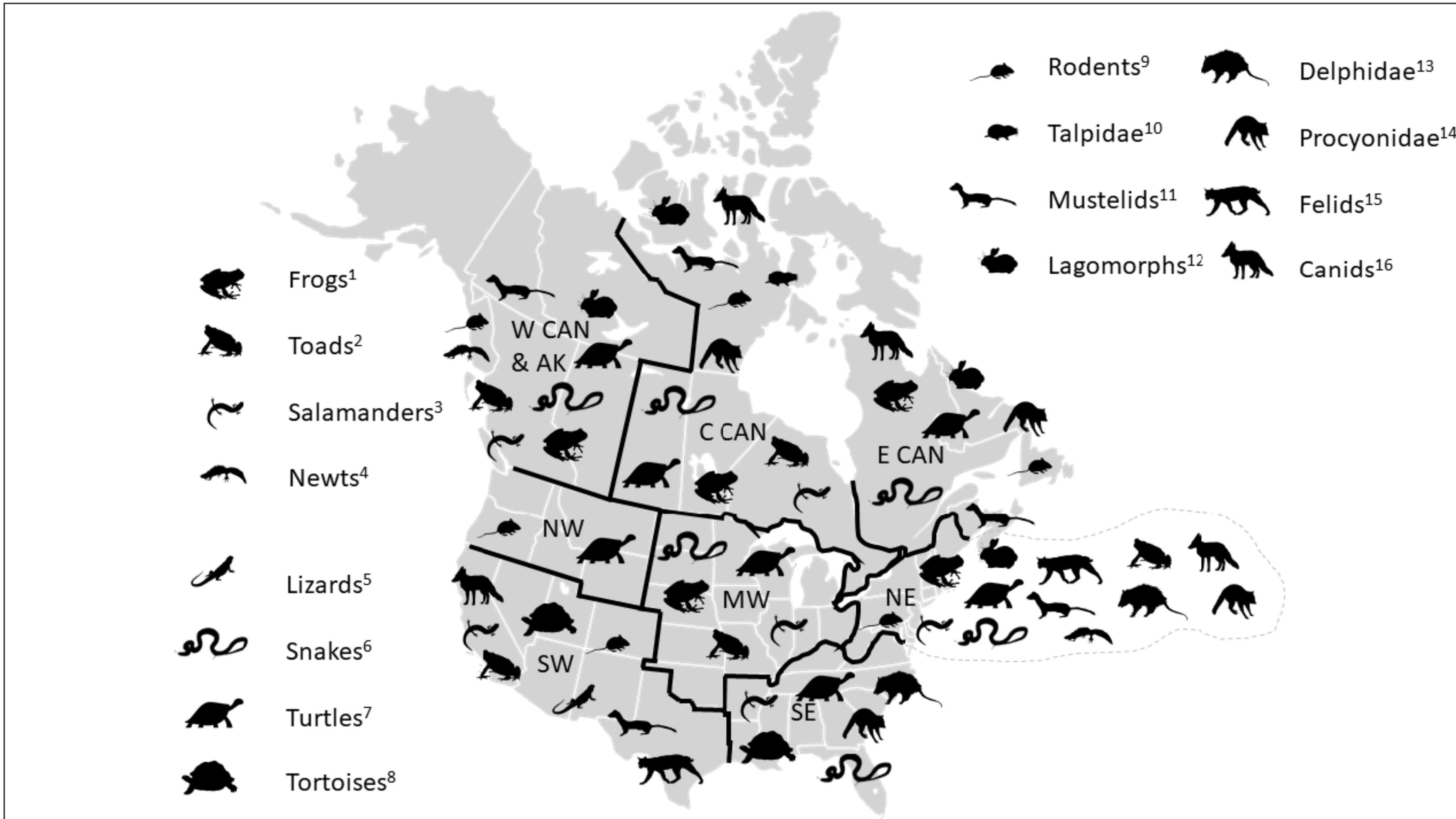

Effective measures: they can help meet the objectives
Measures that may or may not meet the objectives (unknown)
Ineffective measures: they do not help meet the objectives
SCIENCE
Literature review: Measures we investigate for their effectiveness
We know these measures are “effective”
We do not know if these measures are “effective” or “ineffective”
We know these measures are “ineffective”
BEST PRACTICE
We know these measures are “effective” and we implement them
PRACTICE
Survey: Measures we implement based on what respondents share
We implement these measures and we think they are “effective”
We implement these measures and we do not know if we think they are “effective” or “ineffective”
We implement these measures while we think they are “ineffective”

Survey



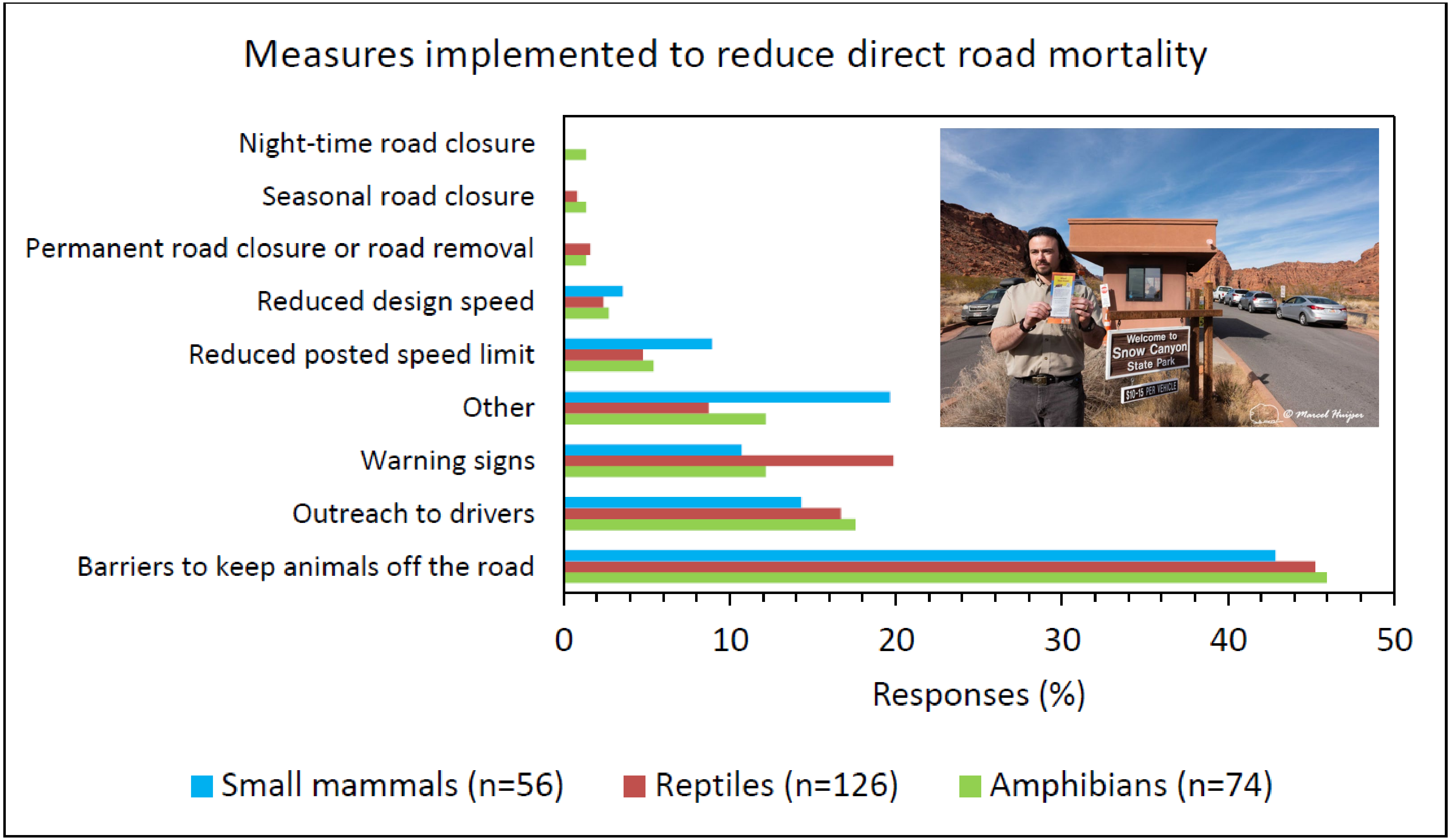
Concerns or policies that triggered mitigation measures
Noise, light, or chemical pollution etc. from road
Human safety from small animal-vehicle collisions
Public or political pressure, regardless of laws
Habitat loss
General concern for biological conservation
Barrier effect of road
Unnatural (road) mortality
Regulatory status (e.g. Endangered Species Act)
0
5
10
15
20
25
Responses (%)
Small mammals (n=193)
Reptiles (n=258)
Amphibians (n=205)

Survey:
Mitigation measures for species groups



Note: Superscripts indicate credit statements for animal icons; see speaker notes and Expert Survey Report.

Survey: road mortality



Barriers

Chain link

Mesh

- Plastic
- (Hard-ware cloth/Wire)

Concrete wall

Plastic (HDPE, PVC, recycled)

Wood

Chris Slesar, Monkton Cons. Com.

Concrete wall

Jochen Jaeger, Concordia University

Chain-link fence

Ausable Bayfield Conservation Authority

Plastic attached to guard-rail

Kari Gunson

Kari Gunson

Mesh Hardware cloth (wire) with steel frame (left); wood frame (right)

Considerations: Successful barriers

Design stage

Target species

Height: 25-100 cm

Buried into soil

Large mammals

Turtles

Medium mammals

Amphibians, reptiles, small mammals

Tortoises

Considerations: Successful barriers

Design stage
Landscape aesthetics

Biology / Characteristics

Climbing species

- Use top lip or solid barrier

Slender species, e.g., snakes

- Use solid barrier

Burrowing species,
e.g., cray fish and small mammals

- Buried barrier

Chain-link fence with top lip

Snapping turtle climbing

Eastern garter snake poking

Considerations: Successful barriers

Design stage

Variable terrain conditions

Desert wash

High water level

Rocky soil

Considerations: Successful barriers

Design stage

Durable
Long life span
Low maintenance

Considerations: Successful barriers

Installed correctly
- Mortality hotspot
- Buffer zone
- Combined with structures
- Connect to structures (no gaps)
- Buried into soil

Maintained
- Erosion
- Vegetation

Fence-end treatments

- Hotspot and adjacent buffers
- Habitat or topography (top)
- Angle fence away from road
- Include electro-mat or wildlife guard (bottom)

Fence-end tie-in with cliff face

Angle fence

Texas gate

- Access roads and trails

Right: A pedestrian gate with a "flap" to keep amphibians, mostly the common toad (*Bufo bufo*), out of the road corridor

Left: A wildlife guard at a low volume dirt access road

Right: A wildlife guard at a bicycle path to keep amphibians, mostly the common toad (*Bufo bufo*), out of the road corridor

▪ Escape opportunities

- Jump-out for turtles and escape ramp allow animals to move from road-side to safe-side

Marcel Huijser

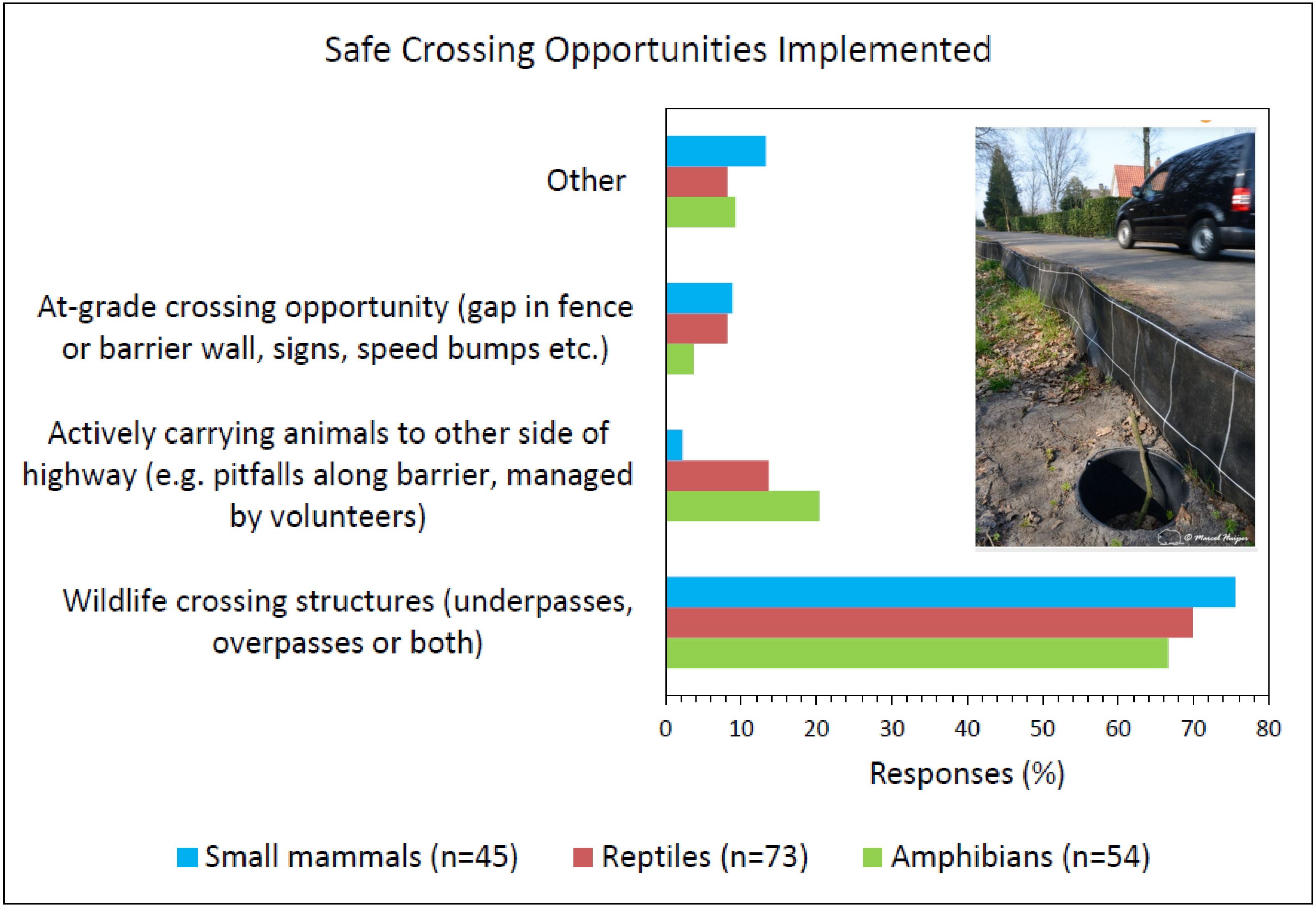
Kari Gunson

- A one-way gate for Eurasian badgers and below-grade installation allow animal to escape along its length

Considerations: Successful barriers

Monitored for effectiveness
in reducing direct road mortality

Survey



Note that a respondent could list multiple measures for each species group.

Designated Crossing Structures

- Sufficient number, spacing
- Location **improved connectivity**
- **… the greatest benefit for survival of the population**
- Adjacent habitat

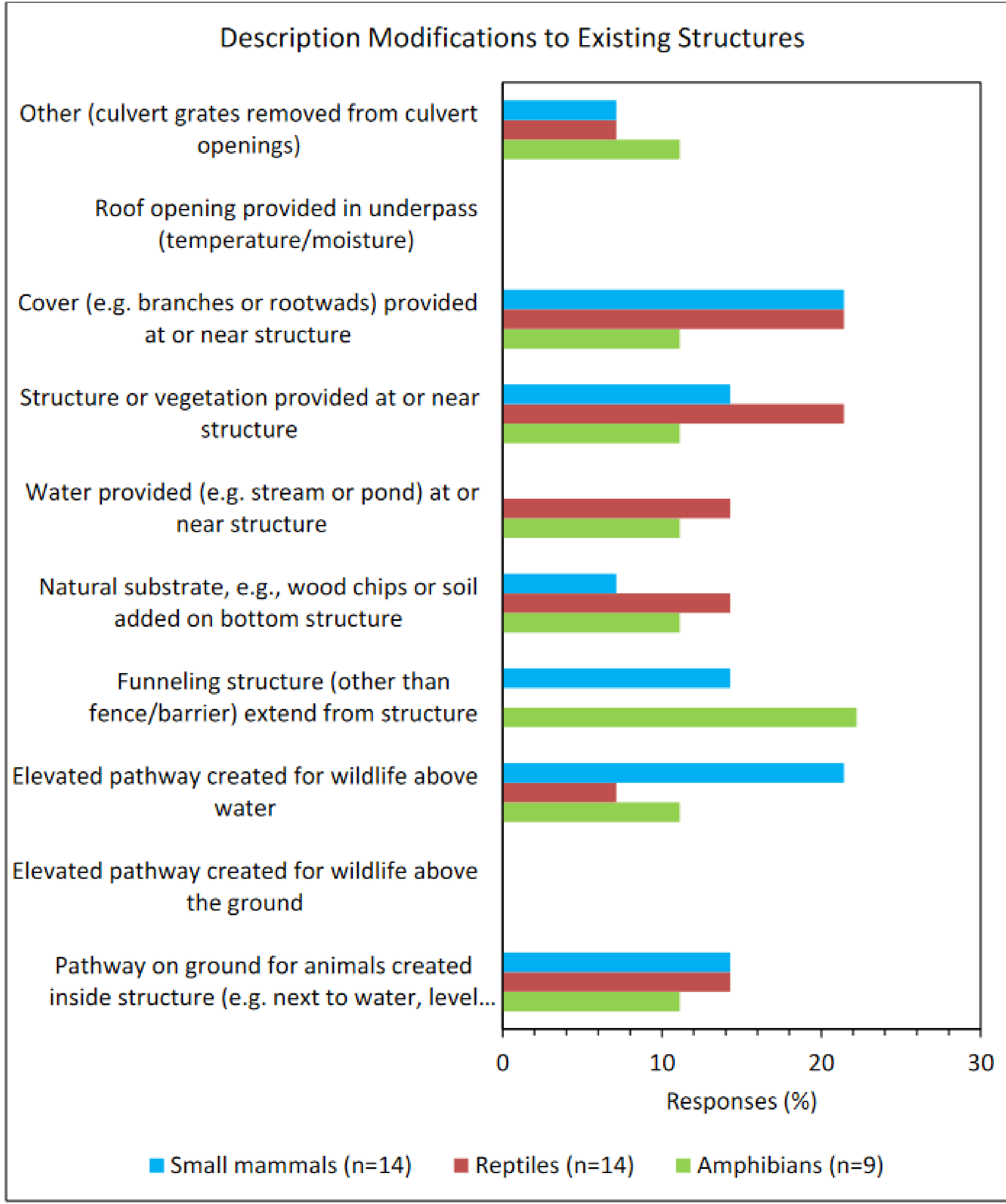
- Structure type, dimensions
- Connected to fences/barriers

Survey: Modified structures

Cover

Soil, water

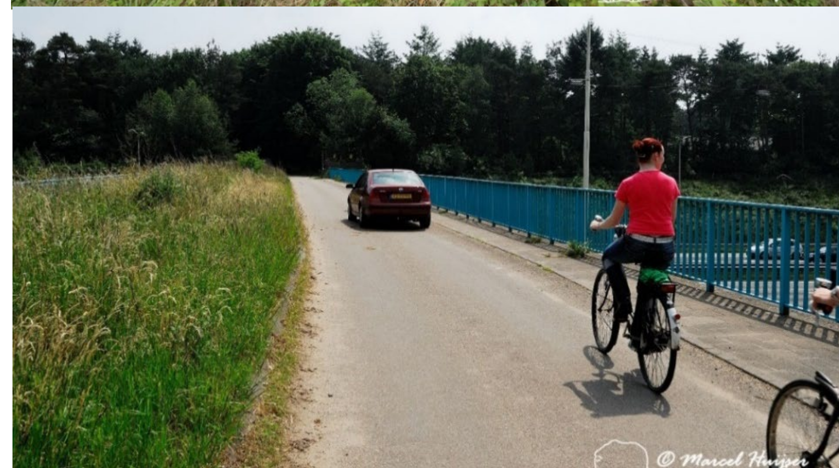
Pathways



OVERPASSES

Types

- Designated for wildlife
- Non-designated, modified for wildlife
- Combined designated and non-designated (e.g., recreational)



Ministry of Transportation Ontario,
Wood Environment & Infrastructure Solutions

LARGE UNDERPASSES

(>3 m)

Types

- Designated for wildlife
- Non-designated, modified for wildlife
- Combined designated and non-designated (e.g., hydrology)

SMALL UNDERPASSES (≤3 m)

Types

- Designated and non-designated for wildlife
- Box or round
- Corrugated steel, cement, or plastic pipe arch

Parks Canada Agency

Box culverts for snakes and turtles.

Jochen Jaeger

Round pipe culvert top left with drainage culvert

Kari Gunson

Non-designated round CSP culvert

Co-use by wildlife

- Physical access
- Pathways

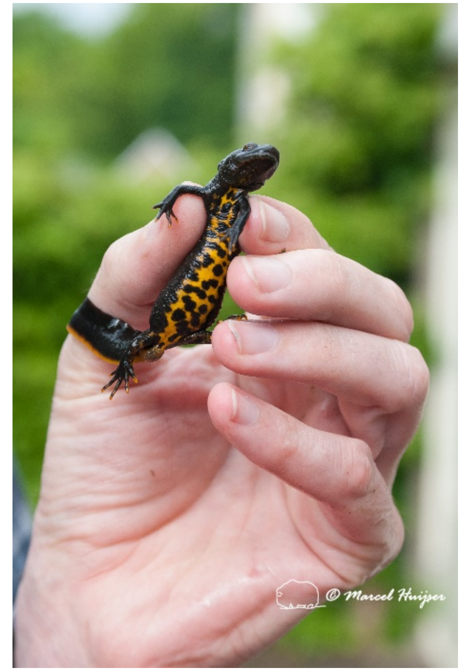
Photo credit: Peter Leete, DNR–MnDOT liaison

Ambition Level

Cover
Food
Water

No habitat | Some habitat | Full habitat

CASE STUDY: "GROENE WOULD" OVERPASS, NETHERLANDS



- Capture-mark-recapture (belly pattern)
- Three seasons
- Wooden plates in dry and wet zones
- 6 amphibian species, 2,706 observations, 44 great-crested newt, 2 individual newts captured on both sides
- Demonstration of newts using the overpass as habitat

CASE STUDY: DESIGNATED UNDERPASSES FOR SNAKES

- Rattlesnakes have used structures with dry substrate.
- Colley et al. (2017) showed open-grate, open-top crossings used by 14 Massasauga rattlesnakes
  - Temperature was important
- Preference is for structure that maintains appropriate thermal environment for target species
  - Open-grate tunnels

Kari Gunson

Top: Massasauga rattlesnake travelling through 1.2-m dry-pipe culvert

Kari Gunson

Bottom: Open-grate and open-bottom underpass, Killbear Provincial Park, Ontario

Challenges

Barriers

Robust designs
Installation (oversight in field)
Innovative designs, reduced costs
Effectiveness studies
Effectiveness jump-outs or escape ramps

Crossing structures

Formulate objectives
Measure effectiveness (not only use), study design
Experimental approach dimensions, design characteristics

Thank you!

Marcel Huijser
Kari Gunson

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NCHRP 25-25/Task 113 [Final]

Road Passages and Barriers for Small Terrestrial Wildlife: Summary and Repository of Design Examples
[NCHRP 25-25 (Research for the AASHTO Committee on Environment and Sustainability)]

Project Data	
Funds:	$125,000
Research Agency:	Louis Berger U.S. Inc./Western Transporation Institute/Eco-Kare International
Principal Investigator:	Dr. Marcel Huijser and Kari Gunson
Effective Date:	3/20/2018
Completion Date:	9/19/2019

STATUS: Research is complete. A brief summary report is available HERE (.pdf; 495 KB). Presentation slides summarizing the project are available HERE (pptx; 43 MB).

The repository of design examples is available for download HERE (.zip, 528 MB; includes repository materials, a spreadsheet index to the repository, and information on how to access repository material; please note this is a large file and will take some time to download).

A series of illustrated case studies is available HERE (.zip, 6.2 MB).

Design considerations for 6 categories of crossings and barriers are available HERE (.zip, 9.1 MB).

A literature review and summary of a expert survey are available HERE (.zip, 4.8 MB)

BACKGROUND:

Since the Nutty Narrows squirrel bridge was constructed in Longview, Washington in 1963, a wide range of projects have been implemented by state DOTs, local governments, and non-governmental organizations to remedy situations with high levels of road-related mortality for smaller wildlife, reptiles and amphibians. These projects include incorporation of measures into new roads, retrofits of existing infrastructure, and addition of infrastructure specifically for wildlife use. Many of these projects have also implemented post-construction monitoring to evaluate effectiveness. However, many of these projects are not known beyond the local area or state where they were constructed. As a result, the designs and lessons learned from their implementation are not available to inform current projects.

An overview of reptile use of crossing structures in Ontario

As part of work completed by principal investigators Dr. Marcel Huijser & Kari Gunson in Association with Louis Berger. Funded by the National Cooperative Highway Research Program in 2019
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4337

Presented, compiled and updated by: **Kari E. Gunson**

12-Aug-2021 Transportation Research Board

Objectives

- Summarize the existing current state of practice
- Review recently published monitoring studies in Ontario, Canada)
- What we know and what we don't know

Small underpass structures (≤3 m)

- Designated and non-designated for wildlife
- Shape
  - Box or round
  - Arch
- Material
  - Steel, cement, or HDPE plastic

Parks Canada Agency

Round pipe culvert top left with drainage culvert (Jochen Jaeger)

Non-designated round CSP culvert t (Kari Gunson)

Considerations

- Wing walls
- Substrate added or natural bottom (next slide)
- Maximize openness;
  - Open medians
  - Skylights
  - Open grates (next slide)
  - Oversize and reduce length

Chris Slesar

Utah Dept. of Transportation

Wing walls used for reinforcement work well for wildlife (K. Gunson)

Substrate scooped into culvert (B. Beasley)

Open-top;

- Grates or open slots
- Installed for amphibians in England and Ontario
- Installed for turtles in Ontario
- Low volume roads

Open-bottom;

- Footings used for arch
- Ideal for maintaining stream habitats
- If not possible, substrate added or bottom buried

Snapping turtle exiting open-top tunnel in Ontario, Long Point Biosphere Reserve

Jarvis LE, Hartup M, Petrovan SO. 2019. Road mitigation using tunnels and fences promotes site connectivity and population expansion for a protected amphibian. European Journal of Wildlife Research **65**:27.

Colley M, Lougheed SC, Otterbeing K, Litzgus J. 2017. Mitigation reduces road mortality of a threatened rattlesnake. Wildlife Research.

Existing drainage culverts for turtle passage

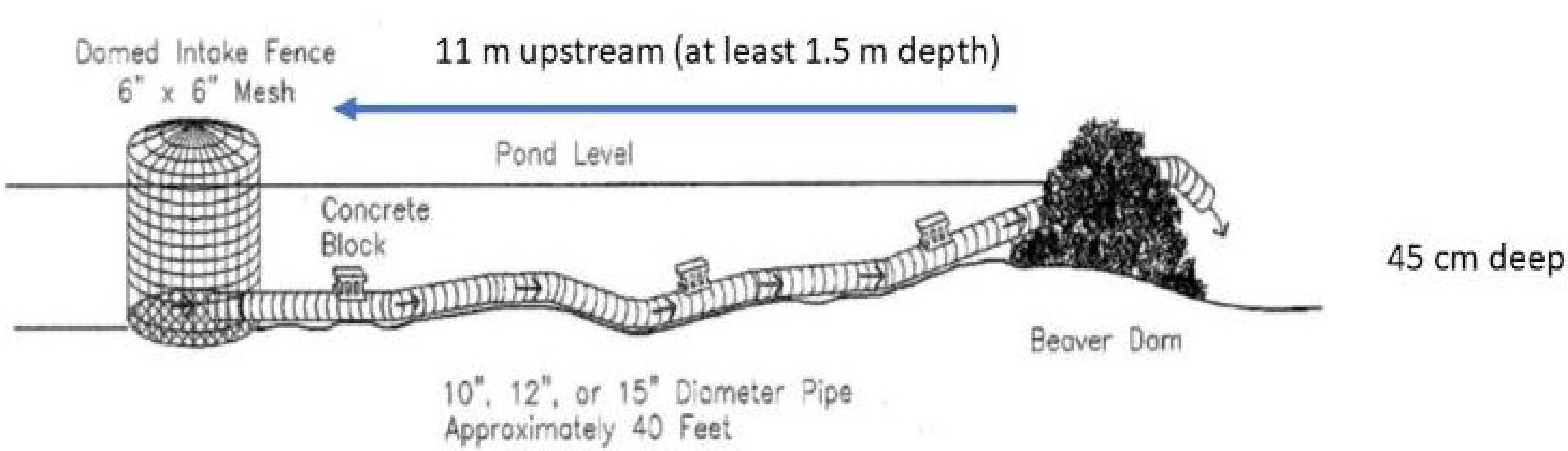
- Existing drainage culvert (< 3m) are
  Found along roads
  often in wetlands
- Require exclusion fencing and guide-walls to be effective
- Culverts can be submerged or not submerged
- Culverts with light may be more attractive

Existing drainage culvert used by freshwater turtles Photo Credit: Ausable Bayfield Conservation Authority

Beaver considerations

- Beaver screens / grates do not allow passage
- Use pond levelers in dams to keep water levels at desirable level and beavers are happy

Beaver screen on existing drainage culvert, Ausable Bayfield Conservation Authority



Leveler pipe can be installed in nearby dam; Adapted from Beaver Institute.

Case study 1 (Heaven et al. 2019)

- Two years camera monitoring (Time-lapse 1 minute); day time hours in may and June over two years
- 4 Blanding's Turtles, 42 Snapping Turtles and 14 Painted Turtles used culvert
- Measured the proportion by species using culvert and and compared to adjacent abundance
  - Blanding's Turtles use was proportionally less than observed
  - Snapping turtles use was proportionally higher
- Evidence for species-specific difference in use between freshwater turtles

Blanding's Turtle entering the 1.2 m drainage culvert shown in red circle. Photo Credit: Paul Heaven.

Case study 2 (Brock and Gunson, in prep)

- Two years camera monitoring (Time-lapse 15 seconds)
- 6 species of freshwater turtles:

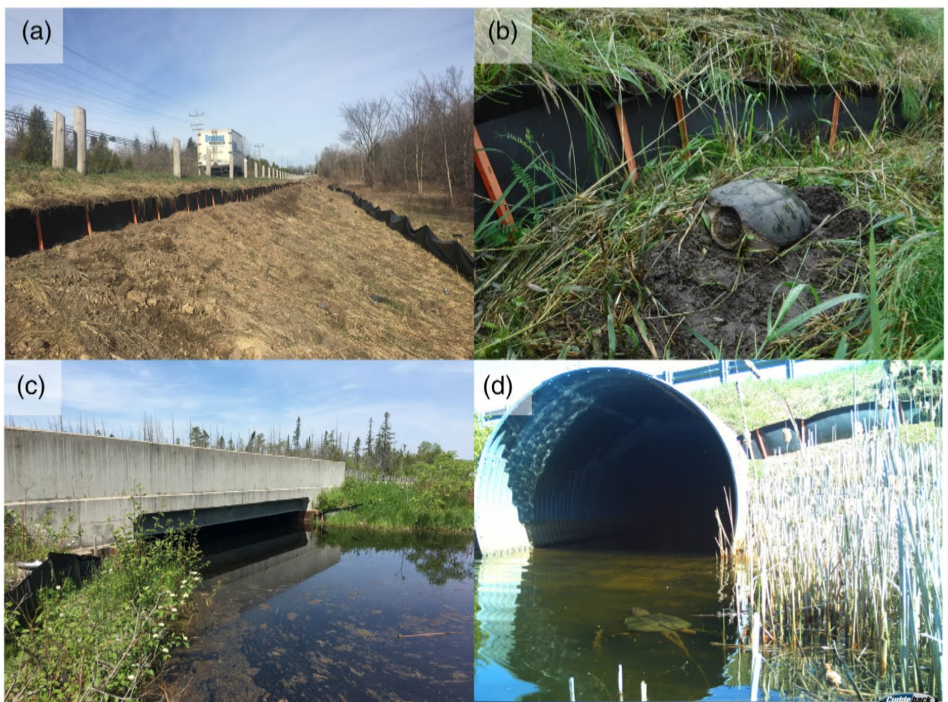
Species	Cross	Potential Cross	Total Cross	Turn-around	Unknown	Grand Total	Passage rate
Blanding's turtle	1	0	1	3	2	6	0.25
Musk turtle	9	12	21	1	32	54	0.95
Northern Map turtle	0	1	1	0	0	1	1.00
Painted turtle	16	36	52	5	53	110	0.91
Snapping turtle	11	22	33	2	31	66	0.94
Spotted turtle	0	2	2	0	1	3	1.00
Grand Total	**37**	**73**	**110**	**11**	**119**	**240**	**0.91**

Conclusions

- Monitoring measured first time use by Spotted and Musk Turtles in Ontario
- Study showed challenges of monitoring in submerged culverts
- Turtles primarily cross during the day
- In 2018, turtles crossed more times westerly during two one-week periods at the end of May and second week of June, and this is likely due to turtles moving to nesting habitat on the west side of the culvert

Case study 3 (Read and Thompson 2021)

- One year camera monitoring at three CSP culverts (Time-lapse; 1 minute) for 219 days
- Two species: Snapping Turtles and Painted Turtles (448 occurrences, 106 complete passages)



Read, K. D., & Thompson, B. (2021). Retrofit ecopassages effectively reduce freshwater turtle road mortality in the Lake Simcoe Watershed. *Conservation Science and Practice*, e491.

FIGURE 2 Herpetile ecopassage fence installation showing the below-grade design (a, b), and the connection to existing road crossing infrastructure (i.e., bridges (c) and culverts (d))

In summary

- These three studies looked at use of one to three structures;
  - Read et al. data has potential to compare the following:
    - Three CSP structures
    - Temporal variation
    - Time of day of use
    - Species-specific use comparisons
- All three studies demonstrated ‘use’ of existing drainage culverts by freshwater turtles; possible hesitancy of use by Blanding’s Turtles
- Possible to compile for co-ordinated experimental designs

Case study 4 (Boyle et al. 2021; new research)

- Used pit-tagging and cameras (one year motion only; second year time lapse 1 minute) for monitoring three structures
- Demonstrated genetic connectivity for reptiles through structures
- Evaluated use by demographic structure (age and sex-related)

Boyle, S. P., Keevil, M. G., Litzgus, J. D., Tyerman, D., & Lesbarrères, D. (2021). Road-effect mitigation promotes connectivity and reduces mortality at the population-level. *Biological Conservation*, *261*, 109230.

Case study 5 (Eco-Kare International in prep, 2020)

- Improvement of camera monitoring techniques (Time-lapse-15 seconds); standardized across structures
- Compare relative use between species and taxa (turtles and snakes)
- Goal is to evaluate use of structures as compared to size, shape, hydrology, etc.


06/01/2016

Large vs. small adjacent

Structures (only 2019)

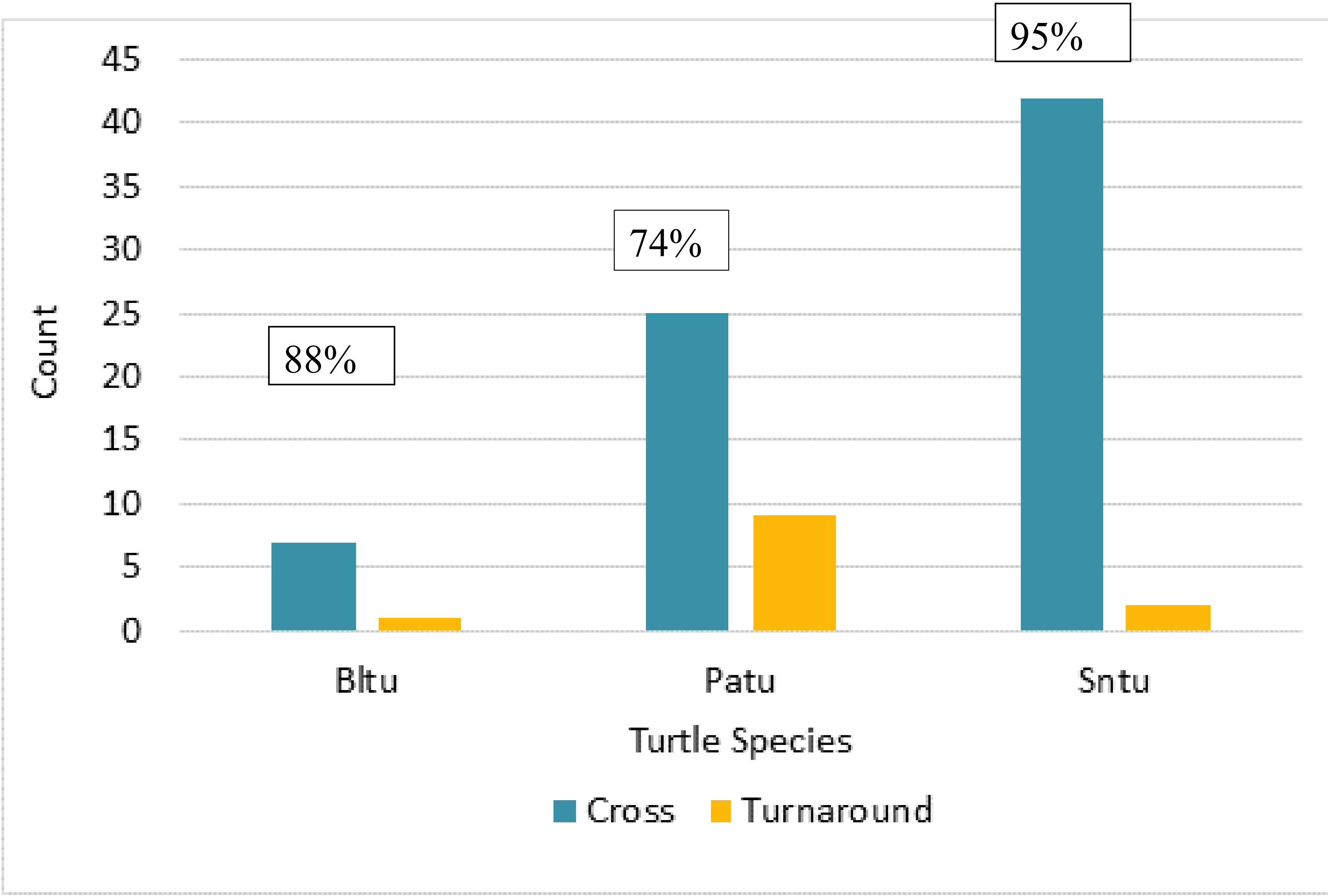
Other measures

- Motion vs. Time Lapse
- Use of structures by species, taxa (snakes vs. turtles) and structure type
- Influence of temperature

Preliminary Results 2015-2019

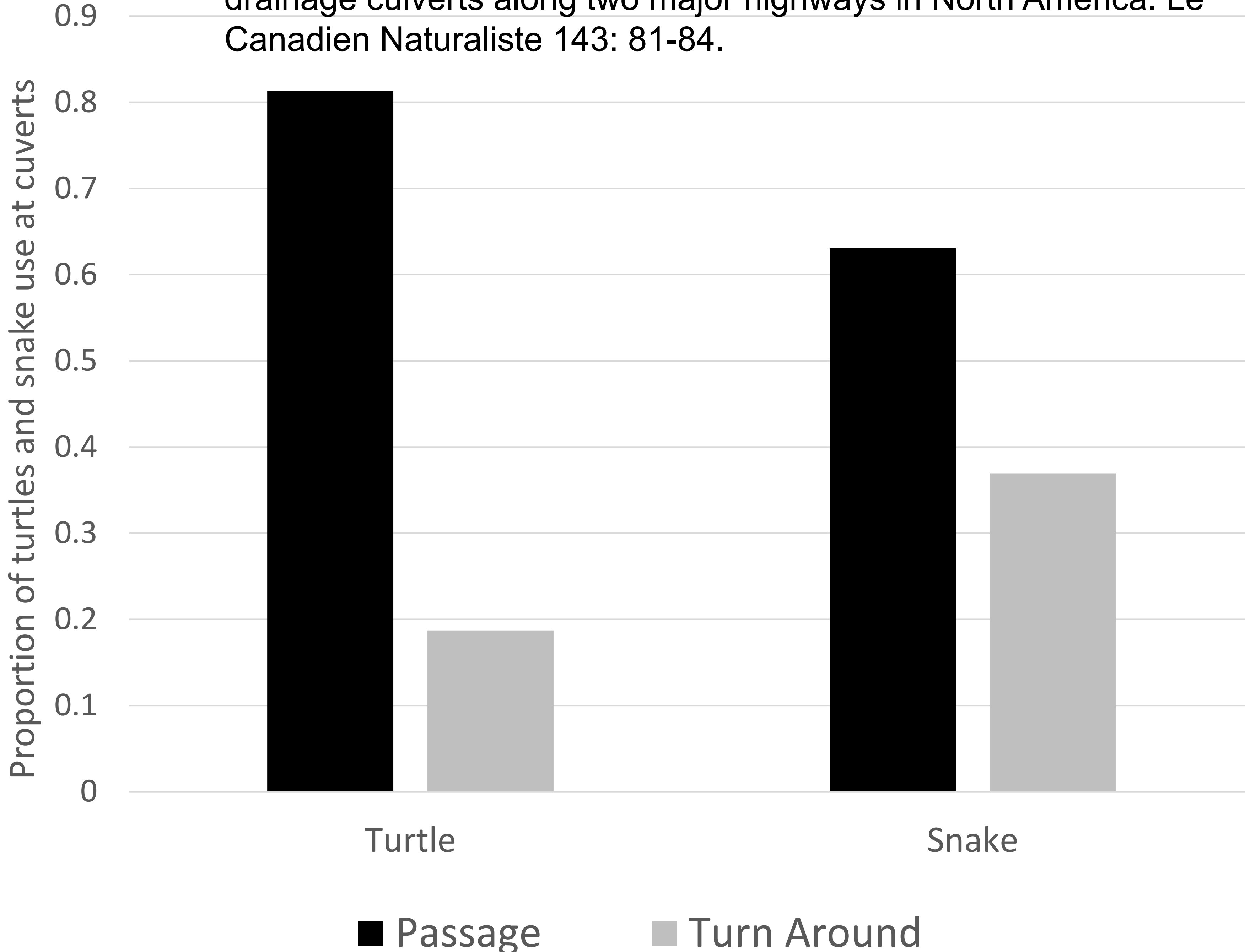
- 162 Turtles
  - 16 Blanding's Turtle
  - 83 Snapping Turtles
  - 61 Painted Turtles

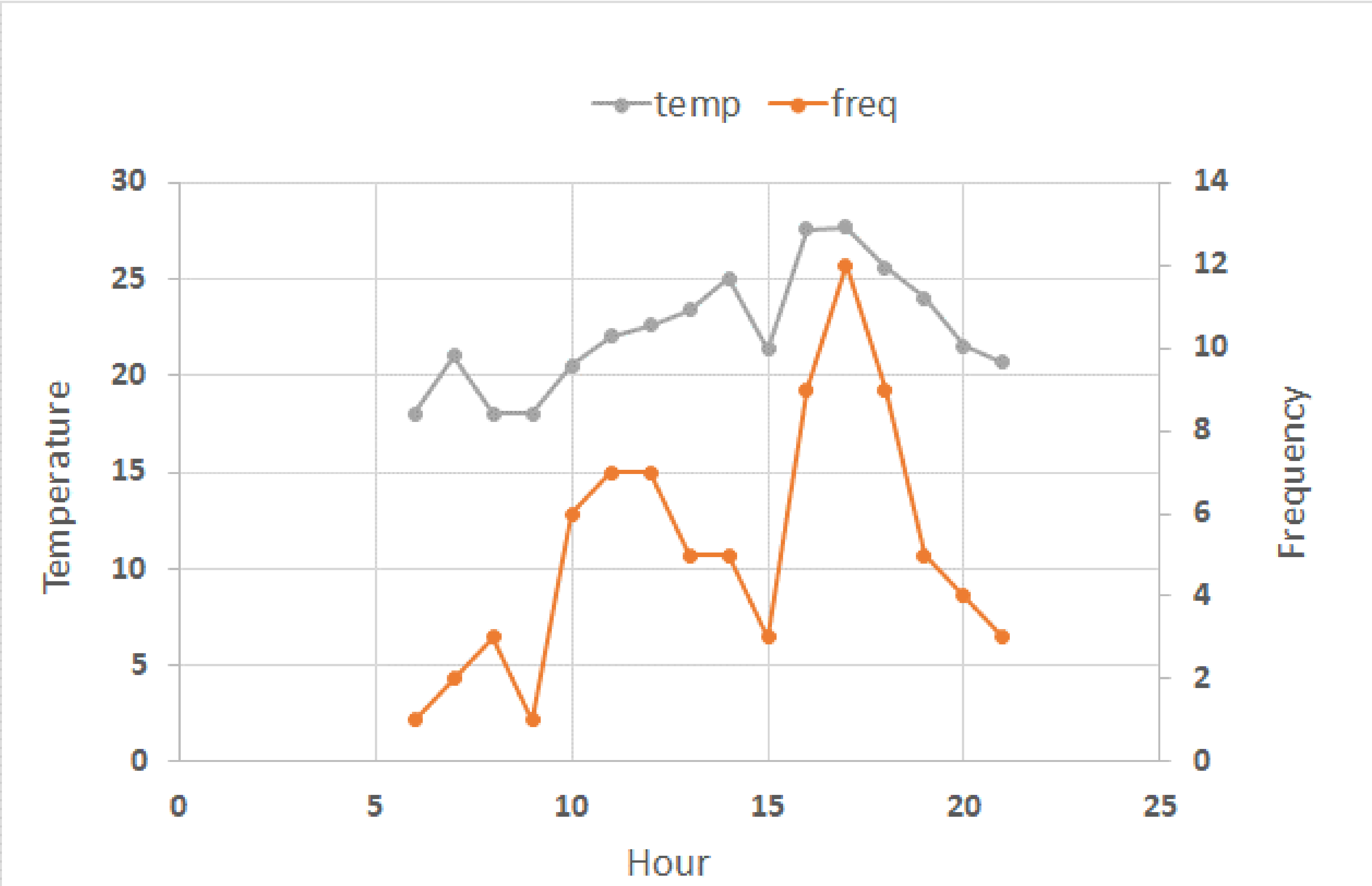
- 82 Snakes
  - 44 Gartersnakes
  - 10 Hognose
  - 2 Massasauga
  - 5 Milksnake
  - 20 Watersnake



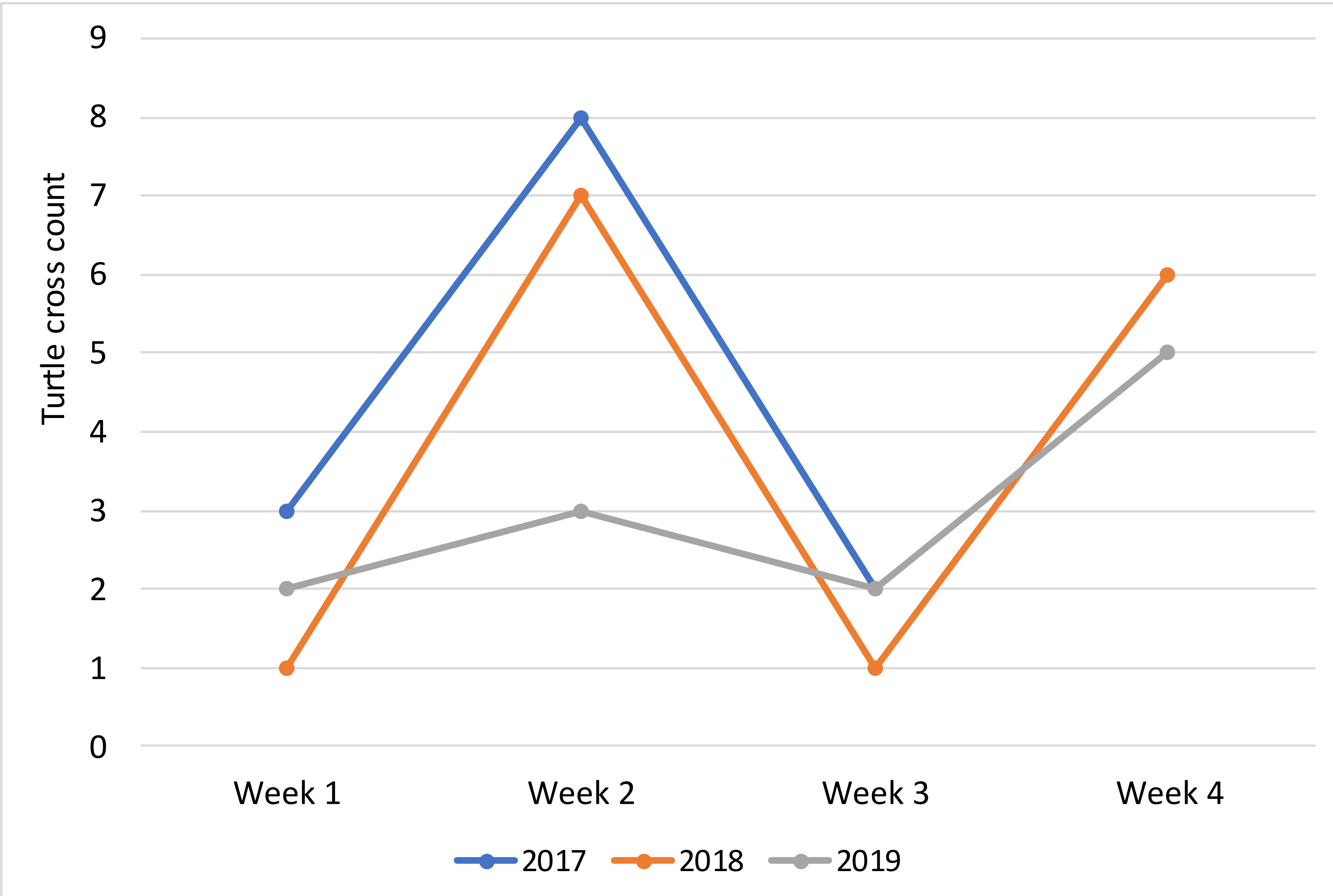
95%
74%
88%
45
40
35
30
25
20
15
10
5
0
Count
Bltu
Patu
Sntu
Turtle Species
Cross
Turnaround

Gunson, K.E. 2019. A comparison of turtle and snake passage at drainage culverts along two major highways in North America. Le Canadien Naturaliste 143: 81-84.





temp
freq
Temperature
Frequency
Hour
30
25
20
15
10
5
0
14
12
10
8
6
4
2
0
0
5
10
15
20
25



Turtle cross count
9
8
7
6
5
4
3
2
1
0
Week 1
Week 2
Week 3
Week 4
2017
2018
2019

In summary

- Require long-term studies and consistency in monitoring
- Turtles are more inclined to use crossing structures than snakes
- Turtles show temporal use during the day and during the nesting period
- Turtle passage highest when passages located at wet connected habitat
- Multivariate studies as

part of future work; requires population abundance measures

Challenges

- Camera capture rate varies from site to site (Time lapse 15 seconds best setting);
  - water levels change; rocks may become barriers to movement,
  - technical difficulties with each camera;
- Low sample size using structures annually compared to large animals and other sites monitored for turtles in Ontario
- Do not know population abundance adjacent to tunnels
  - Local abundance fluctuates from wetland to wetland more so than when evaluating larger animals that move large distances

Monitoring conducted up to 2019

- In the literature review, crossing structures were monitored (49 of 57 or 86%) of the time
  - 48 studies monitored the crossing structures for use by the target group(s) or species and 3 studies showed no use
  - one study measured change in population abundance (before and after implementation)

Ministry of Transportation, Eco-Kare International

Monitoring conducted (to date)

- We are learning more about crossing structures and reptile use but have a long way to go……
  - Require BACI type studies, population measures before and after crossing structures implemented
  - Need to measure population abundance adjacent to structures to be able to evaluate preferred use of a diversity of structures

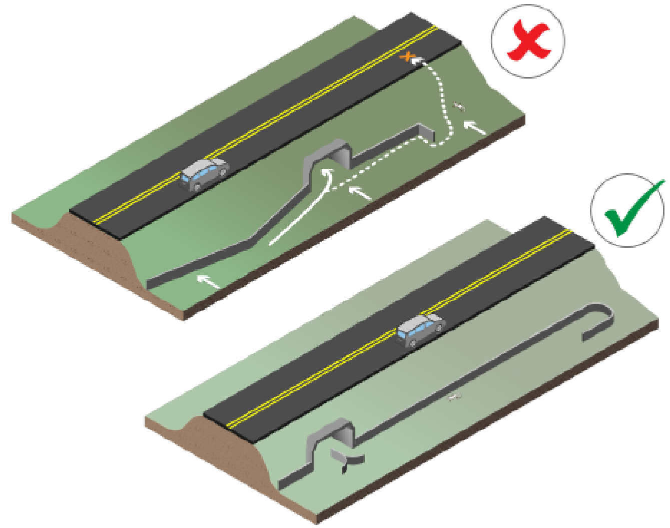
Ministry of Transportation, Eco-Kare International

Research/Case studies: Cheryl Brehme, USGS

USGS
science for a changing world

Research to Inform Caltrans Best Management Practices for Reptile and Amphibian Road Crossings

Measures to Reduce Road Impacts on Amphibians and Reptiles in California: Best Management Practices and Technical Guidance



Final October 2020 DRAFT FOR REF ONLY 29.09 NOT COMPLETE

Caltrans
MONTANA STATE UNIVERSITY
Western Transportation Institute
HERPETOFAUNA CONSULTANTS INTERNATIONAL, LTD

Collaborators: Tony Clevenger (WTI), Tom Langton (Transport Ecology Services)
Robert Fisher (USGS)
Reports posted on Caltrans DRISI website & USGS road ecology website

USGS Contributions to Inform Technical Guidance Manual

- CA Amphibian & Reptile Road Risk Assessment (Landscape Ecology 2018)
- Spatial Geodatabase- Planning Tool
- Literature Review & Gap Analysis (led by WTI)
- Field Studies to address information gaps
  - Effects of Fence transparency on movement (speed/behavior)
  - Effectiveness of Turnarounds
  - “Give-up Distances” along fencing- migratory species
  - New crossing structure

Study 1: Fence Transparency

Fencing

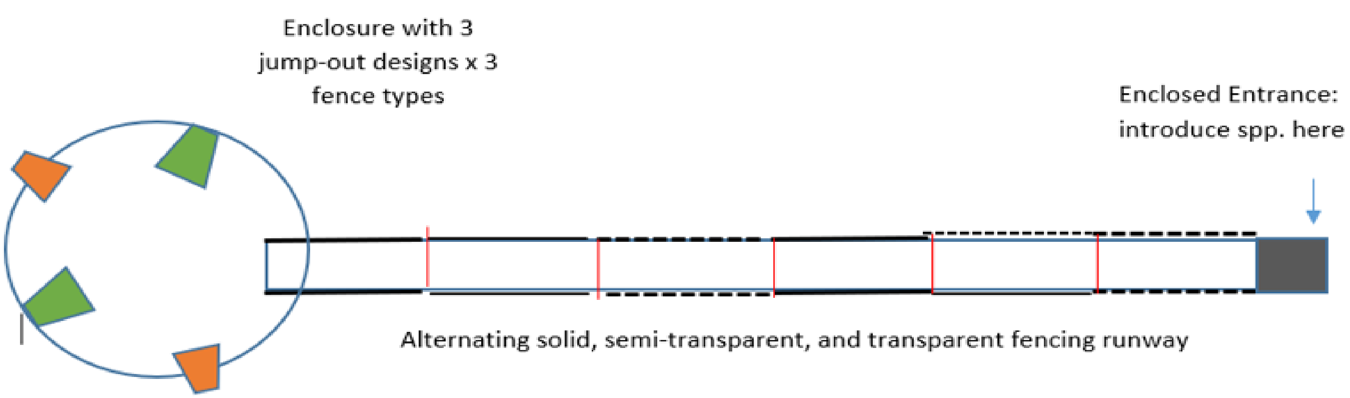
- Solid
- Semi-transparent (Mesh)
- Transparent (HC)

Behavioral Enclosure

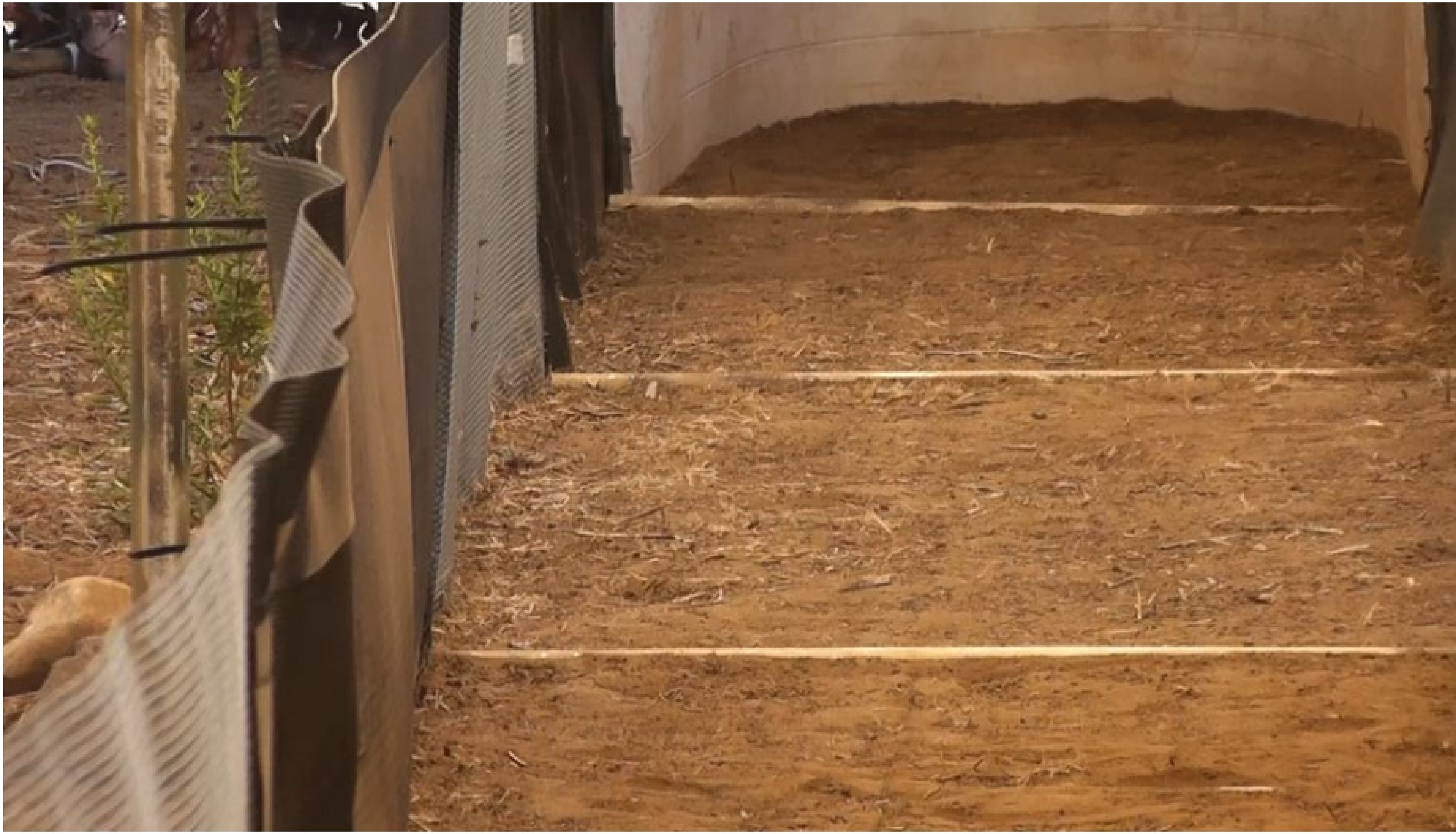
- Lizards: n=81, 7 spp.
- Snakes: n=27, 9 spp.
- Toads: n=5, 2 spp.

Responses:

- Behaviors (poking, back and forth, climbing)
- Time



Fence interaction Behaviors

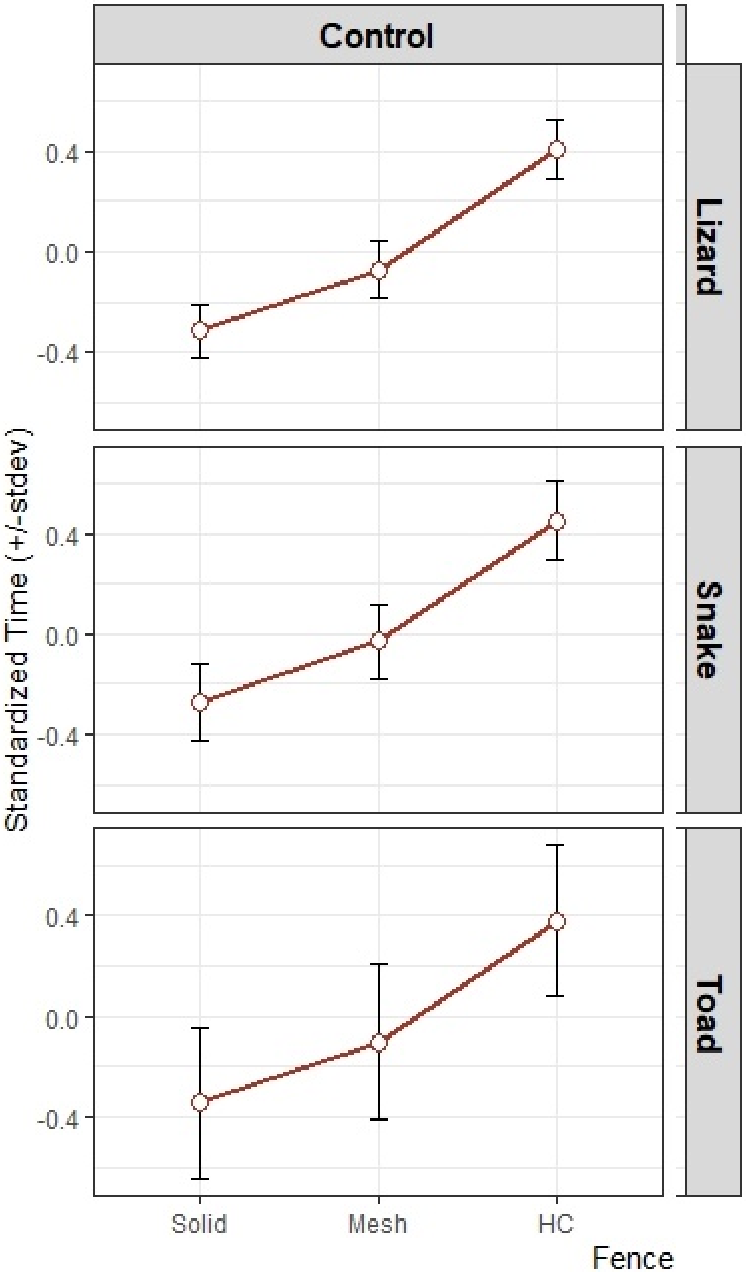


(video)

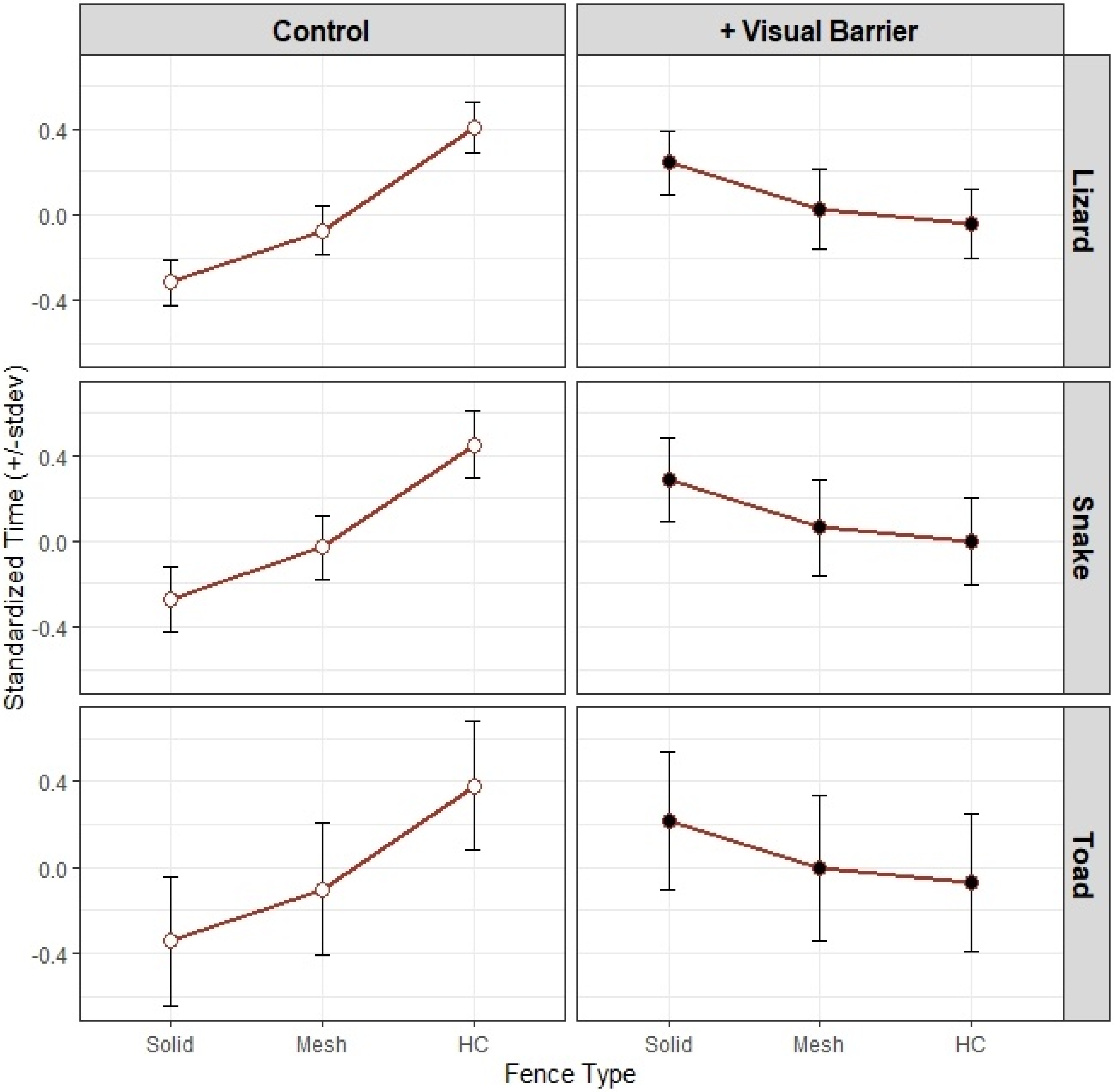
Movement Time

- If they can't see through it, they move faster

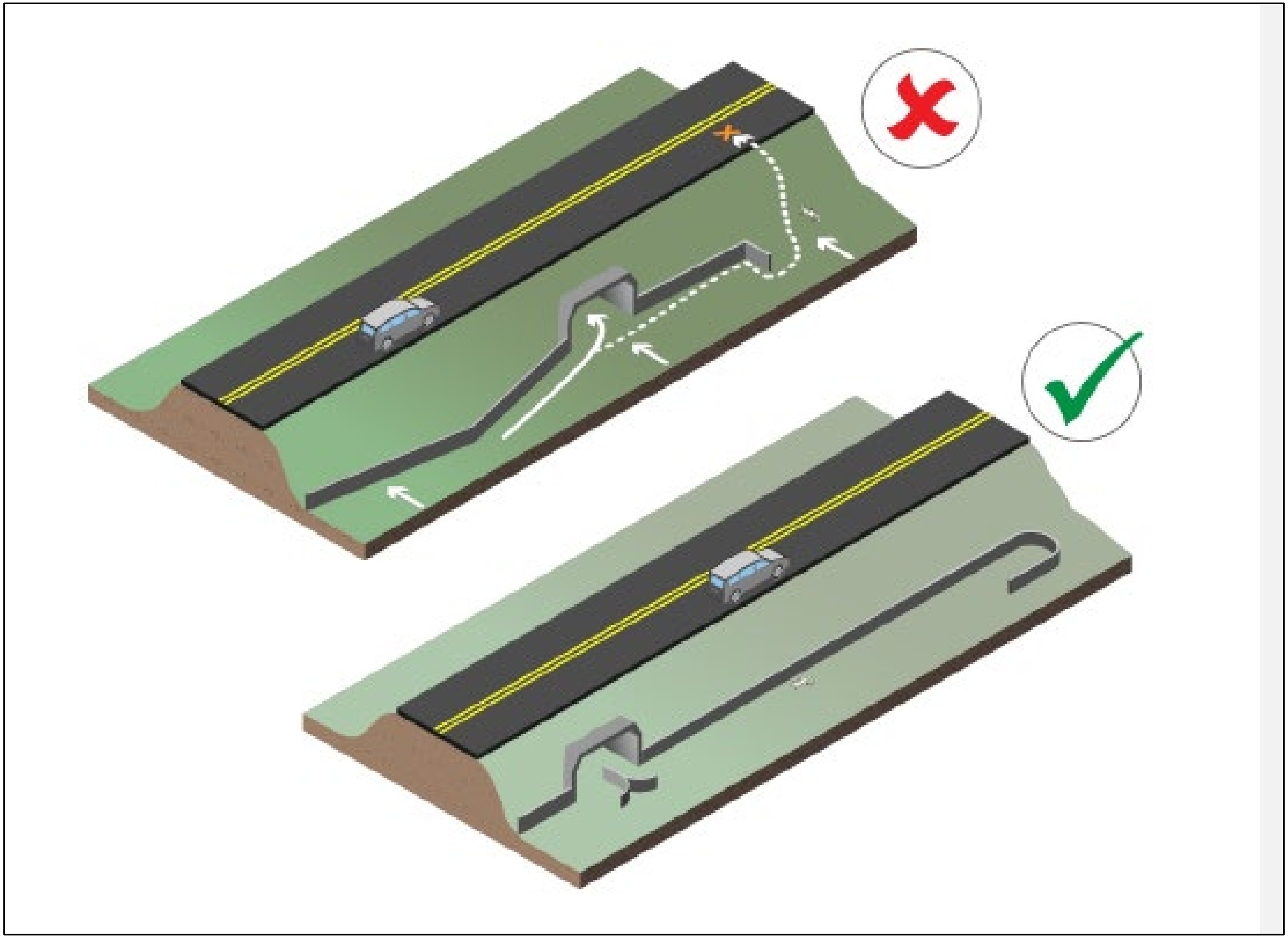
- Addition of 6" Visual Barrier at Bottom of Fence?



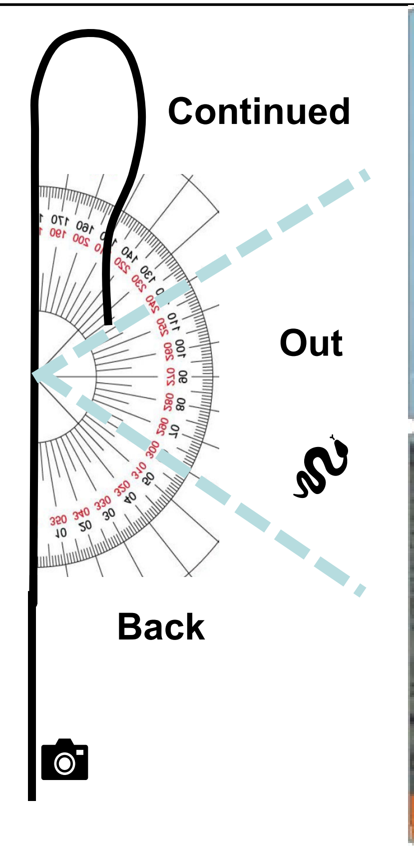
- Addition of 6” Visual Barrier at Bottom of Fence?



Study 2: Turnarounds



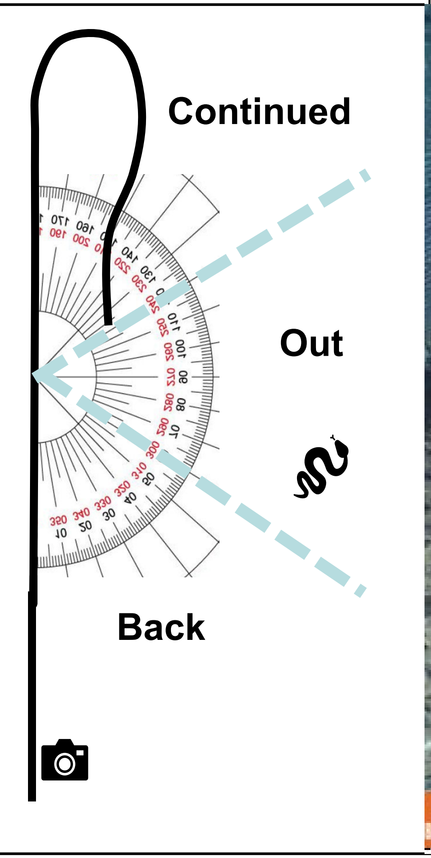
Turnarounds



(video)

Continued = not effective

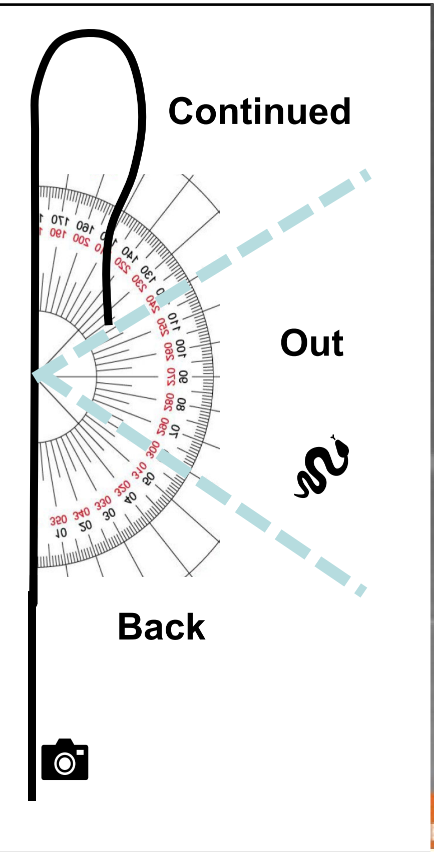
Turnarounds



(video)

Out = effective

Turnarounds



(video)

Back = effective

Results

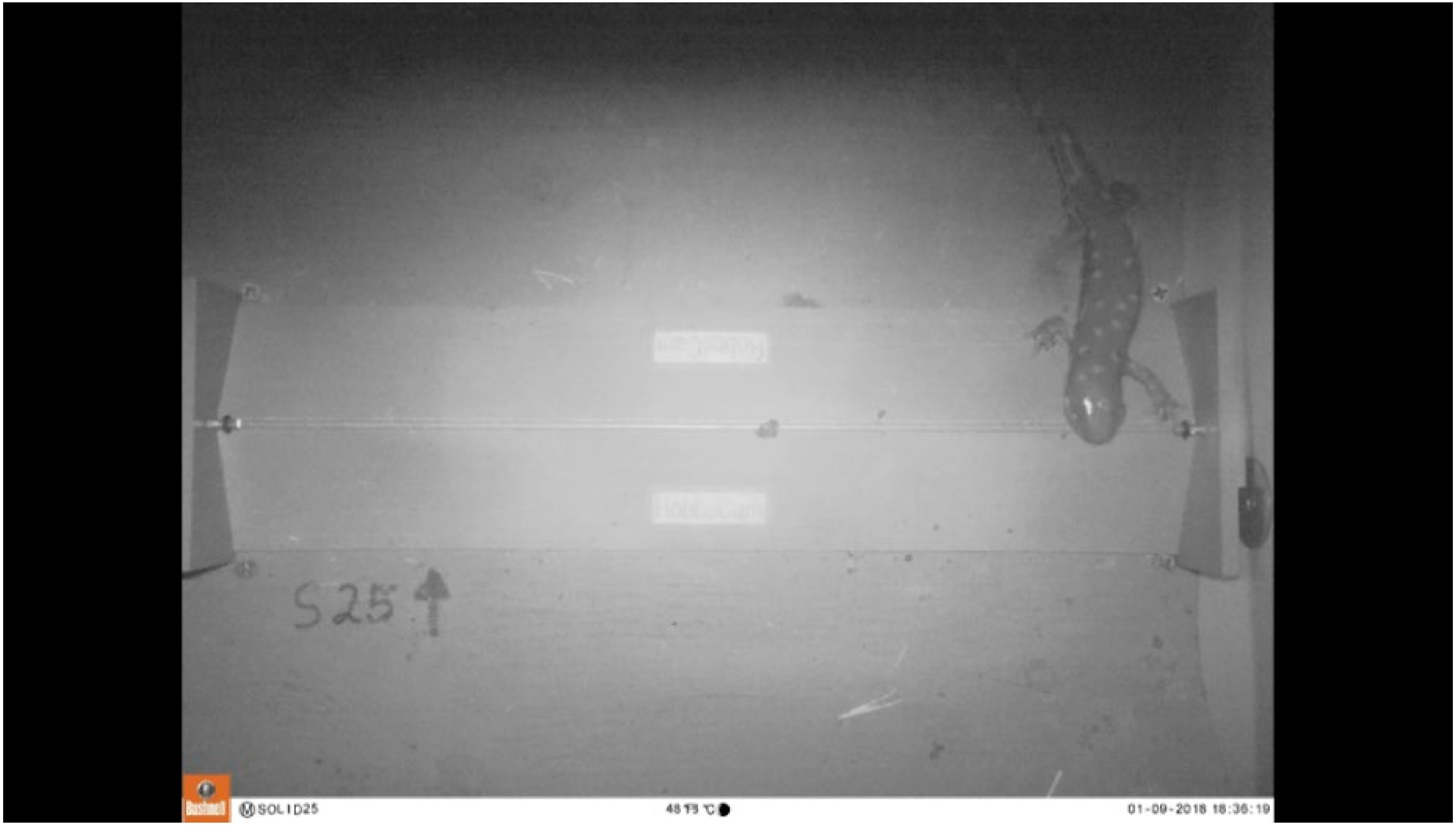
- 264 lizards, 96 snakes, 59 toads, 370 small mammals

- 92% herps & 62% of small mammals changed course along fence or went back to habitat

Longer distances?
- CA Tiger Salamander
    - 2/3 documented 25-125m back along fence
- Yosemite toad
    - 7/10 changed course
    - 4/7 documented 40-80m back along fence

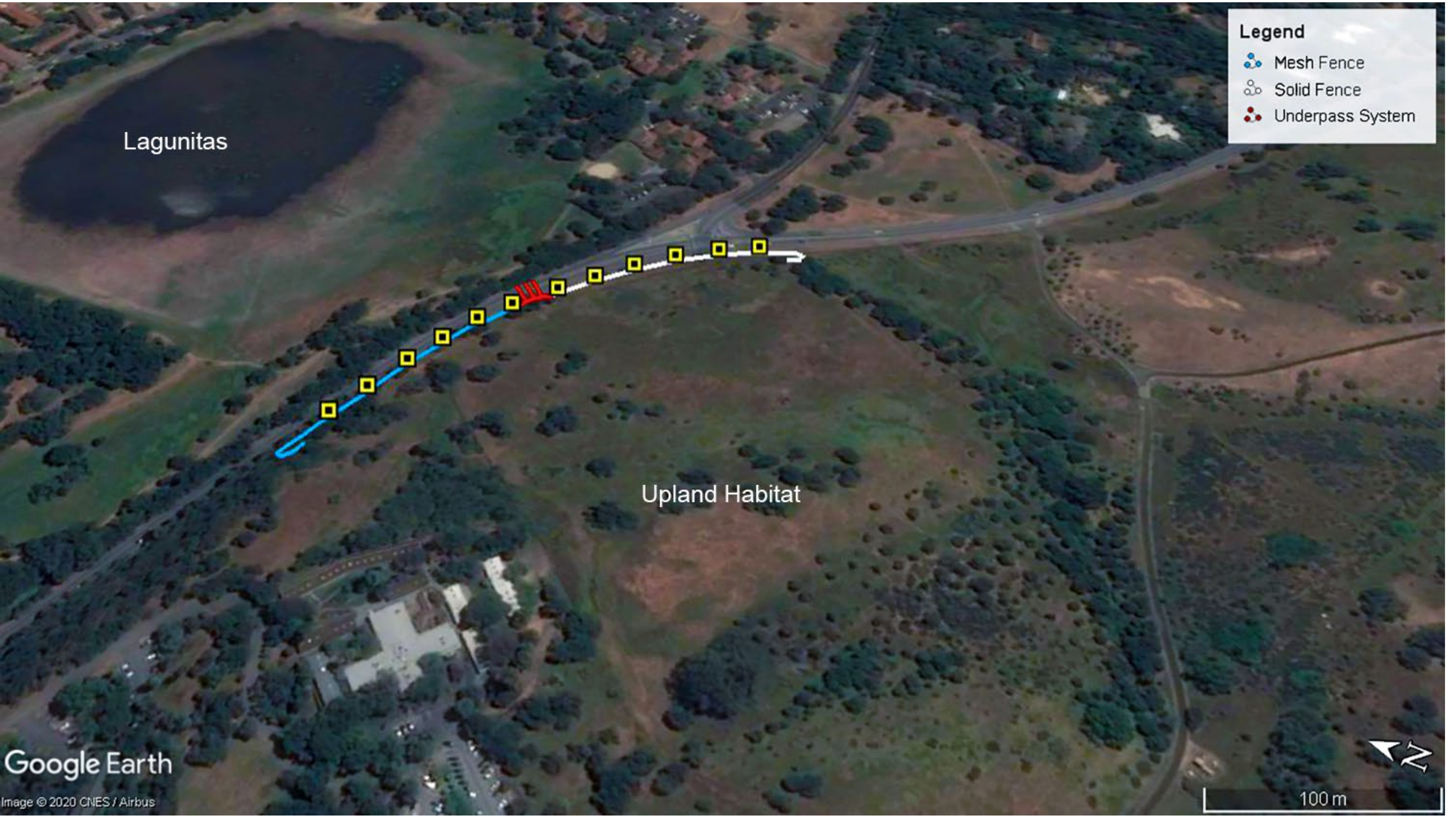
		Fence lines passed (out of 6)			Proportion
Taxon	Species	Continued	Out	Back	Back+ Out
Lizard	*SubTotal*	26	69	169	0.90
	Aspidoscelis hyperythrus	12	53	69	0.91
	Aspidoscelis tigris			2	1.00
	Elgaria multicarinata			1	1.00
	Plestiodon gilberti			1	1.00
	Plestiodon skiltonianus		1		1.00
	Sceloporus occidentalis	3	1	15	0.84
	Uta stansburiana	11	14	79	0.89
	Unknown lizard			2	1.00
Snake	*SubTotal*	1	30	65	0.99
	Coluber fuliginosus		2	12	1.00
	Coluber lateralis	1	9	23	0.97
	Coluber flagellum		6	9	1.00
	Crotalus oreganus		6	5	1.00
	Crotalus ruber		2	1	1.00
	Lampropeltis getula		2	3	1.00
	Pituophis catenifer		2	11	1.00
	Salvadora hexalepis		1		1.00
	Unknown snake			1	1.00
Toad/Frog	*SubTotal*	5	8	47	0.92
	Anaxyrus boreas	4	5	31	0.90
	Pseudacris regilla			1	1.00
	Unknown anuran	1	3	15	0.95
Small Mammal	*SubTotal*	120	91	159	0.68
	Chaetodipus spp.	3	15	33	0.94
	Dipodomys simulans	29	22	36	0.67
	Microtus californicus	3	2	2	0.57
	Neotoma spp.	5	2		0.29
	Notiosorex crawfordii	1	1	2	0.75
	Otospermophilus beecheyi	41	16	35	0.55
	Peromyscus spp.	37	30	47	0.68
	Reithrodontomys megalotis		1	1	1.00
	Thomomys bottae		2	1	1.00
	Unknown rodent	1		2	0.67
	Grand Total	152	198	440	0.81

CA Tiger Salamander Video

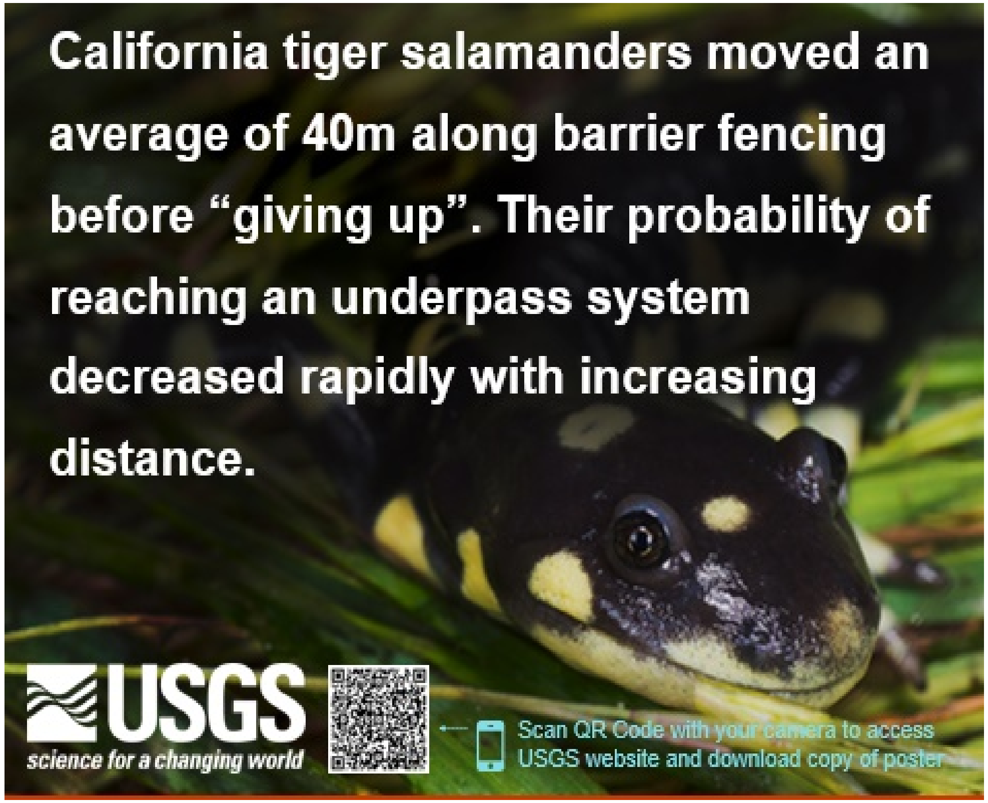


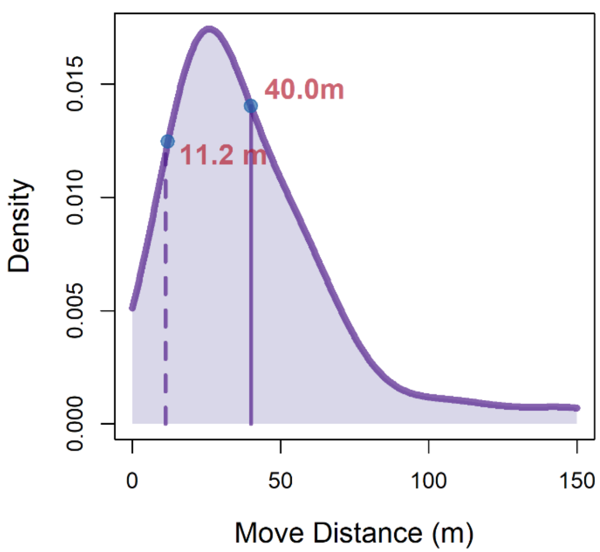
(video-see USGS road ecology webpage

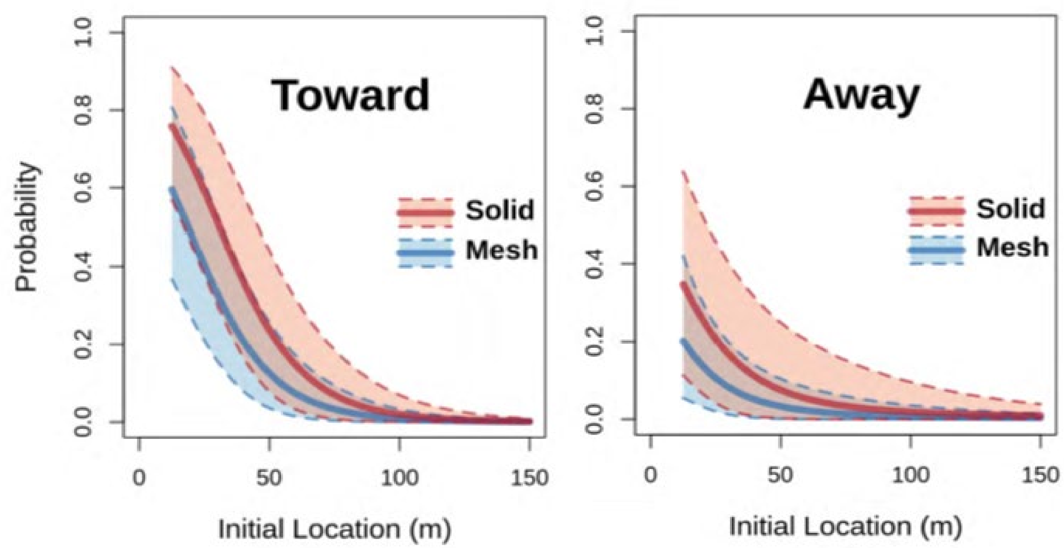
Study 3: "Give Up" Distances for Migratory Amphibians



- Stanford- CA Tiger Salamander. Western Toad[TBD], Sierras- Yosemite Toad


California tiger salamanders moved an average of 40m along barrier fencing before "giving up". Their probability of reaching an underpass system decreased rapidly with increasing distance.
USGS
science for a changing world
Scan QR Code with your camera to access USGS website and download copy of poster


40.0m
11.2 m
Density
0.000
0.005
0.010
0.015
0
50
100
150
Move Distance (m)


Toward
Away
Solid
Mesh
Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
Initial Location (m)

		Fence Distance (m)		Movement Speed (m/min)*		Direction Changes (turnarounds/25m)	
Fence Type	Sample Size	Mean	90% CI	Mean	90% CI	Mean	90% CI
Solid	37 (14*)	41.8	32.0- 47.8	2.1	1.7-2.5	0.13	0.04- 0.23
Mesh	54 (26*)	39.3	34.5- 42.2	1.2	1.0-1.4	0.41	0.15- 0.67

*individuals that passed more than one camera where movement speed was calculated

Study #4: How about a wider crossing?

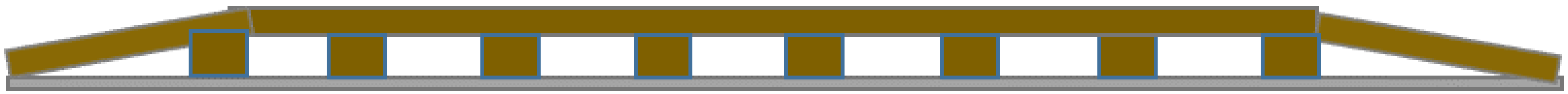
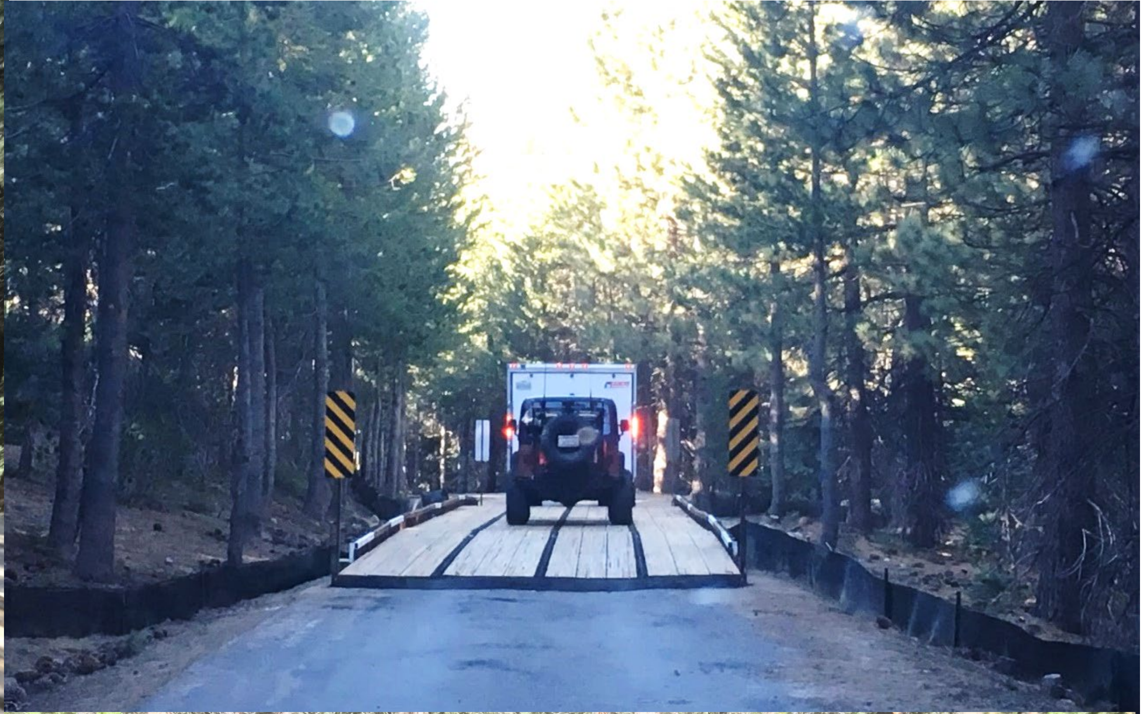
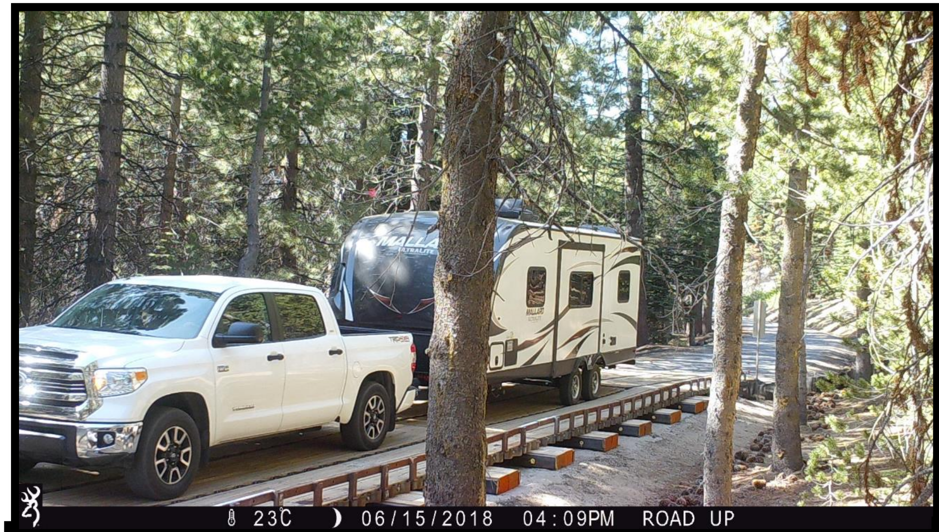
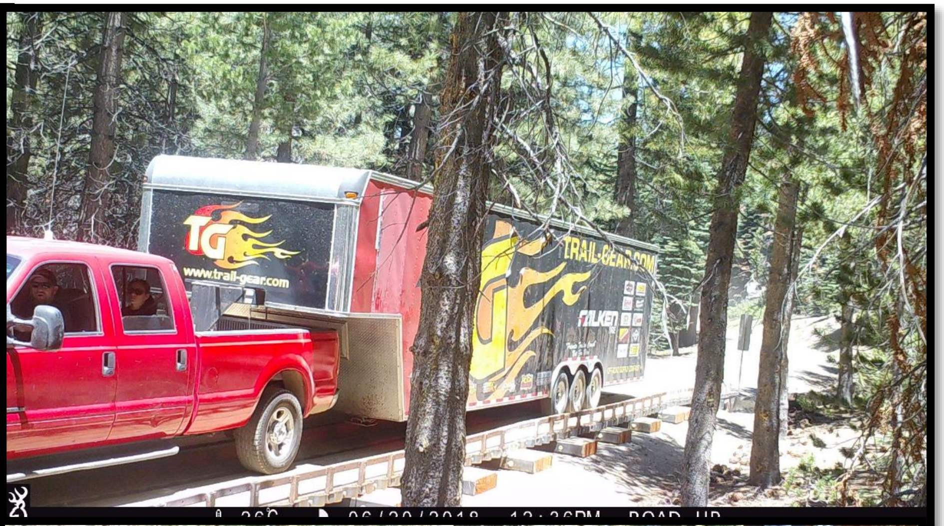


Diagram: Side view depiction of elevated road segment (rectangle with vertical lines) with barrier fencing (lines) and openings for toad passage underneath (solid rectangles); not to scale.

Prototype 100' using road mats for construction projects on sensitive habitats



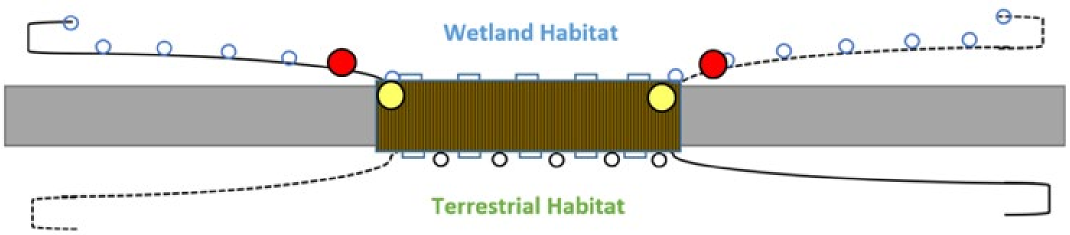




Temporary to Permanent with annual maintenance- can be built to any length

Built to meet codes and specifications for USFS, County, City Roads

Preliminary Results- ERS Effective



			RELATIVE ACTIVITY		
			Outside	Inside	Ratio
AMPH	Pacific Treefrog	*Hyla regilla*	209	174	0.83
	Yosemite Toad	*Anaxyrus californica*	20	19	0.95
	Sierra Nevada Ensatina	*Ensatina eschscholtzii platensis*	12	4	0.33
	Unknown salamander		0	3	na
		Subtotal Amphibians	241	200	0.83
REPT	Mountain Gartersnake	*Thamnophis elegans elegans*	25	14	0.56
	Rubber Boa	*Charina bottae*	6	4	0.67
	Sierra Alligator Lizard	*Elgaria multicarinata*	6	7	1.17
	Western Fence Lizard	*Sceloporus occidentalis*	6	2	0.33
	Unknown lizard		1	4	4.00
		Subtotal Reptiles	44	31	0.70
MAMMALS	Mice/Rats	*Family Rodentia*	165	534	3.24
	CA ground squirrel	*Otospermophilus beecheyi*	19	38	2.00
	Long-tailed Weasel	*Mustela frenata*	0	1	>1.0
	Spotted skunk	*Spilogale putorius*	0	4	>1.0
	American marten	*Martes americana*	0	2	>1.0
	Chipmunk	*Neotamias spp.*	3	1	0.33
	CA Vole	*Microtus californicus*	2	1	0.50
	Shrew	*Sorex spp.*	1	16	16.00
	Yellow-bellied Marmot	*Marmota flaviventris*	1	1	1.00
		Subtotal Mammals	191	598	3.13

- Continued Study (DOT Pooled Fund Partners)
- Transportation Engineering Evaluation (Caltrans Overview)
  - Concept
  - Permanent Designs currently being Engineered

Using Crossing: Yosemite Toads

(video-Yosemite toads under ERS

Using Crossing: Other Species

(video-other species under ERS

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Research to Inform Caltrans Best Management Practices for Reptile and Amphibian Road Crossings

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Today's Presenters

- Moderator: Kris Gade, *Arizona Department of Transportation*
- Marcel Huijser, *Montana State University*
- Kari Gunson, *Eco-Care International*
- Cheryl Brehme, *United States Geological Survey*

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