Research to Inform Passage Spacing for Migratory Amphibians and to evaluate

Efficacy and Designs for Elevated Road Segment (ERS) Passages.

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Western Ecological Research Center U. S. Geological Survey

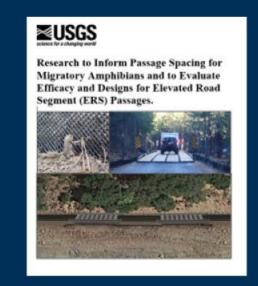
Funding:

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U.S. Geological Survey

Caltrans, Department of Transporatation





Objectives

- Spacing of underpasses for migratory species-Yosemite Toad?
- Effectiveness of barrier fencing (opacity).
- Effectiveness of prototype elevated road segment (ERS) passage for Yosemite toads and other small animals.
- Designs for primary roads and highways.

	https://doi.org/10.1007h/10980-018-0640-1		
ĺ,	RESEARCH ARTICLE		
	An objective road risk assessmer	nt method for multiple	
	species: ranking 166 reptiles and amphibians in California		
	Cheryl S. Brehme Or Stack A. Hathaway Or Robert	t N. Hisher©	
	Received: 10 July 2017/ Accepted: 26 March 2018 10 The Authority: 2018 Abstract Context: Transportation and Context Transportation of Context Transportation of Context Transportation of Context Transportation and Context Transportation of Context Transportation and Context Transportation of Context Transportation and Conte	Ranked	
	Abstract	2% of snakes, 50% of	
	Context Transportation and	and and 17% of salamande	
	consider the need for	Ornia were ranked at high or very-high	
	wildlife road-cro	r negative road impacts. Results were largely	
	viability of	eleastent with local and global scientific literature is	
	face 1000	identifying high risk species and groups.	
	mond YOU I INTE	Conclusions This comparative risk assessmen	
	Purpo pilles and	method provides a science-based framework to iden	
	amphib risk from road	tify species at highest risk from road impacts. The	
	mortality with over 160 species and a late apecific research data, we	results can inform regional-scale road mitigation planning and prioritization efforts and threat assess	
	de veloped cure risk assessment method based	ments for special-status species. We believe this	
	upon road ecology acience.	approach is applicable to numerous landscapes an	
	Methods Risk scoring was based upon a mite of life	tatommic groups.	
	history and space-use characteristics associated with		
	negative road of fects applied in a hierarchical manner	Keywords Reptile - Amphibian - Road mortality -	
	from individuals to species. We evaluated risk to both	Habitet fragmentation - Road ecology - Risk	
	aquatic and terrestrial connectivity and calculated	assessment	
	buffer distances to encompass 95% of population-		
	level movements. We ranked species into five relative		
	categories of road-related risk (very-high to very-low) based upon 20% increments of all species scores.	Introduction	
	nessa upon acce measurems or an openes secures.	an arthur Canna	
		There have been many attempts to better characterize	
	Electronic supplementary material. The online variou of	and quantify threat criteria in order to classify specie	
1	this article (https://doi.org/10.1000/s1090-018-0640-1) one- tains supplementary material, which is available to authorized	at higher risk of estinction at state, national, and global	
2	SMET.	le sels (Congress 1973 (U.S. Endangered Species Act)	
2			
2 3	C. S. Berbon (SD), S. A. Harbarov, W. N. Harry		
45	C. S. Behme (50) - S. A. Hadaway - R. S. Faber 113. Geological Survey, Western Ecological Research Center, San Diego, CA, USA	Mace et al. 2008; Hobday et al. 2011; Thomson et al. 2016; IUCN 2017). Roads are a significant threat to wildlife populations (e.g., Forman et al. 2003;	



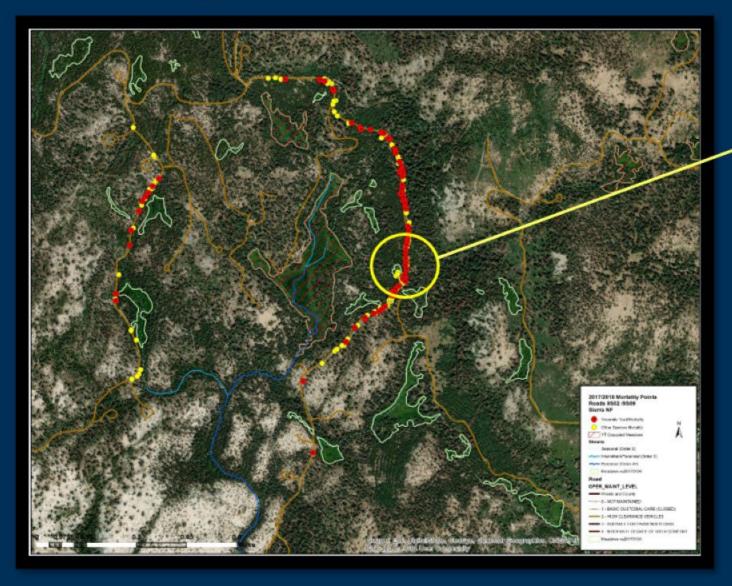
Yosemite Toad

- Listing status: Federally Threatened (April 29, 2014)
- Elevation Range = 6,400-11,000 feet
- Long lived: 12-15 years
- Move up to 1 km or more between terrestrial & aquatic breeding habitats
- Straight-line movement patterns not associated with drainages, roads, or other similar features
- Moves upland throughout the summer, especially during rain events





Sierra National Forest Study Area



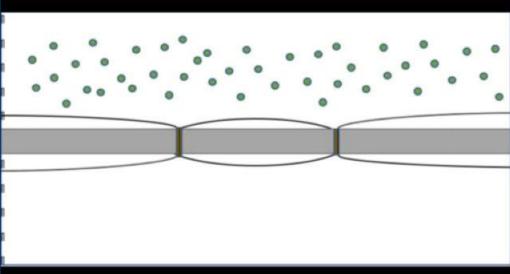




Mitigation Possibilities- 1?

- Barrier Systems & Wildlife Passages can reduce mortality and help to maintain connectivity
- However... can be unintended consequences...
 - e.g. Woltz et al. 2008, Matos et al. 2016, Ottburg and van der Grift 2019,
 Hedrick et al. 2019, Brehme et al. 2021









California Tiger Salamander

Global Beology and Conservation 31 (2021) #01057

Contents lists available at Science Direct



Global Ecology and Conservation



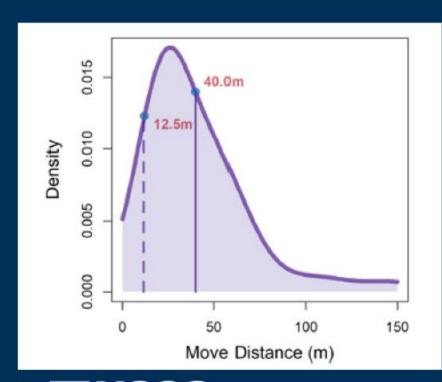
journal homepage: www.elsevier.com/locate/gecco



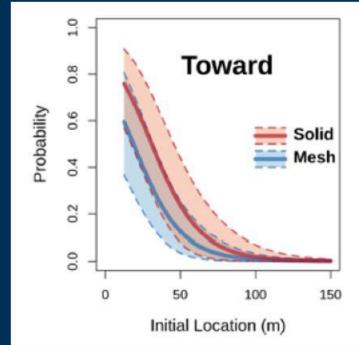
Responses of migratory amphibians to barrier fencing inform the spacing of road underpasses: a case study with California tiger salamanders (Ambystoma californiense) in Stanford, CA, USA

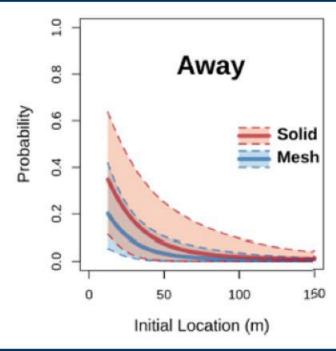
Cheryl S. Brehme ".", Jeff A. Tracey ", Brittany A.I. Ewing ", Michael T. Hobbs b, Alan E. Launer . Tritia A. Matsuda . Esther M. Cole Adelsheim . Robert N. Fisher

Average movement distances along fence



Probability of Reaching Underpass based on distance from underpass based on distance from underpass they encounter a fence



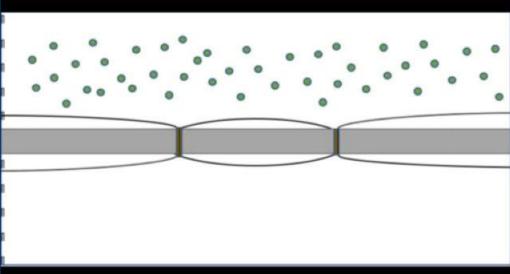




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How about a wider crossing?

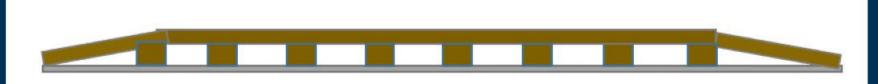


Diagram: Side view depiction of elevated road segment (rectangle with vertical lines) with barrier fencing (lines) and openings for toad passage underneath (solid rectangles); not to scale.

Prototype using road mats for construction projects on sensitive habitats

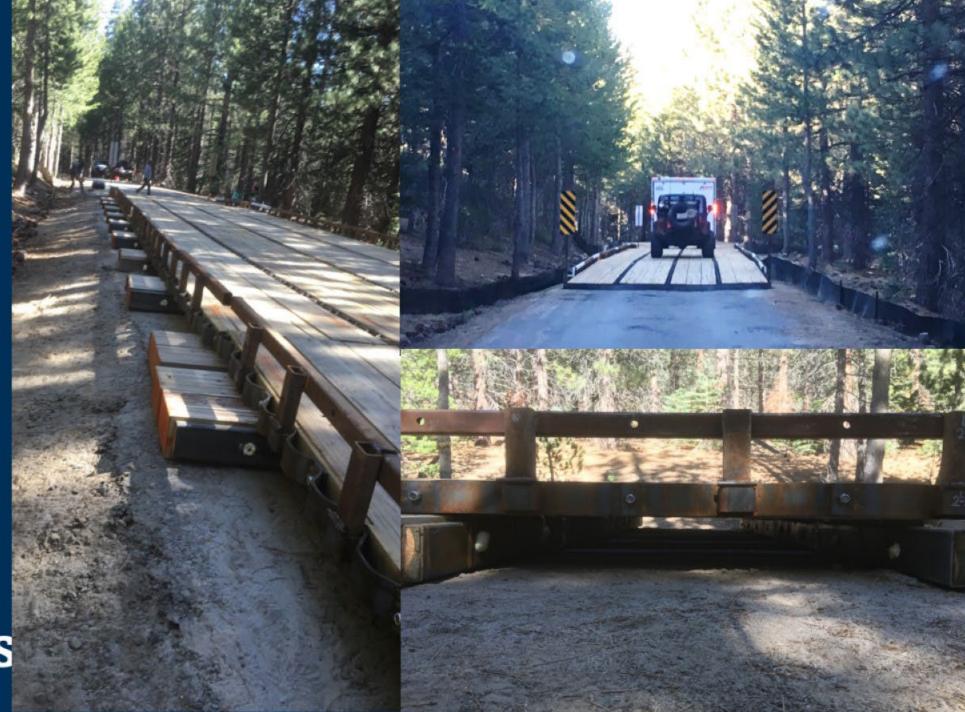






Built to meet codes and specifications for USFS, County, City Roads (Anthony Composites- Emtek)

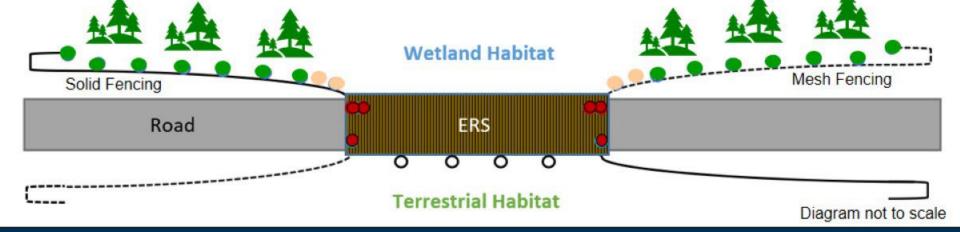




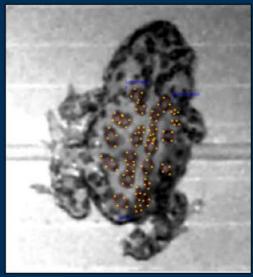




Study Design • Forest • Adjacent to ERS • Under ERS Wetland Habitat







Movement from meadow to upland terrestrial habitat

Fencing: ERTEC & Animex

120 m on each side of passage

Camera spacing= 20 m

10m next to road

Cameras:

HALT© Active Light Trigger & Reconyx- Time Lapse

i3s software



Results: Individual Movement

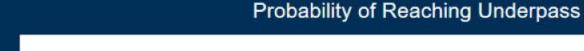
- 42 individual YT along the fence-line
 - 27 in 2018 & only 15 from 2019-21 (drought, fire, forest clearing)
 - 24 mesh fencing, 16 solid fencing, 2 both
 - 24 subadults, 18 adults
- Average "give-up" distance= 46m (median 40m)
- Direction changes (0-4 per individual)
- 29 Individuals detected moving under ERS (estim >100)
- Adults moved farther along solid fencing (80 vs 30 m)
- No difference for subadults (40-50m)

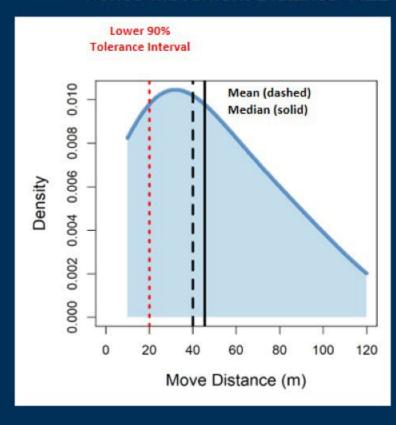


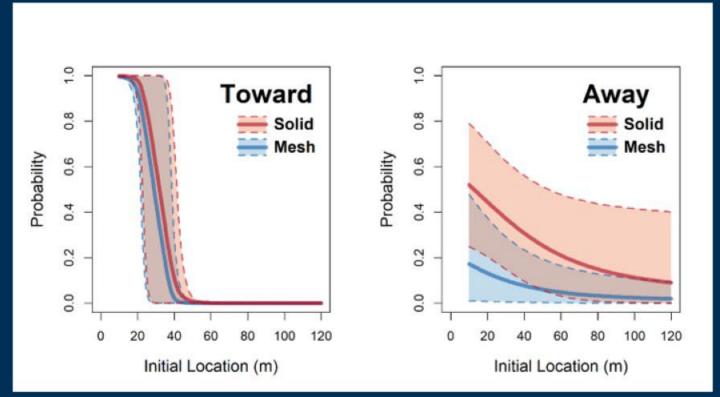


Results: Individual Movement

Fence Movement Distance- ALL









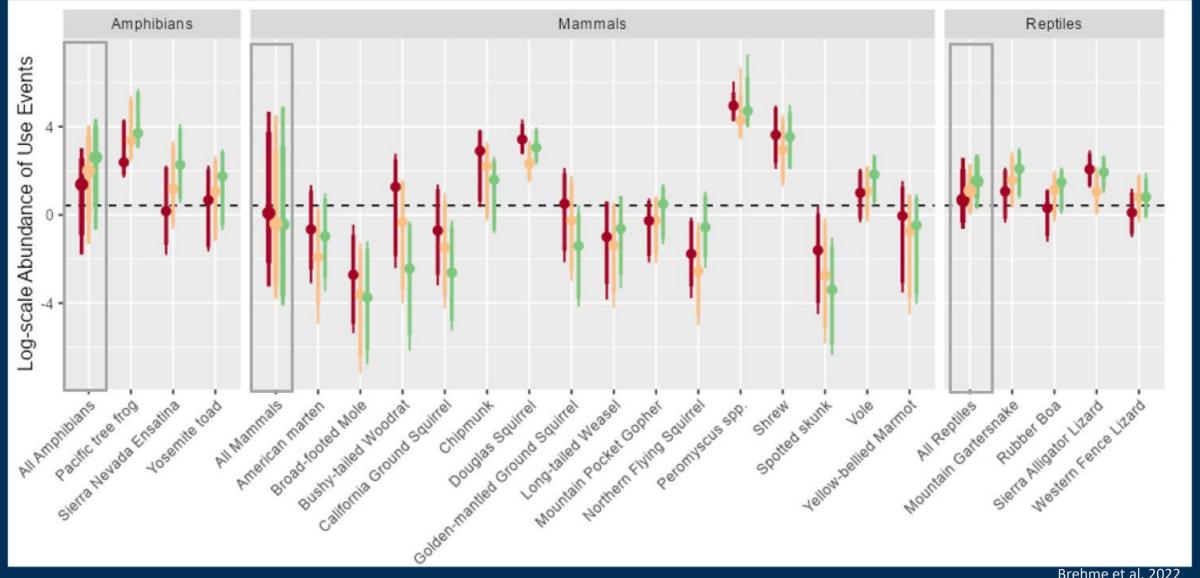
Spacing between passages (90% permeability) = 20 meters



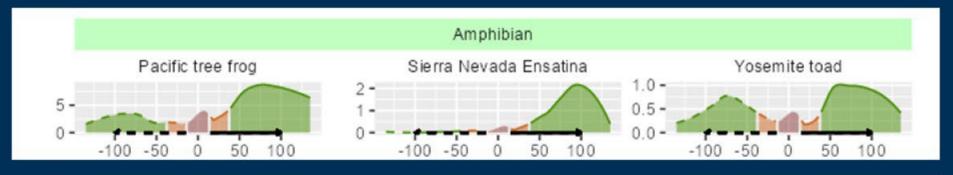


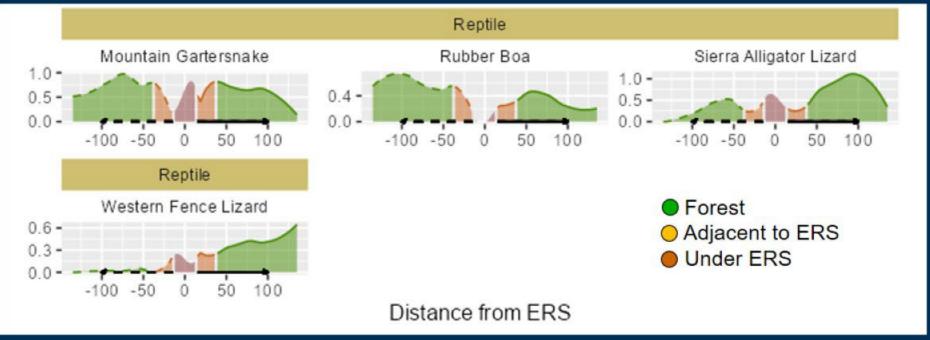
Results: All Species Activity





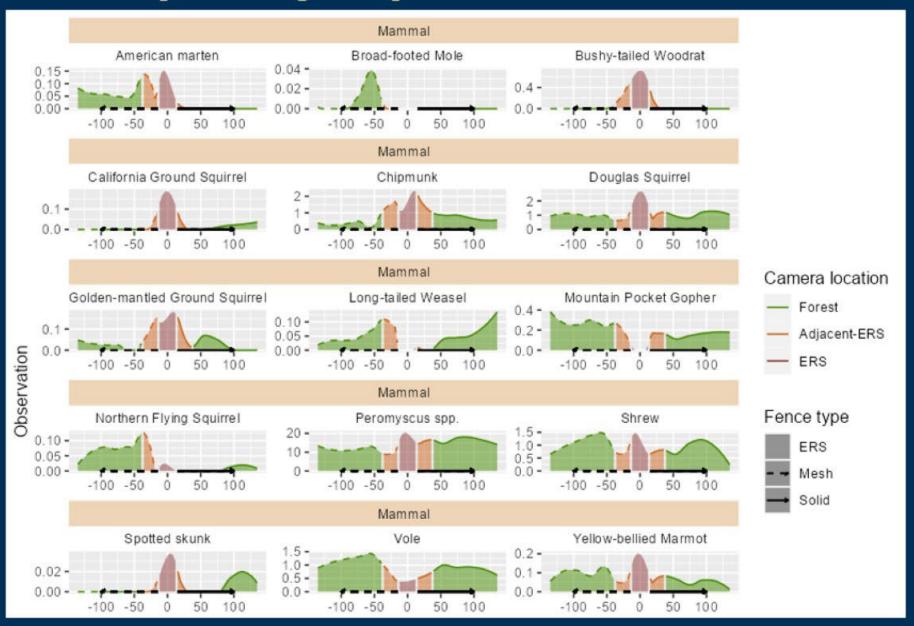
Spatially explicit: Amphibians & Reptiles







Spatially explicit: Mammals



Conclusions

- 10-20m between passages currently supported by science for migratory amphibians
- Current literature indicates wider passages are more permeable to movement of many amphibian species.
- ERS Highly Permeable to Small Animal Movement
 - Potential to better maintain connectivity over large road spans with widespread mortality.
 - Permeable to rain and light---Incorporates moisture during rain events and more natural climate conditions within passage.
 - No effect on drainage- Passage less prone to flooding- at natural grade
 - No damage to adjacent habitat- small area of impact
 - Eliminate or reduce need for barrier fencing and associated maintenance.
 - Removable



Additional Designs



Additional Designs- Goals

- Adapt ERS prototype concept to high volume roads
- Meet AASHTO standards
- Permeable to light and moisture
- Natural soil bottom
- 1 foot passage height
- Safe for vehicles and bicycles

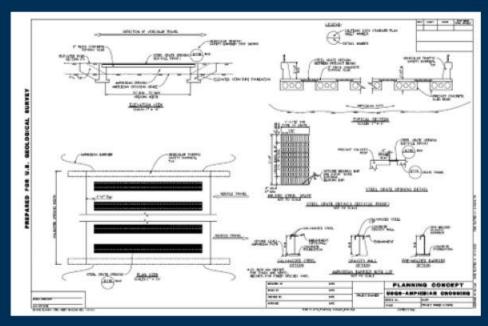


Dokken Engineering

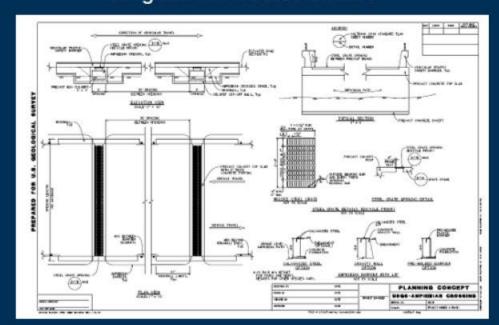
Bridges

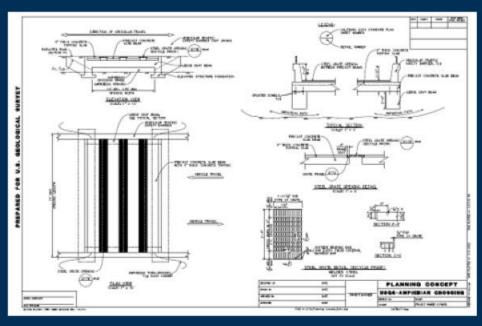
Repeating Culverts in Raised Road



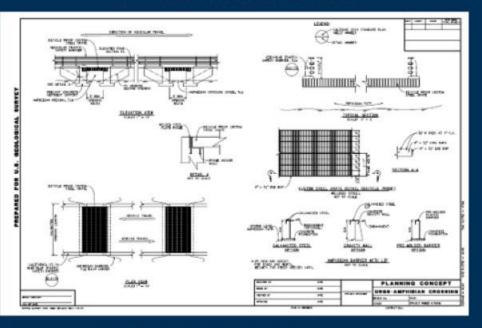


Longitudinal Precast Girders





Transverse Precast Girders











Repeating Elevated Precast Abutments with short span metal grates



Cost Considerations

Itemized Tasks	Cost Range (square foot)	Cost Range (100 linear feet- 2 lane road)	Remarks
Original ERS Design Sierra NF		14' wide= \$47K 20' wide = \$68K	Removable, can be made to meet local, city, county road standards. Requires regular check- ups and maintenance
ERS Bridge Structures	\$250/SF - \$350/SF (Structure only)	14' wide= \$500K 20' wide = \$700K	Includes Foundation Improvements/Preparation, Structural Concrete Supports and Span Elements, Vehicular Safety Railing, and Steel Grates
ERS Repeating Culvert and Short Span Structures	\$250/SF - \$350/SF (Structure only) \$75/SF - \$100/SF (Structure + Road Improvements with structures spaced at 10 m apart)	10 m spacing 14' wide= \$150K 20' wide = \$200K 20 m spacing 14' wide= \$101K 20' wide = \$136K	Includes Raising Roadway, Traffic Handling/Staging, Drainage, Amphibian Barriers, Lighting/Signals, and Safety Improvements Structure Includes Foundation Improvements/Preparation, Structural Concrete Supports and Span Elements, Vehicular Safety Railing, and Steel Grates
Construction Management	10% - 15% CON		Includes Construction Inspection and Documentation, Materials Submittal Reviews, As-Built Documentation



Considerations- Elevated Road Segments (ERS)

- Challenging topography
- No alteration of drainage patterns
- Property Constraints

Cost savings- high volume designs

- Stage Construction
- ABC- accelerated bridge construction 3-5 days
- Repeating culvert:
 - Smaller culvert (i.e. 2x4' vs. 3x5' or reduced height (Pre-cast abutment)
 - Grading and excavation outside road footprint to reduce height
 - \$ Reduction- grade



Final Take-aways

- Passages systems for migratory species should consider filtering effect from barrier fencing and "give-up" distances so that the mitigation solutions both reduce mortality and increase connectivity.
- Elevated road segment designs can provide another alternative to provide high permeability to movement for migratory amphibians and other species.
- Many design options available depending upon road characteristics and site-specific considerations.



Acknowledgments



























