WELCOME: ARC WILDLIFE CROSSING SOLUTIONS

Technology Presentation

Lakewood, CO June 1, 2012

U.S. Department of Transportation

Federal Highway Administration

Federal Lands Highway

Commitment to Excellence

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Technology Delivery Engineer

FHWA – CFLHD

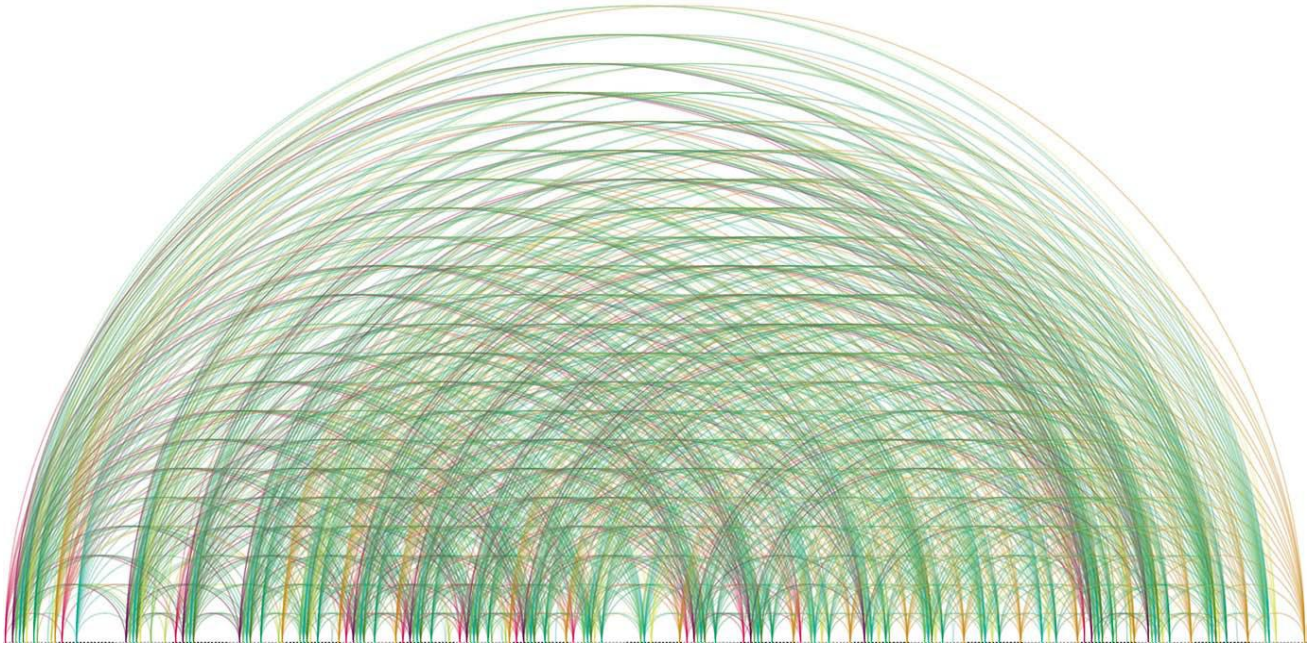
ARC WILDLIFE CROSSING SOLUTIONS: PRESENTER

Rob Ament

Road Ecology Program Manager

Montana State University

Western Transportation Institute

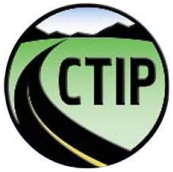


ARC - Solutions

GOAL: Ensuring safe passage for both humans and animals on and across our roads.

We do this through supporting the study, design and construction of wildlife crossing structures throughout North America.

INCREDIBLE PARTNERS & SUPPORT



Others: Western Governors' Wildlife Council, Parks Canada Agency, Canadian Pacific, Center for Large Landscape Conservation

WILDLIFE CROSSINGS
WHY TAKE ACTION?

- Improve motorist safety
- Reduce collision costs
- Reduce wildlife mortality
- Conserve T and E species
- Improve wildlife population survival
- Address mass mortality
- Loss or suffering of wildlife
- Promote habitat connectivity

WVCs: International Issue (Transportation Safety)

	US	Canada	Europe
Animal-vehicle-Collisions	1-2 million (deer)	± 28,000	507.000 (ungulates)
Human injuries	29.000	1,565	30.000
Human fatalities	211	18	300
Property damage	> 8 billion US$	200 million CAN$	> 1 billion US$

Conover et al., 1995; Cook & Daggett, 1995;
Groot Bruinderink & Hazebroek, 1996';
L-P Tardiff & Associates Inc. 2003;
Huijser et al. 2008

per year

…. and increasing

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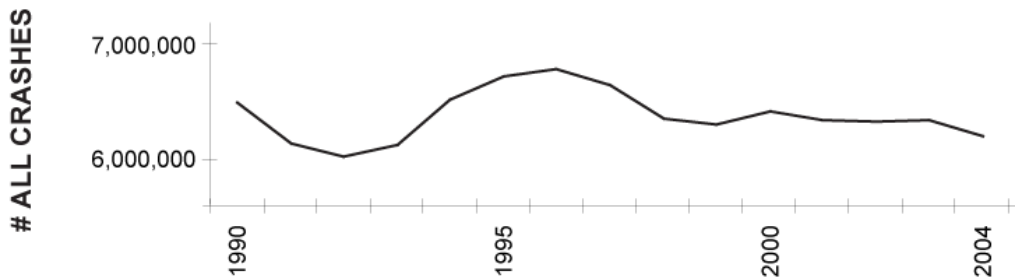
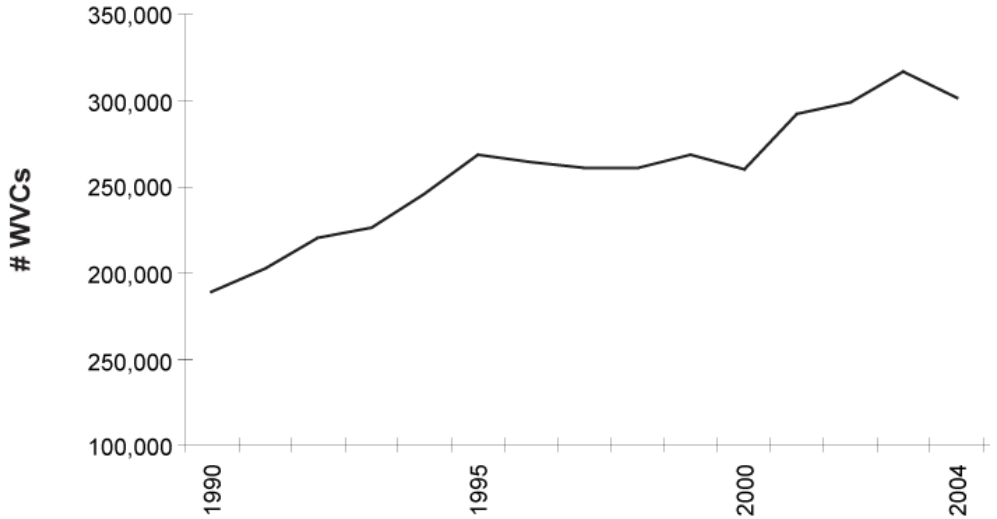
U.S. trend: animal-vehicle collisions





1-2 million ungulate-vehicle collisions / year in US (Huijser et al. 2008)

AVCs: $P < 0.001$, $R^2 = 0.89$
GES (General Estimates System
Sub-sample for every US state)
Huijser et al., 2008

Species and Numbers
A Conservation Issue

Table 1. *Estimates of annual nationwide road kills in wildlife, as obtained from field inventories or drivers enquiries.*

Species	Road kills *	Country	Year/Period	Reference
vertebrates	365	USA	1960's	Humane Society 1960, in Lalo 1987
	100	ES	1990's	Caletrio et al. 1996
	6.5	FI	2002	Manneri 2002
	4.0	BE	1994	Rodts et al. 1998
birds	8.5	SE	1998	Svensson 1998
	5.0	BL	1983	Mankinov & Todorov 1983
	4.0	UK	1966	Hodson 1966
	3.7	DK	1981	Hansen 1982
	2.5	UK	1965	Hodson & Snow 1965
	2.0	NL	1993	Tempel 1993
	1.0	SE	1970's	Göransson et al. 1978
	0.6	NL	1977	Jonkers & De Vries 1977
birds & mammals	2.0	CAN	1970's	Oxley & fenton 1976
large & medium sized mammals	1.5	DK	1980	Hansen 1982
	0.5	SE	1970's	Göransson et al. 1979
	0.2	NL	1977	Jonkers & De Vries 1978
amphibians	5.0	AUS	1983	Ehmann & Cogger 1983, in Bennett 1991
	3.0	DK	1982	Hansen 1982
ungulates	0.5	USA **	1991	Romin & Bissonette 1996
	0.5	EU	1995	Groot-Bruinderink & Hazebroek 1996
	0.004	F	1990's	SETRA 1998
	0.002	ES	1992	Fernandez 1993

** in millions per year, nationwide*
*** only deer (Odocoileus spp.)*

Seiler (2003)

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Federally Listed T&E Species

Species Group	Species Name
Amphibians	*California tiger salamander (Ambystoma californiense), C. CA, S. Barb., Son. county*
Amphibians	*Flatwoods salamander (Ambystoma cingulatum)*
Amphibians	*Houston toad (Bufo houstonensis)*
Reptiles	*American crocodile (Crocodylus acutus)*
Reptiles	*Desert tortoise (Gopherus agassizii), except in Sonoran Desert*
Reptiles	*Gopher tortoise (Gopherus polyphemus), W of Mobile/Tombigbee Rs.*
Reptiles	*Alabama red-bellied turtle (Pseudemys alabamensis)*
Reptiles	*Bog turtle (Muhlenberg) northern population (Clemmys muhlenbergii)*
Reptiles	*Copperbelly water snake (Nerodia erythrogaster neglecta)*

Species Group	Species Name
Reptiles	*Eastern indigo snake, eastern indigo (Drymarchon corais couperi)*
Birds	*Audubon's crested caracara (Polyborus plancus audubonii), FL pop.*
Birds	*Hawaiian goose (Branta sandvicensis)*
Birds	*Florida scrub jay (Aphelocoma coerulescens)*
Mammals	*Lower Keys marsh rabbit, (Sylvilagus palustris hefneri)*
Mammals	*Key deer (Odocoileus virginianus clavium)*
Mammals	*Bighorn Sheep, Peninsular CA pop. (Ovis canadensis)*
Mammals	*San Joaquin kit fox (Vulpes macrotis mutica)*
Mammals	*Canada lynx (Lynx canadensis), lower 48 states*
Mammals	*Ocelot (Leopardus pardalis)*
Mammals	*Florida panther (Felis concolor coryi)*
Mammals	*Red wolf (Canis rufus), except where XN*

Huijser et al. 2008

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North America: costs of collisions

Description	Deer	Elk	Moose
Vehicle repair costs per collision	$2,622	$4,550	$5,600
Human injuries per collision	$2,702	$5,403	$10,807
Human fatalities per collision	$1,002	$6,683	$13,366
Towing, accident attendance and investigation	$125	$375	$500
Hunting value animal per collision	$116	$397	$387
Carcass removal and disposal per collision	$50	$75	$100
Total	$6,617	$17,483	$30,760

Huijser et al. 2009, Ecology and Society

Effective Measures

Mitigation measure	Effect-iveness	Source
Seasonal wildlife warning sign	26%	Sullivan et al. (2004): 51%; Rogers (2004): 0%
Vegetation removal	38%	Jaren et al. (1991): 56%; Lavsund and Sandegren (1991): 20%
Fence, gap, crosswalk	40%	Lehnert and Bissonette (1997): 42%, 37%
Population culling	50%	Review in Huijser et al. 2007a
Relocation	50%	Review in Huijser et al. 2007a
Anti-fertility treatment	50%	Review in Huijser et al. 2007a
Fence (incl. dig barrier)	86%	Reed et al. (1982) 79%; Ward (1982): 90% Woods (1990): 94-97%; Clevenger et al. (2001): 80%; Dodd et al. (2007): 87%
Fence, underpass	86%	Reed et al. (1982) 79%; Ward (1982): 90% Woods (1990): 94-97%; Clevenger et al. (2001): 80%; Dodd et al. (2007): 87%
Fence, under- and overpass	86%	Reed et al. (1982) 79%; Ward (1982): 90% Woods (1990): 94-97%; Clevenger et al. (2001): 80%; Dodd et al. (2007): 87%
Animal detection system (ADS)	87%	Mosler-Berger and Romer (2003): 82%; Dodd and Gagnon (2008): 91%
Fence, gap, ADS	87%	Mosler-Berger and Romer (2003): 82%; Dodd and Gagnon (2008): 91%
Elevated roadway	100%	Review in Huijser et al. 2007a
Road tunnel	100%	Review in Huijser et al. 2007a

PROVEN

EXPERIMENTAL

EXPENSIVE

Fences in combination with crossing structures

DESIGN*

Overpass Design:

1 Landscape bridge
2 Wildlife overpass
3 Multi-use overpass
4 Canopy crossing

Underpass Design:

5 Viaduct/Flyover
6 Large mammal underpass
7 Multi-use underpass
8 Underpass with waterflow
9 Small/Medium-size mammal underpass
10 Modified culvert design
11 Herp tunnel

*Guidelines for designing and evaluating North American wildlife crossing systems, Clevenger et al. 2009

Wildlife Crossings, Eco-ducts, Fauna Passages

A Brief History

1950s - First wildlife crossings in Europe and USA

1960s – France: First wildlife overpasses; Hunters involved

1970s – 1st Overpasses in North America (UT, NJ)

1980s – 1st Wildlife Crossings in Banff National Park

1990s – Florida I-75 Alligator Alley, 1st large-scale works

1st Overpass in Canada (Coquihalla Highway, BC)

1st Overpasses in Banff National Park (phase 3A)

*From a history of road ecology (Forman et al. 2003)

Present state of wildlife crossing integration with transportation networks

<u>On all major continents</u>

Most active: Europe, North America, Australia

Increasing activity: Asia, India, Latin America

Urcel, France

Germany

European wildlife overpasses

A sampler

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What does the endangered crested newt like?…
50-m wide overpasses with water

Topside View of Overpass in Holland

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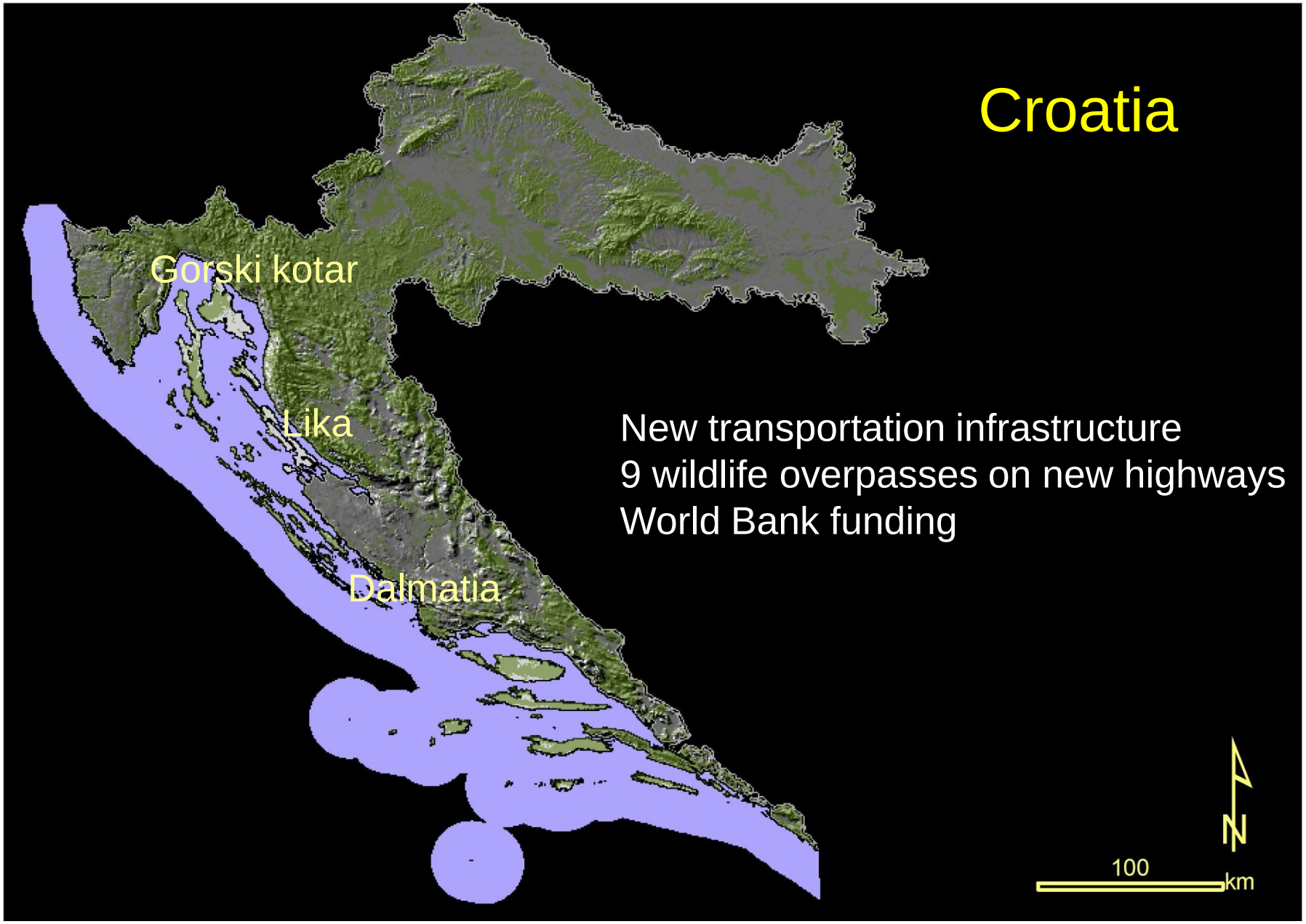

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Landscape:
Central European hardwood forest
Eurasian brown bear, lynx, wolf

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Spain

Paso superior, Autovia de Algadefe LE-4 (Leon), España

Landscape:
Agricultural/riparian mix
Wolves, roe deer, wild boar

Paso superior, Autovia de Matilla Arzon (Zamora), España

Current North American wildlife crossings

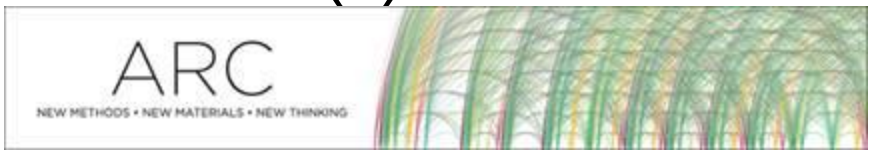
Wildlife underpasses - over 500

Wildlife overpasses - 13

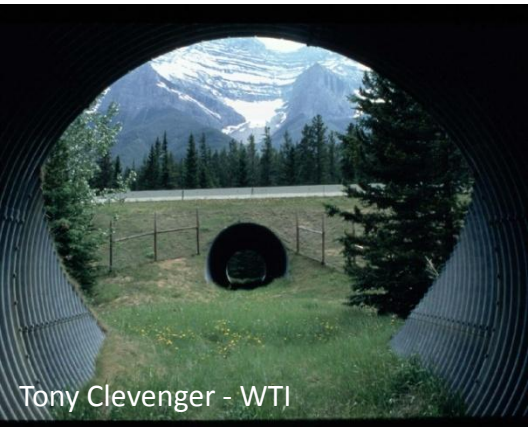
- British Columbia (1)
- Alberta (4)
- Utah (1)
- New Jersey (2)
- Florida (1)
- Montana (1)
- Nevada (1)
- Wyoming (2)

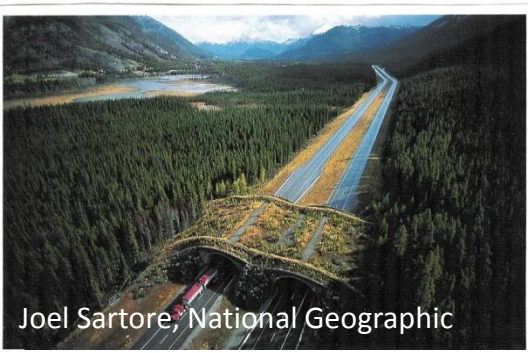
More in planning stages

- Washington (2)
- Alberta (2)



LESSONS FROM BANFF NATIONAL PARK





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Use of Crossing Structures

Banff National Park, Albert (Nov '96 to Oct '08)

185,683 detections, 12 large mammal species, 28 crossing structures

Ungulates

Deer	**127,553**
Elk	**37,772**
Moose	**144**
Bighorn sheep	**4,592**

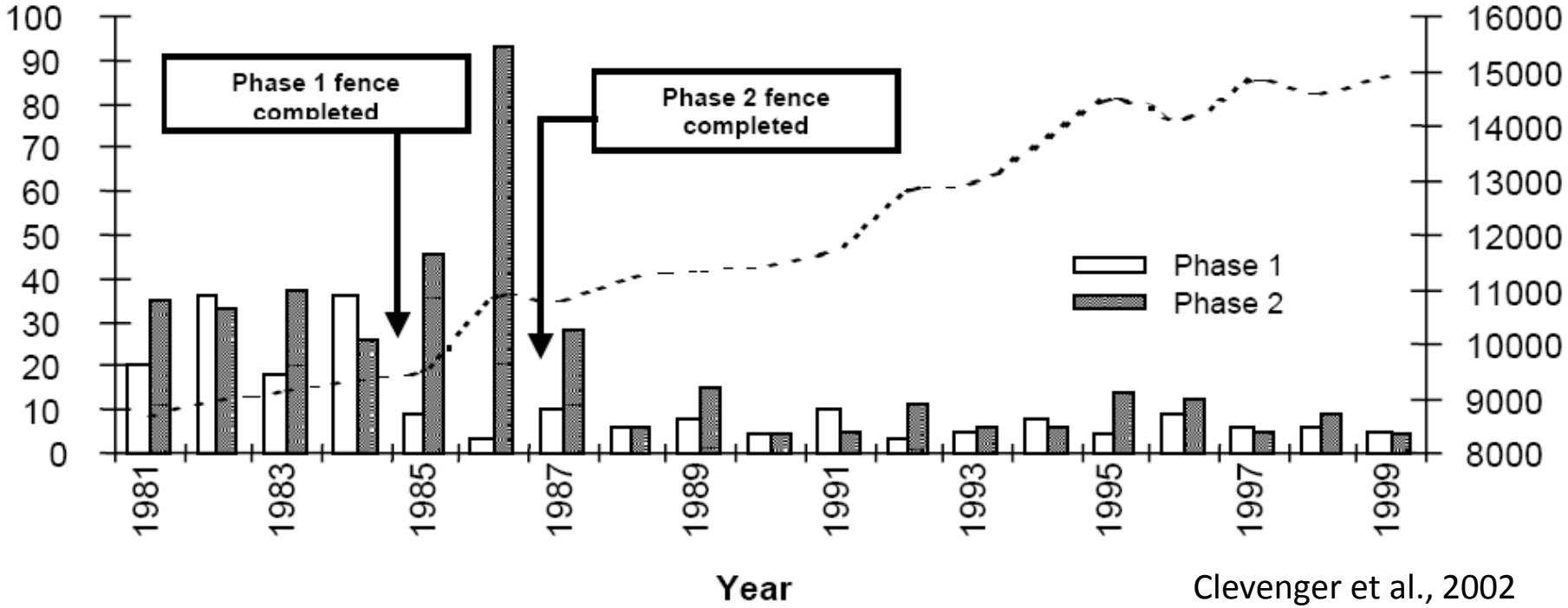
Clevenger et al., 2009

Carnivores

Black bear	**1,191**
Grizzly bear	**679**
Bear ssp.	**24**
Wolf	**5,113**
Coyote	**7,202**
Cougar	**1,405**
Lynx	**4**
Wolverine	**4**

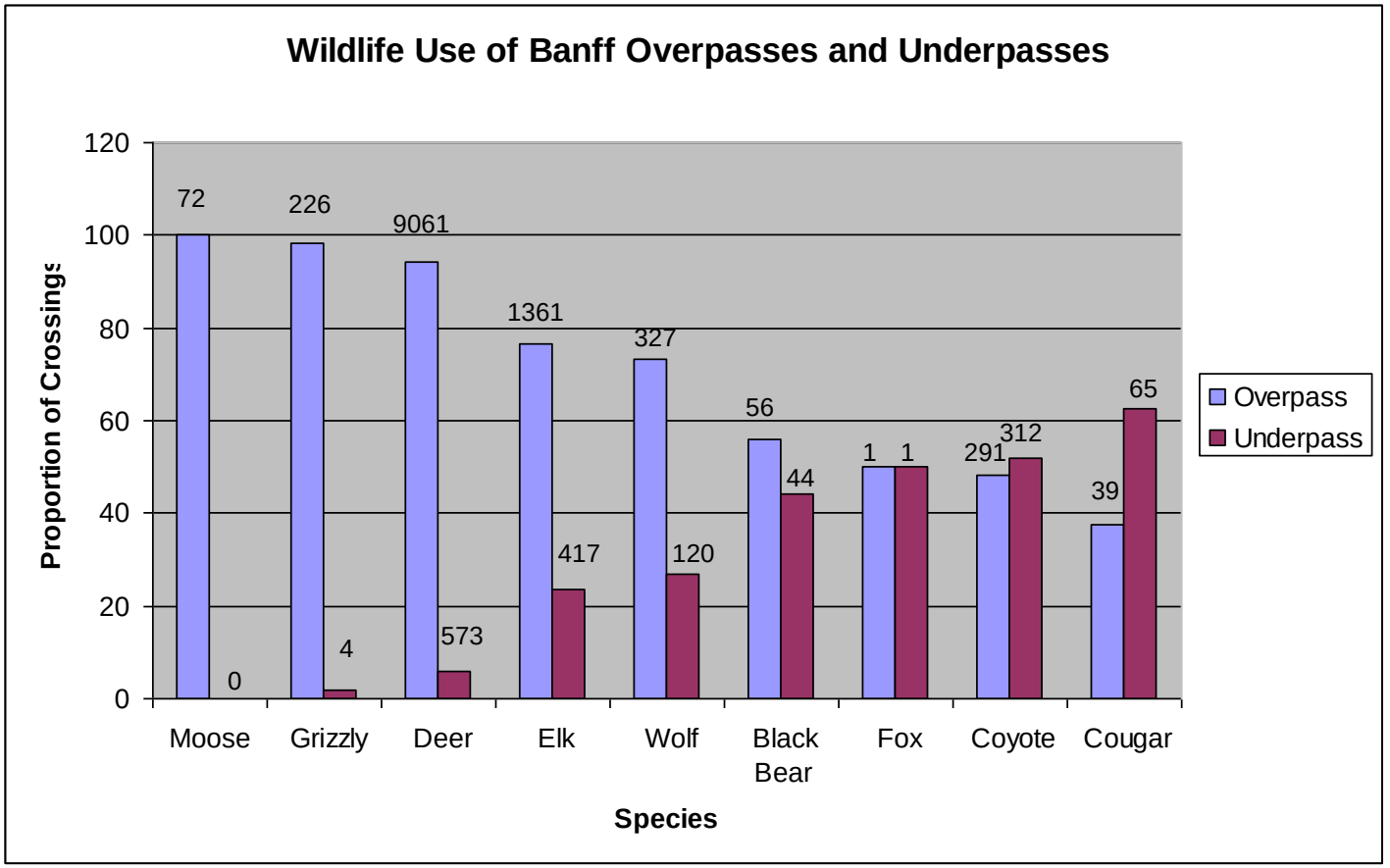
Wildlife-Vehicle Collision Reduction

86% reduction (79-99%)



Clevenger et al., 2002

Differential Use of Crossing Type



Pair-wise comparison of Wolverine Overpass/Underpass and Red Earth Overpass/Underpass

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INTERESTING INTERACTIONS

Wolf v. Elk (underpass)

Sparring Grizzlies (overpass)

Photos: WTI Research Cameras

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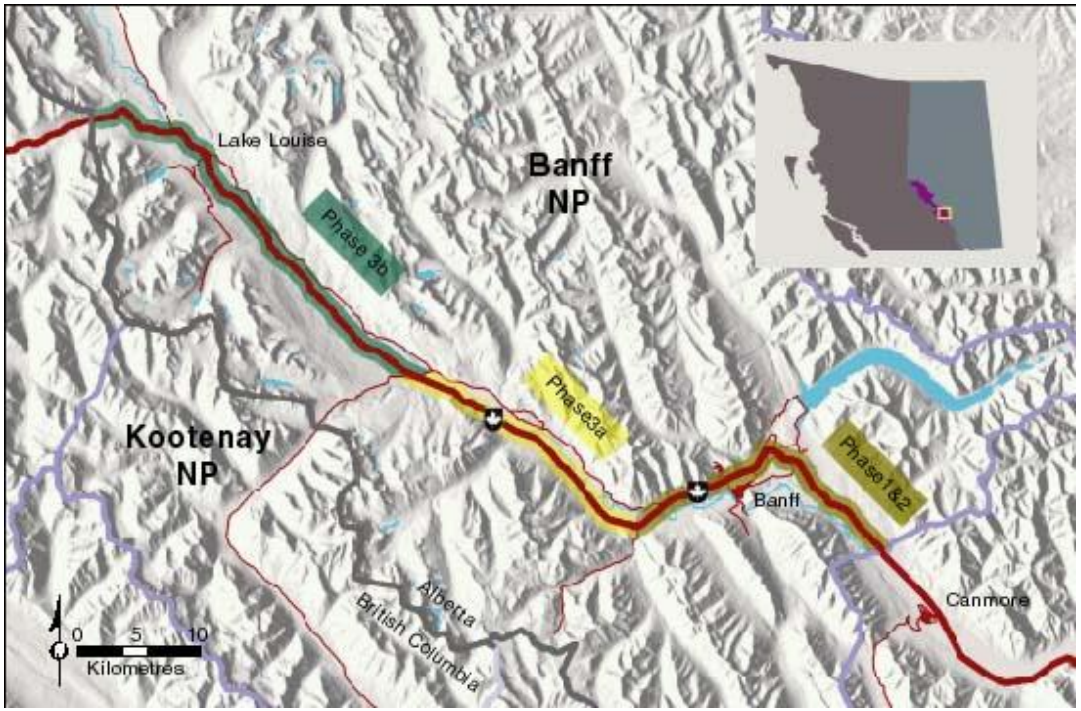
Banff TransCanada Highway Wildlife Mitigation

Costs as proportion of expansion project:

TCH phase 1 & 2 (1986) - 15%
TCH phase 3A (1997) - 25-30%
TCH phase 3B (2008) - 40-45%



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Costs of Wildlife Crossing Mitigation ?

***1997* and *2008* figures**

Wildlife overpass, 50-m wide* = $C 2.5 - 3 M

Wildlife overpass, 60-m wide* = $C 9 M

Wildlife underpass, 4 x 12 m* = $C 750,000

Wildlife underpass, 5.5 x 24 m* = $C 6 M

Wildlife underpass, 4 x 7 m* = $C 500,000

Wildlife underpass, 4 x 7 m* = $C 1.5 M

Wildlife underpass, box culvert* = $C 250,000

Wildlife underpass, box culvert* = $C 1.2 M

Fencing, wood posts w/apron = $C 35 per metre

Fencing, wood posts w/apron = $C 110 per metre

*Span 4-lanes with 32 m median.

Why not have a competition ?

ARC DESIGN COMPETITION: The Rationale

WCs proven effective in reducing WVCs

WVCs increasing significantly across NA

WCs passing many types of species

Overpasses may support different species

WCs becoming increasingly expensive

Europe developing more diverse overpass designs

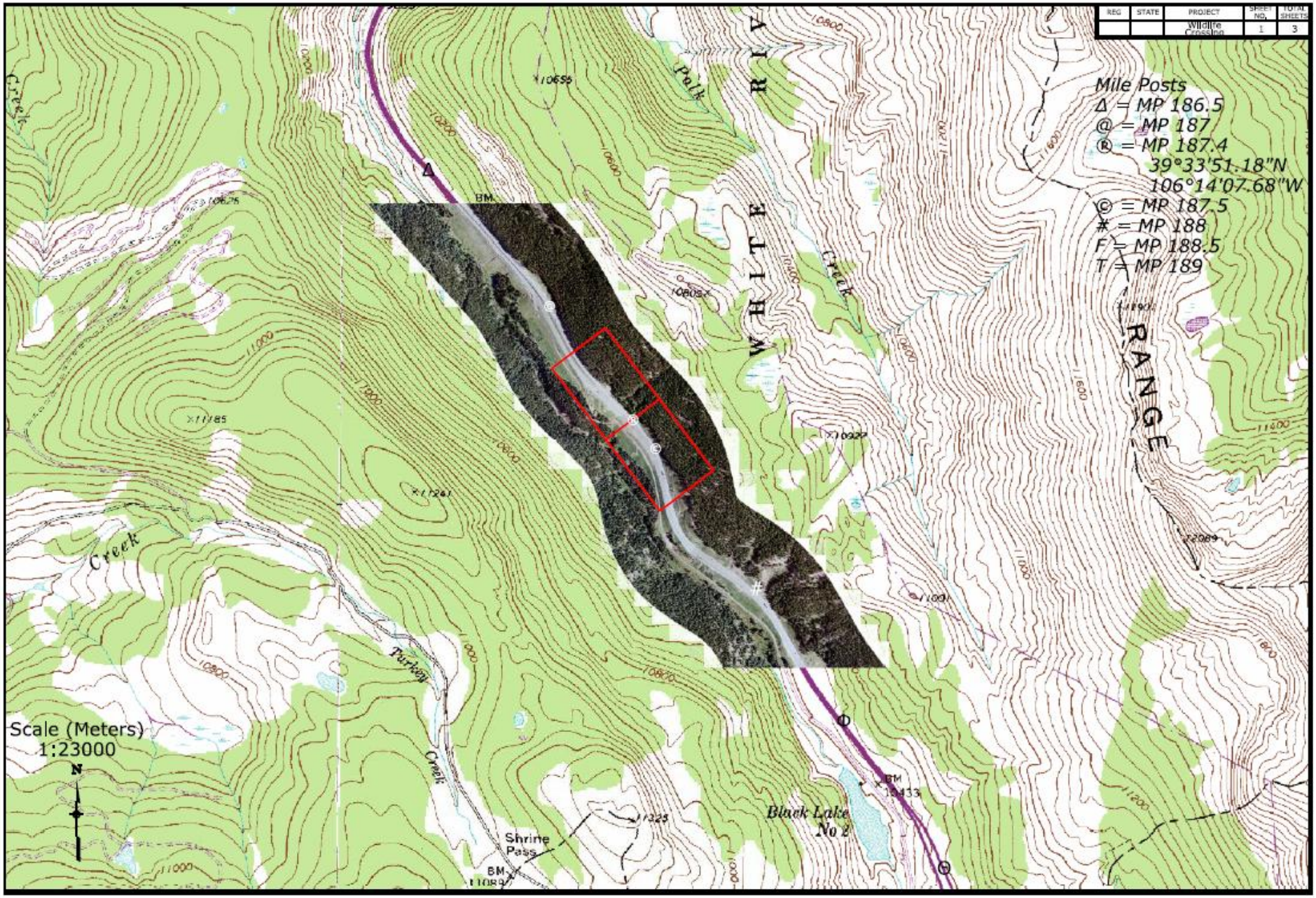
Context Sensitive, Green Highways, Climate Change

DESIGN COMPETITION

Objective : a real-time, in-situ application

Site competition: sent notice out to various networks (AASHTO, Transwild, WFT Listserve, etc.) regarding interest in potential sites

- 22 locations were nominated/suggested across North America
- Nominations reviewed by ARC Technical Advisory Committee
- ARC Steering Team selected Vail Pass
- Worked with CDOT and signed MOU



West Vail Pass Regional Context Map. Source: Federal Highway Administration, 2010.

Phases & Stats

Phase 1 - Call for Expressions of Interest

100 firms

9 countries

36 teams

qualifications and design approaches

Phase 2 – Invited

5 finalist teams

model, panels & booklet

Partnership among disciplines

Engineering

Ecology

Architecture

Landscape Architecture

Wildlife Biology

Transportation

Landscape Design

Graphic Design

Jury

Prof. Charles Waldheim (Jury Chair), John E. Irving Professor and Chair of Landscape Architecture, Harvard University, Graduate School of Design

Jane Wernick, Structural Engineer and Director of Jane Wernick Associates, London.

William L. Withuhn, Curator Emeritus, History of Technology and Transportation, Smithsonian Institution

Prof. Jane Wolff, Associate Professor and Chair of Landscape Architecture, John H. Daniels Faculty of Landscape, Architecture and Design, University of Toronto

Dr. Anthony Clevenger, Senior Research Scientist (Road Ecology), Western Transportation Institute, Montana State University

Finalist teams

Balmori Associates (New York)

with StudioMDA, Knippers Helbig Inc., David Skelly, CITA, Bluegreen, John A. Martin & Associates, & David Langdon

HNTB with Michael Van Valkenburgh & Assoc. (New York)
with Applied Ecological Services, Inc.

Janet Rosenberg & Associates (Toronto)
with Blackwell Bowick Partnership, Dougan & Associates, & Ecokare International

The Olin Studio (Philadelphia)
with Explorations Architecture, Buro Happold, & Applied Ecological Services

Zwarts & Jansma Architects (Amsterdam)
with OKRA Landscape Architects, IV-infra, & Planecologie

ARC DESIGN COMPETITION FINALISTS

Olin Studios (Philadelphia) *with* Explorations Architecture (Paris), Buro Happold (London) and Applied Ecological Services.

OLIN Team panels

Girard/ARC

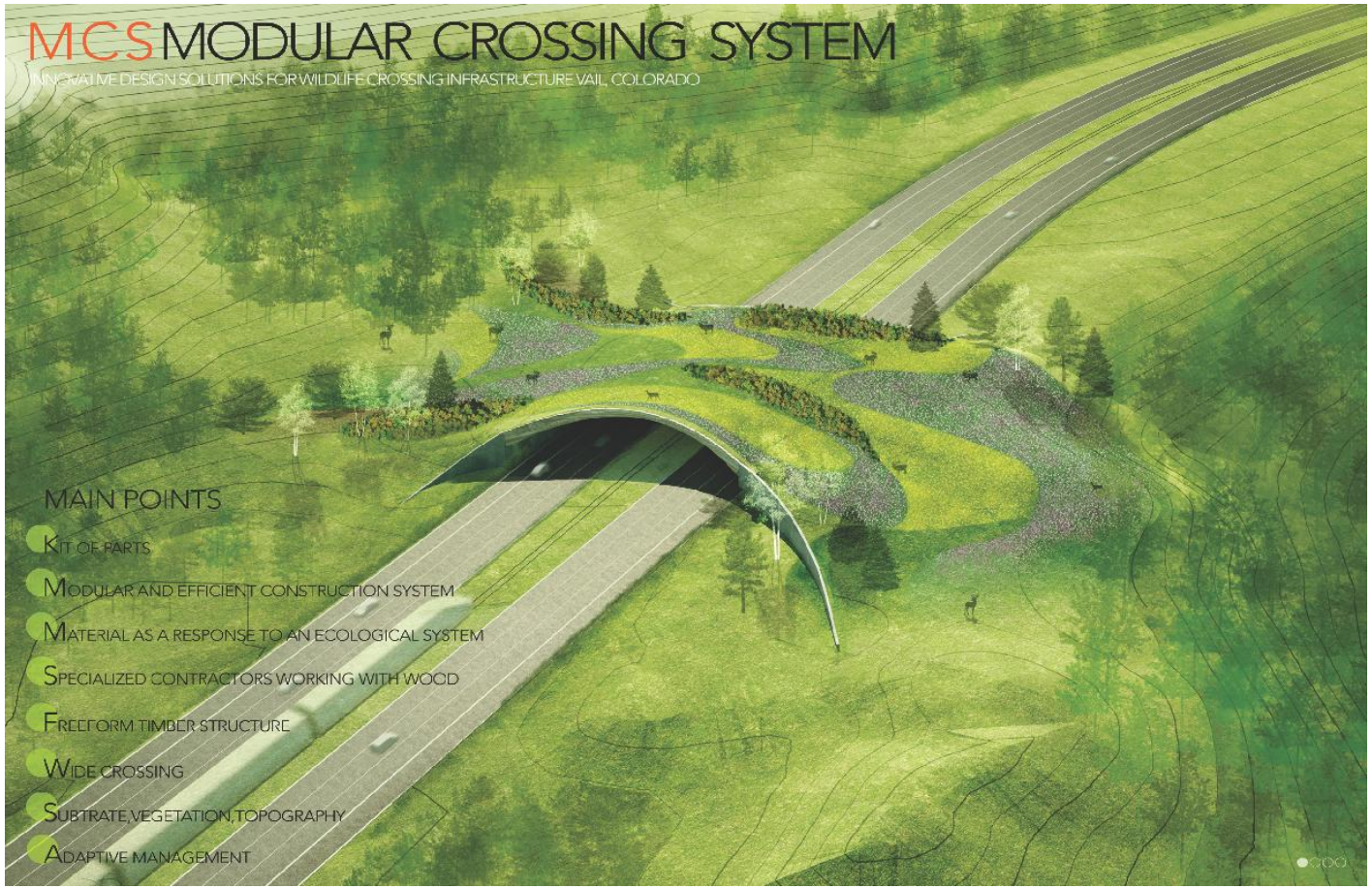
ARC DESIGN COMPETITION FINALISTS

Janet Rosenberg & Associates (Toronto) *with* Blackwell Bowick Partnership, Dougan & Associates, and Ecokare

Rosenberg Team 3-D model

Girard/ARC

ARC DESIGN COMPETITION FINALISTS



Balmori Associates (New York) *with StudioMDA, Knippers Helbig Inc., David Skelly, CITA, Bluegreen, John A. Martin & Associates, and David Langdon*

ARC DESIGN COMPETITION FINALISTS

Zwarts & Jansma Architects (Amsterdam*) with* OKRA Landscape Architects, IV-infra and Planecologie

Jury assessment:

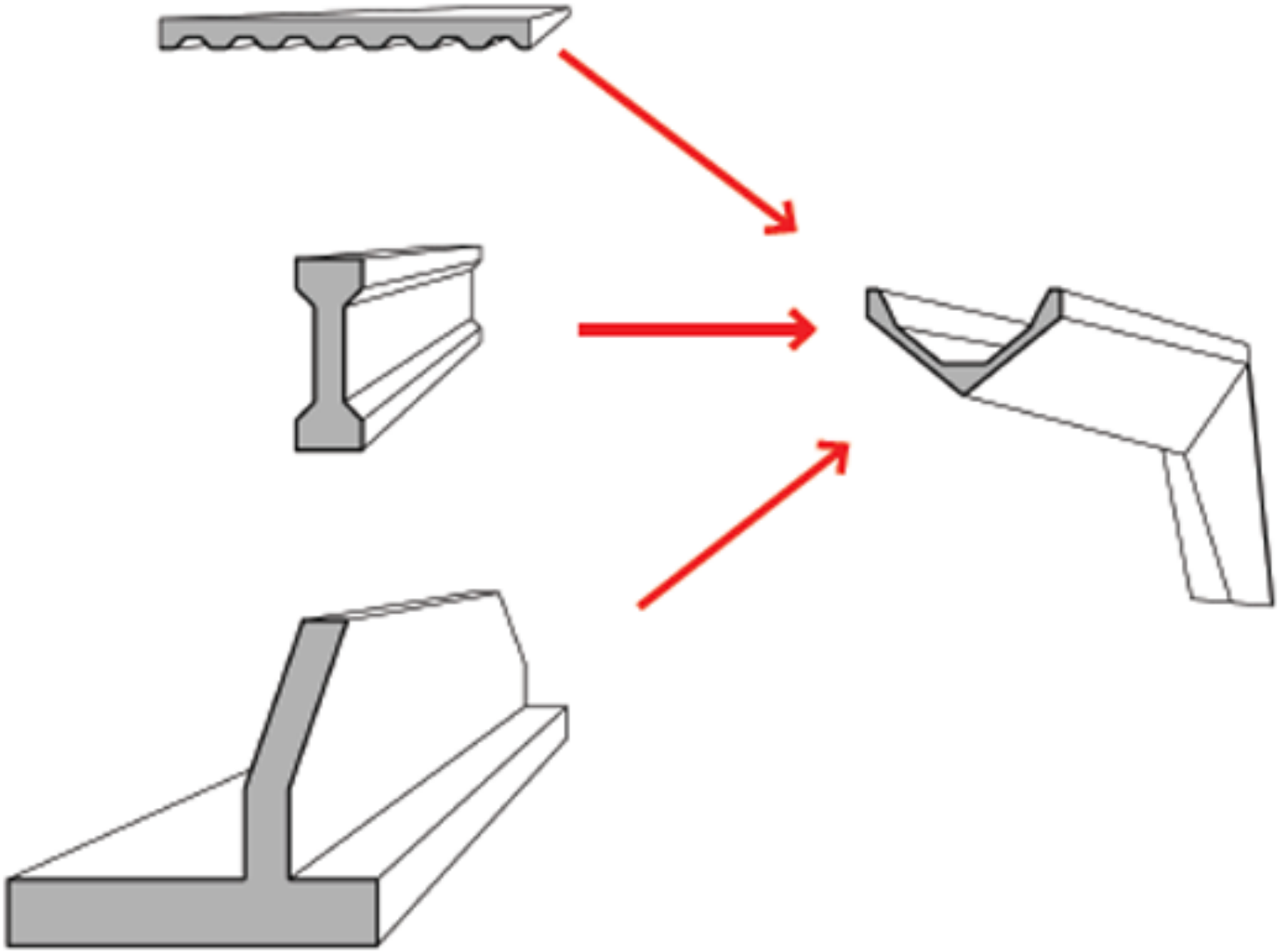
"the winning proposal by HNTB Engineering with Michael Van Valkenburgh & Associates was not only eminently possible; it has the capacity to transform what we think of as possible."

hypar - nature

hyper-nature: \hī-pər nā-chər\
a landscape of optimal ecological function at the point of scalar compression

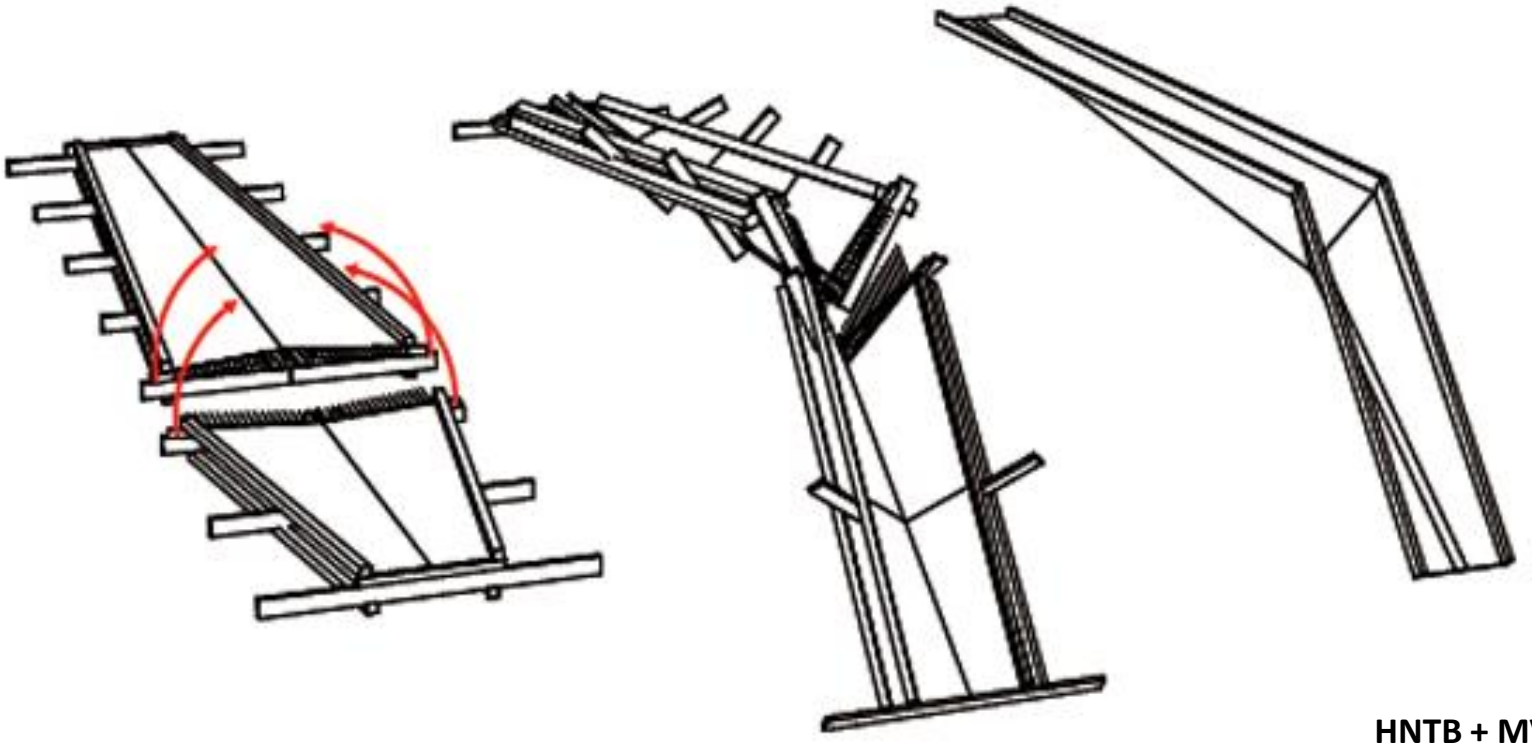
hypar (hyperbolic parabaloid) vault: \hī-pär vȯlt\
a modular unit that pairs a doubly-curved surface with a form that depends on a counter-resistance to the exertion of lateral thrust

HNTB + MVVA TEAM



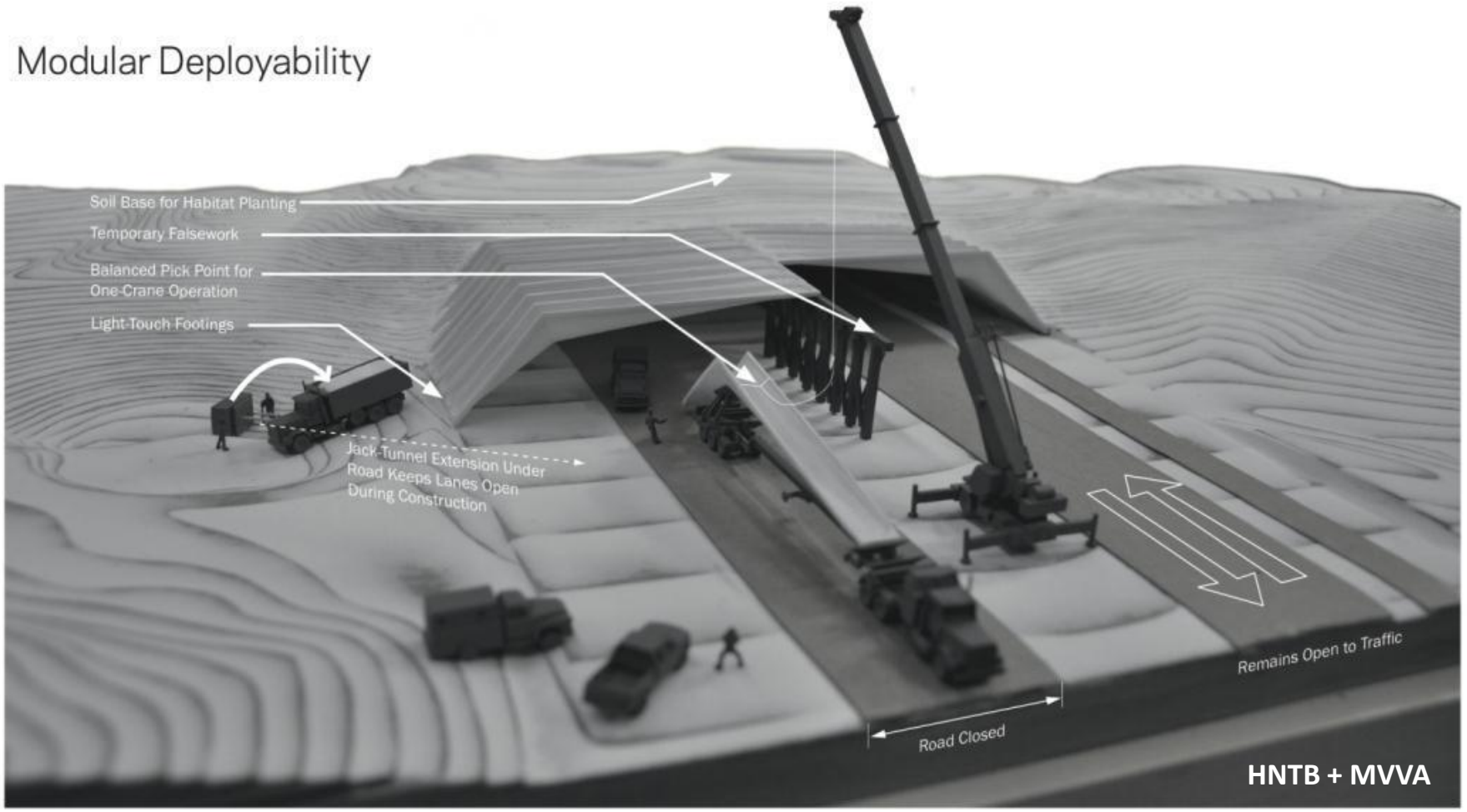
HNTB + MVVA

Crux of Hypar-nature



HNTB + MVVA

Modular Deployability



National

MONDAY, JANUARY 24, 2011

The New York Times

here a Highway Crosses Wildlife's Path, Designers Compete to Avert Collisions

By MATTHEW L. WALD

SHINGTON — At a picturesque the mountains near the ski re- of Vail and Breckenridge, Colo., reams of traffic converge: peo- iving east and west on Interstate d animals — black bears, cou- bobcats, elk and deer — headed and south to feed and mate. they collide, the animal is al- always killed and the vehicle damaged, even if the driver is enough to escape injury.

e obvious solution is a bridge or a el for the animals, but how do you d one they will use?

n Sunday, a nonprofit group an- nced the winner of a competition design such a crossing: Michael Valkenburgh & Associates, a land- pe architecture firm with offices in w York City and Cambridge, Mass. e design team, associated with the tional construction firm HNTB, sub- tted a proposal for a bridge made of htweight precast concrete panels at are snapped into place and cov- ed with foliage.

The bridge is broad enough to allow r strips — lanes, actually — that re- emble forests, shrubs and meadows ith the aim of satisfying the tastes o

any of the animals in the area. Miles of fences on either side of the highway would funnel animals to the bridge.

The state has not committed to build such a structure at that spot. The per- centage of crashes caused by animals is far [illegible] other areas, said Sta- cey St Colori tion. learn entr anir

endangered.

More broadly, the highway forms a threatening barrier between nature preserves on either side, increasing the likelihood that the populations will become genetically isolated.

"As you fragment the habitat, th long-term prognosis for wildlife bad," said Rob Ament, the proje manager for the group sponsoring

competition, which bestows a $40,000 [illegible] was initiated by the West- [illegible] at Mon-

DENVER AND THE WEST

Design selected for I-70 wild crossing near Vail

By Jessica Fender
The Denver Post

POSTED: 01/24/2011 01:00:00 AM MST
UPDATED: 01/24/2011 08:46:26 AM MST

Calling it a potential "model for the world," a pane engineers Sunday picked a Ne crossing over I-

THE WALL STREET JOURNAL.

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Wildlife bridge contest: Winning West Vail Pass entry "elegant" yet practical

By Alan Prendergast, Mon., Jan. 24 2011 @ 2:50PM
Categories: Fashion & Design, Follow That Story, Video

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A New York team has won a unique international competit design a special bridge for wildlife crossing I-70 west of V Pass, the first structure of its kind ever proposed for the U States. The winners, HNTB with Michael Van Valkenburg will take home a prize of $40,000. Whether t

CALGARY HERALD

PROUDLY CALGARY SINCE 1883

Banff bridges leading to new ideas

Increasing numbers of animal-vehicle collisions on high

Tell us)

Winning ARC entry by
HNTB + MVVA

www.arc-solutions.org

THANK YOU

QUESTIONS?