

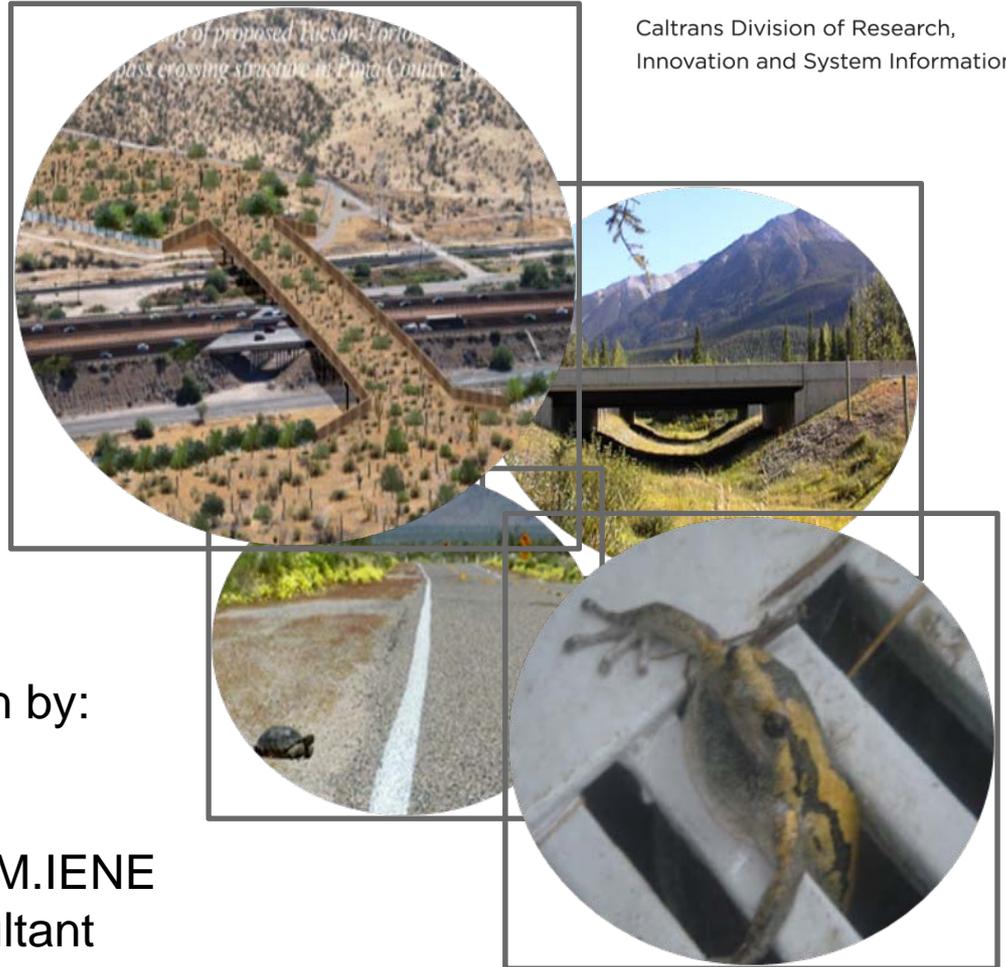


Developing Wildlife Crossing Structures for Small Vertebrates

Wildlife Information Presentation by:

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HCI Ltd.



The Impact of Road Traffic Worldwide

- 750 million vehicles, on 50 million km of public roads
- Minimum estimate: 12,000 vertebrates killed per minute
- Animal-vehicle interactions (AVI) kill up to 10 people and injure up to 900 humans per day, including severe permanent injury. Costs US \$4.6 billion per year.
- USA human fatalities and injuries from AVI have risen around 5% per year



World Problem: More Roads, More Mortality

By 2020 -

- China to build 650,000 km new main roads. 1000 km /week.
- India: estimated US \$ 1Trillion on roads
- European Trans-European Transport Network : € 350 billion to 2020.
- Animal deaths and injuries likely to double by 2020



Additional Road Related Problems

- Animals trapped in grated drains; gully pot and large water storage chambers in side roads, main roads and motorways
- The 'unseen' problem of population fragmentation and population decline and localised extinction



Crossing Designs: Historical

Barriers have 'evolved' from livestock control, road safety and water management:

- Large vertebrate barriers: post and wire, chain link or mesh fencing
- Road over-bridges and underpasses for livestock/tractors and vehicles also used by wide range of animals
- Generally wood, steel, concrete combination constructions
- Lifespan barriers 15-30 years, culverts 30-50 yrs +



Wildlife Passages – The Water Management Relationship

“Drainage pipework with brick and stonework voids made from terracotta (fired clay), lead, wood stave, and even leather pre-date Roman times in Europe. Gravel and loose pebbles have also been used in trenches in ancient techniques to further enable surface water infiltration and diversion. Measures to enable the drainage of water from and around road surfaces, particularly on sloping ground to reduce scouring, erosion and waterlogging include catch-water drains, shallow trenches set back from road edges; and side drains (AASHTO 2007). In more recent times, pre-formed tube and box materials to carry water under linear transport routes, often referred to as culverts, have included bitumen and plastic pipes together with coated steel, and concrete, the materials most frequently used in modern practices.”

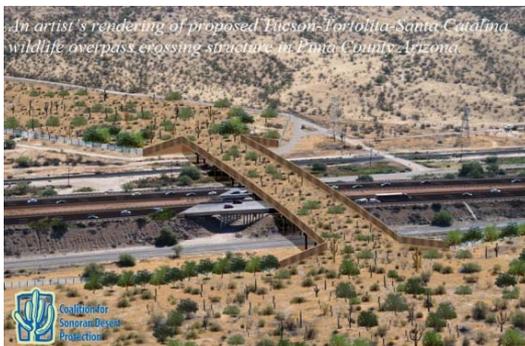
Langton, T.E.S. in prep. A historical analysis of small animal ecopassage systems along transportation corridors. In Andrews, K. Nanjappa, P. and S. Riley (eds.) in prep. Road Planning and Mitigation Design for Small Animals: Concepts and Applications. Johns Hopkins Press: Maryland, USA.

Crossing Designs

- What designs have been used within the USA and around the world?
- Range and scale of construction for different animals and land types
- How does USA compare with rest of world?
- Green bridges or wildlife overpasses
- Barriers guide walls and fencing



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Large and Medium Sized Underpasses



How do West and East USA Compare with Rest of World (Western Europe)?

- | | |
|--|------------------------|
| • Green bridges: | Equal/catching up |
| • Underpasses: inc. retro-improvements | Equal |
| • Small ecopassages | Behind but catching up |
| • Signing | Equal |

Tradition of Concern: Amphibian Road Warning Signs (Europe)



Problems for Small Animals

Defined as those with standing height under 1 metre
Road mortality creates depletion zones, isolation and loss of heterozygosity



Small Underpasses/Wildlife Tunnels

(>3.0 m/12 ft max span) and
micro-tunnels (> 1.0 m/3ft. 3 in max span)



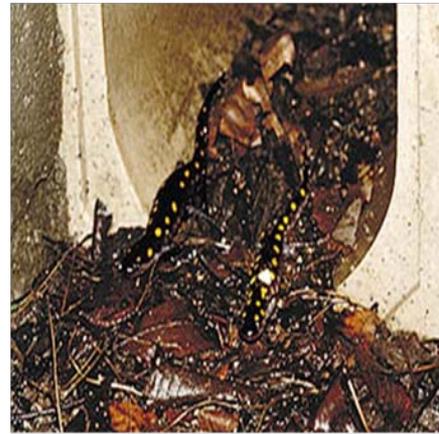
<http://splatfrogunnel.blogspot.co.uk/>



Highway Crossings for Herptiles Nov. 2012
Prelim. Investigation. Produced by CTC & Associates LLC

Small Terrestrial Vertebrates - USA History

- Since 1950's – general wildlife tunnels, Everglades, Florida
- Henry Street, Amherst, MA. 1987 (Spotted salamanders)
- Bastrop State Park, Texas 1989 (Houston toad)
- Davis, California 1995 (Toads)
- Seascape Uplands, Santa Cruz
Santa Cruz long-toed salamander 1999
- Tortoise tunnels; various since 1980s
Slight increase in projects post 2000



Key needs in California and western USA in general.

Q. Concerns have been expressed towards the impact of roads upon salamanders and tortoise populations but what other species are at risk?

A. Many rare and common species.

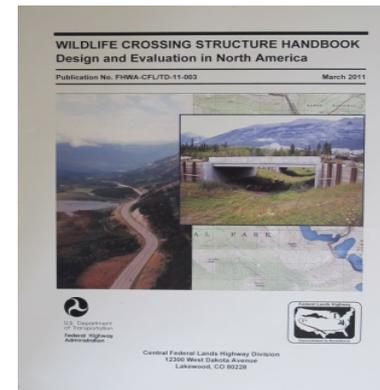
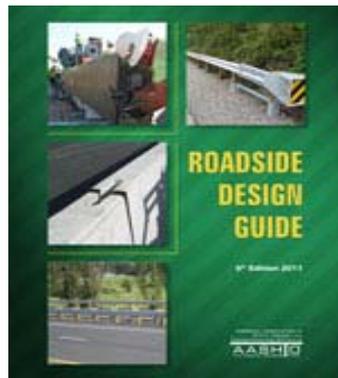
One example: USGS study site: Coastal Sagebrush and Chaparral south of San Diego:

- San Diego pocket mouse *Chaetodipus fallax*
- Cactus mouse *Peromyscus eremicus*
- Deer mouse *Peromyscus maniculatus*
- Dulzura kangaroo rat *Dipodomys simulans*
- Western fence lizard *Sceloporus occidentalis*
- Orange-throated whiptail *Aspidoscelis hyperythrus*



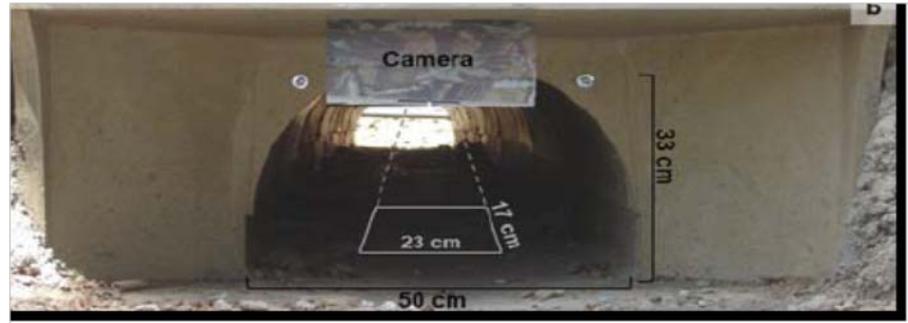
National and State Advice and Guidelines

- ASSHTO Highway design standards
- State guidelines e.g. Caltrans Standard Specifications & research
- **National Cooperative Highway Research Program**
Report 615 Evaluation of the Use and Effectiveness of Wildlife Crossings (2008)
- **US Dept. Transportation, Federal Highway Administration**
Wildlife crossing structure handbooks (2011)



Recent Advances to Assist Road Ecology Evaluation

- Population Viability Analysis (PVA) and analysis software
e.g. RAMAS/VORTEX.
- Greatly reducing cost of molecular analysis to measure heterozygosity (e.g. Hitching & Beebee 2002 loss of fitness in toad tadpoles).
- Infrared movement sensitive night cameras stills/video
e.g. Reconyx/Bushnell



Pagnucco, K.S. Paszkowski, C.A. and G.J. Scrimgeour 2011. Using cameras to monitor tunnel use by long-toed salamanders (*Ambystoma macrodactylum*) an informative, cost-effective technique. *Herpetological Conservation and Biology* 6 (2) 288-286

Pagnucco, K.S., Paszkowski, C.A. and G.J. Scrimgeour 2012. Characterizing movement patterns and spatio-temporal use of under-road tunnels by long-toed salamanders in Waterton Lakes National Park, Canada. *Copeia* (2):331-340

New Camera Based Study: Linnet Lake, Waterton, Canada



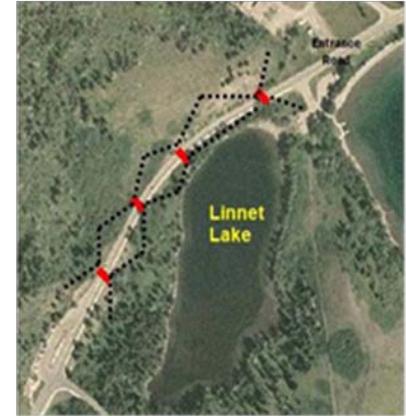
Remotely-triggered cameras (Reconyx PC85) were installed at the roof of each tunnel entrance from 28 August to November 2008 recording movement events (species & no.s in brackets) for:

snowshoe hare (*Lepus americanus*, 113),
red squirrel (*Tamiasciurus hudsonicus*, 109),
mouse (*Peromyscus spp.*, 77),
least chipmunk (*Tamias minimus*, 44),
vole (*Microtus spp.*, 32),
unidentified shrew (1).
raccoon (*Procyon lotor*, 12),
striped skunk (*Mephitis mephitis*, 10),

garter snake (*Thamnophis sp.*, 5),

long-toed salamander (2),
tiger salamander (1) and

Cameras were programmed to take a photograph every minute from 2100 to 0600 Hrs daily. In 2009, from June 2009, 107 long-toed salamanders, moved to and from the lake, have successfully navigated through the tunnels. Most images of salamanders have been captured using fixed-time monitoring rather than motion detection.



Marbled, Jefferson and Spotted Salamanders

Route 78, Nelsonville, Ohio, USA



Lighter coloured frog with the spots square or subgraduate Pickerel Frog *Lithobates palustris*
Dark green with mostly round spots -Leopard Frog *Lithobates pipiens*
Smallest frog: Northern Spring Peeper *Pseudacris crucifer crucifer*
Larger olive green (somewhat mottled frog) is the Green Frog *Lithobates clamitans melanota*
Light brown frog with dark brown face mask is the Wood Frog *Lithobates sylvatica*

Available Techniques and Technology

How do the principal available construction materials react to the outdoor environment, including extremes?

Barriers; Metal

- Flexible manufacturing material
- Mainly used post 1992 in Europe for fencing
- Galvanised/zinc coated/other types
- Rusts – limited lifespan 20-30 years
- Pollutes; zinc and iron oxides/hydroxide
- Highway people tend not to like it
- Reaction to extreme temperatures?
- Dangerous in car crashes?
- Cost volatility according to markets



Available Techniques and Technology

Tunnels; Metal

- Flexible manufacturing material
- Corrugations



Available Techniques and Technology

Plastics

Polythene, polypropylene (PE,PP, PVC)

- UV degradation problem
- Best types 25 yrs+ in shaded sites
- Expansion issues with thin sheet
- Fragile/damages
- Vulnerable to snow/ploughs
- No safety issues

Good for different needs:

Temporary use 1-5 years

Semi-permanent types 15 yrs

Has a role at some selected sites



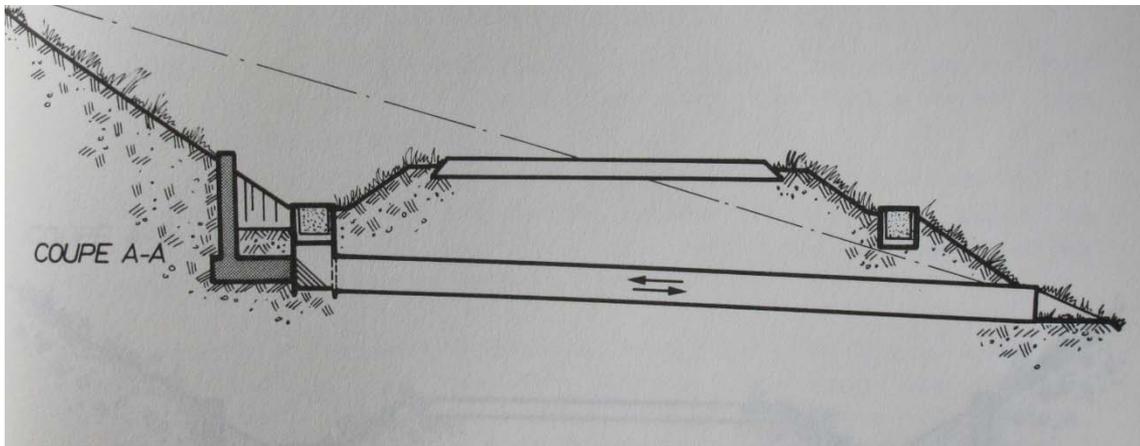
Available Techniques and Technology

Concrete/cement



Early Observations

Concrete – early observations of ‘one-way’ system 1960-1990 in Europe.
Importance of light, heat and humidity to amphibians and other animals



Available Techniques and Technology

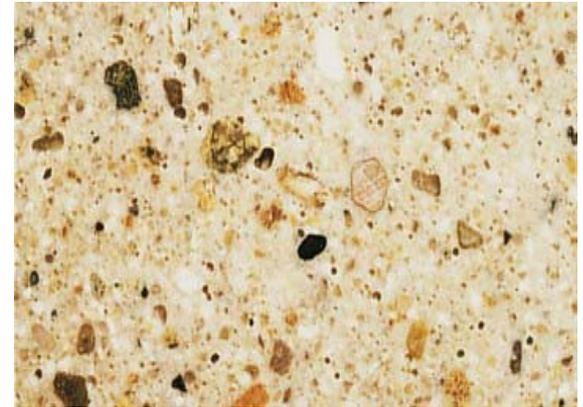
Concrete/cement



Available Techniques and Technology

Polymer concrete

- Cement replaced with resin
- Strength
- Safety vs. metal grating above 30 mph
- Similar wear patterns to black top
- Inert & non absorbant
- No caustic salt residues to burn feed



Available Techniques and Technology

Glass-based (GRP) and emerging experimental new materials



Available Techniques and Technology

- What are the roles of paint and other coatings?
- How does lifespan and durability relate to project cost evaluation and best use of resources?
- How important and frequent should maintenance be?

Maintenance

Q. How important and frequent should maintenance be?

A. Maintenance is more important than construction. At least annual.

Because not maintaining ecopassages wastes the investment.

- Factor the costs in if you can or flag to maintenance.
- Register need in Standards at earliest opportunity.
- Establish simple methods to avoid damage from standard road maintenance techniques. As 'simple' as coloured coded posts and plans.

Funding Crossing Implementations

How are costs distributed within the aspects of selecting materials, construction methods and maintenance procedures?

- Will vary with size and scale of project
- Construction work is not standard and so requires very careful supervision
- Barrier provision and maintenance is often more costly than that for the small ecopassages

What are the typical cost benefit considerations?

- How many passages?
- What type and combination?
- How long does the barrier need to be?

Each site is different, there are multiple options and guidance is needed.

Achieving Crossings that Work to Maximum Benefit



Decision guide/standards for small vertebrate ecopassages, taking into account:

- Long term objective of crossing system in the landscape
- Habitat type/fauna/soils
- Relationship with and shared function amongst all planned bridges/purpose built ecopassages
- Existing or planned drainage/water management options
- Locations in respect of major crossing opportunities (mainly bridges)
- Road size, number of lanes etc.
- Traffic volume, both existing and predicted
- Ground conditions and water level fluctuation including extremes
- Monitoring capacity
- Maintenance capacity