Mitigations to Minimize Transport Infrastructure Impacts to Biodiversity

Asia's first overpass (Singapore)

Crab overpass (Australia)

Flyover (India)

Rope bridge (Costa Rica)

Convention on Biological Diversity

Greening the Transport Sector

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LINEAR INFRASTRUCTURE IMPACTS TO BIODIVERSITY

*"Highways constitute one of the most significant forces altering natural ecosystems and impacting biodiversity in the world."**

Railways

Canals

Powerlines

*Trombulak & Frissell 2000, Forman et al. 2003

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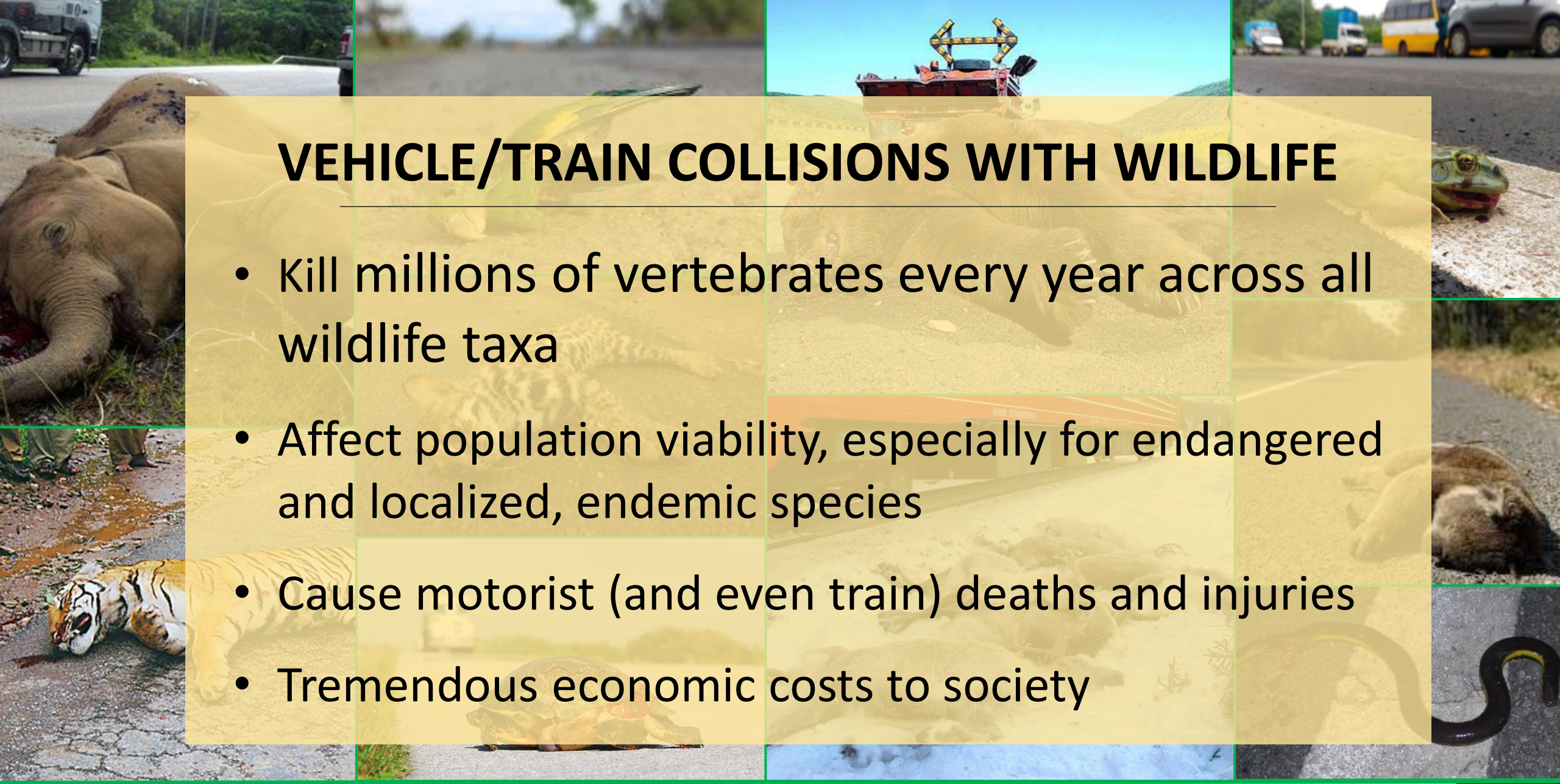
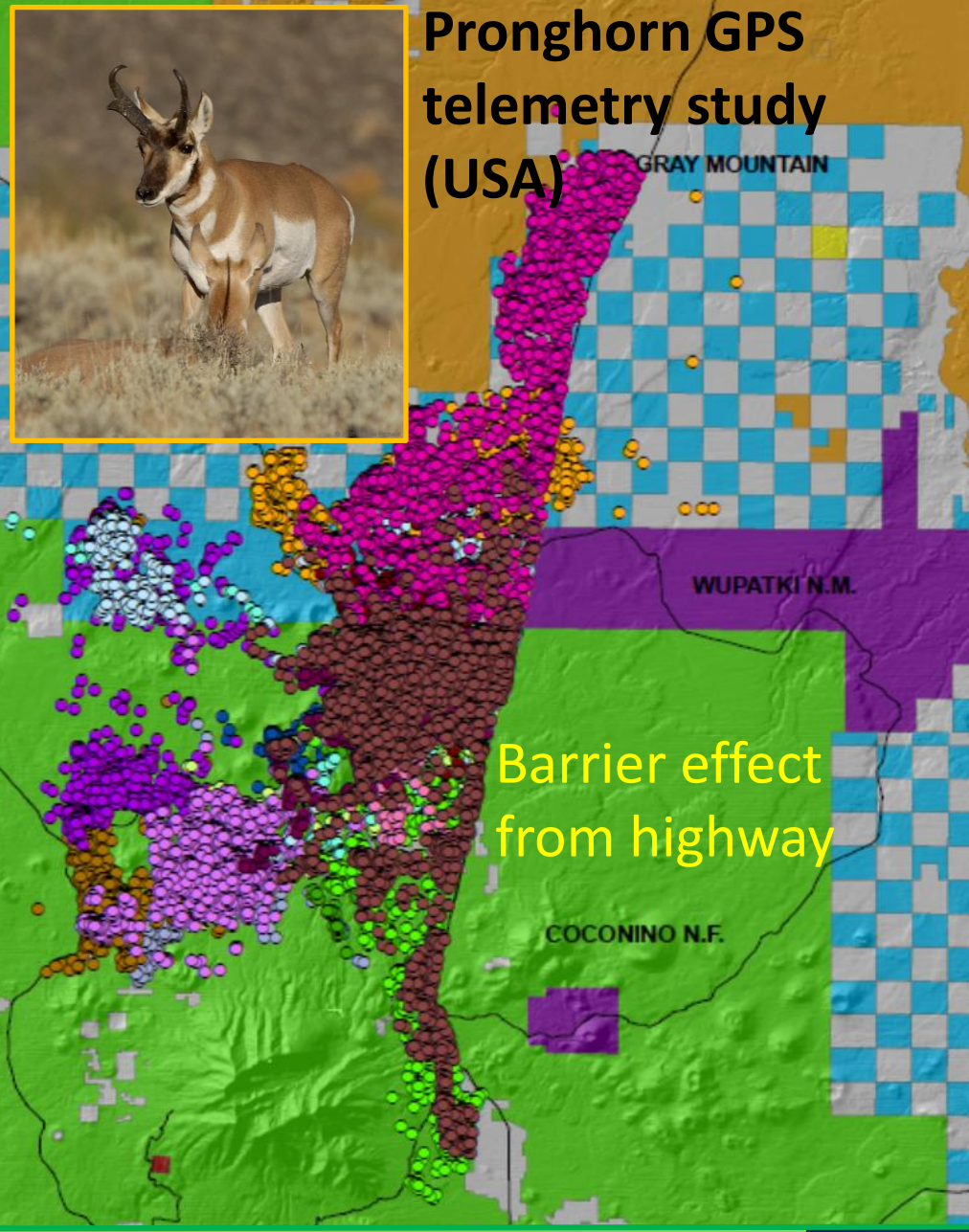


VEHICLE/TRAIN COLLISIONS WITH WILDLIFE

- Kill millions of vertebrates every year across all wildlife taxa
- Affect population viability, especially for endangered and localized, endemic species
- Cause motorist (and even train) deaths and injuries
- Tremendous economic costs to society



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BARRIER EFFECT - FRAGMENTATION

- Highways-railways block animal passage (*permeability*)
- Degree of impact tied to traffic level
- Barrier effect leads to fragmentation of habitats and populations – reduces landscape *connectivity*
- Isolation reduces gene flow and can reduce population viability

Pronghorn GPS telemetry study (USA)

MEASURES TO MINIMIZE TRANSPORT IMPACTS

Measures to modify *human* behavior and reduce collisions

Speed reduction zones
with traffic calming (India)

Animal detection systems (USA)

Such measures can reduce collisions, but do not address barrier effect

MEASURES TO MINIMIZE TRANSPORT IMPACTS

Measures to modify animal behavior with *grade separation*


Viaduct (Brazil)


Bridge (Canada)

WILDLIFE UNDERPASSES

- Animals cross below highway/railway grade
- Best for drainages


Metal Arch (Bhutan)


Flyover (India)


Crossing grates (Australia)

MITIGATIONS TO MINIMIZE TRANSPORT IMPACTS

Measures to modify animal behavior with *grade separation*

WILDLIFE OVERPASSES

- Animals cross above highway/railway grade
- Best for cut slopes

MEASURES TO THE MINIMIZE TRANSPORT IMPACTS

ROLE OF FENCING

- Limits animal access to transport infrastructure, preventing collisions
  - ✓Many projects (USA, Canada, Sweden) with fencing *and* passage structures have resulted in reductions in collisions up to **98%**
- *Funneling effect* promotes effective passage structure use *and* highway permeability


Ungulate (e.g., deer) fence


Reptile fence at passage


Elephant fence

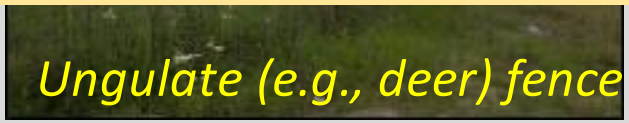
THE DOWNSIDE

- Expensive
- Maintenance intensive

MEASURES TO THE MINIMIZE TRANSPORT IMPACTS

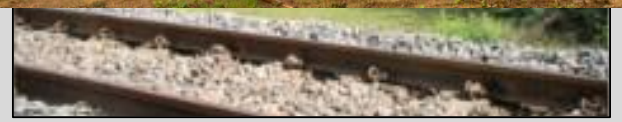
ROLE OF FENCING

Fencing and passage structures can help address resource issues such as Human-Elephant Conflict, facilitating passage and directing elephants away from settlements and croplands to prevent human (and elephant) deaths and injuries, and property damage



Ungulate (e.g., deer) fence

Reptile fence at passage

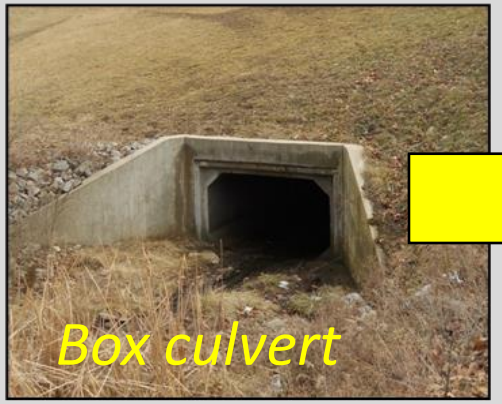


intensive

PROMOTING CLIMATE-CHANGE RESILIENCY and WILDLIFE PASSAGE

"Oversizing" - Drainage Culverts to Underpasses

- ✓ Prevent costly blowouts from increasingly frequent extreme-weather events at ***modest*** additional cost*
- ✓ Provide cost effective "**dual-use**" (drainage & wildlife passage) structures



*_**Intergovernmental Panel on Climate Change**_ Climate Change 2014: Synthesis Report.

BIODIVERSITY MITIGATION PROJECT TYPES

NEW OR RECONSTRUCTION PROJECTS - best avenue to address impacts

- Integrated planning
- Proper planning of mitigation strategies
- Mitigation costs covered by project

Are relatively rare compared to **EXISTING** roads and railways impacting biodiversity

RETROFIT PROJECTS for EXISTING INFRASTRUCTURE

- Innovative, cost-effective prefabricated passage structure designs
- Use of “drop-in” structures
- Minimal traffic disruption
- Fencing to link drainage structures can be effective

Existing need is for action is huge

STATE ROUTE 260, ARIZONA, USA

Phased reconstruction:

- 11 large underpasses (single span bridges)
- 7 large multi-span bridges

Initially, little fencing was erected – **role of wildlife fencing was focus of research**

Underpass (8) monitoring 2000–2008:

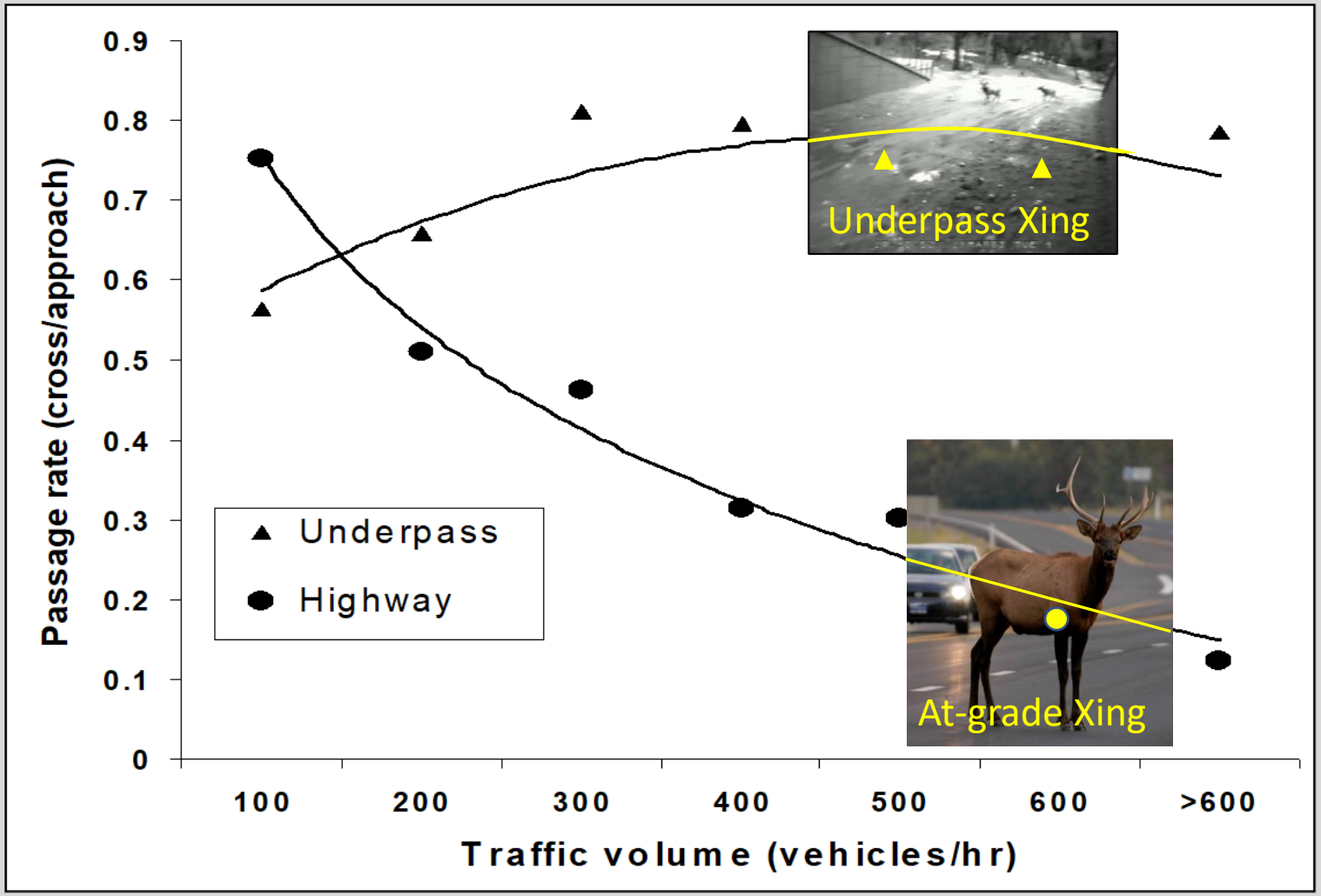
- 11 species recorded
- **15,134** total animals

Underpass Passage Rates (deer and elk):

0.12 crossings/approach ***without*** fencing

0.56 crossings/approach ***with*** fencing (**+367%**)

Influence of Traffic Volume On Permeability – Benefit of Wildlife Passage Structures



Elk Passage Rates:

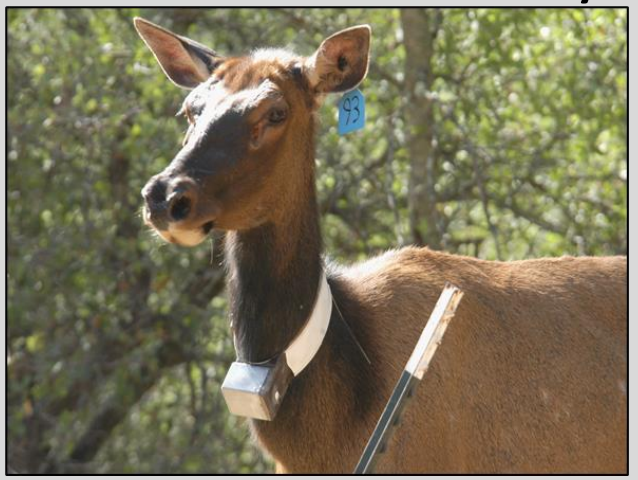
At-grade *Highway*

versus

Below-grade *Underpass* -

determined from

from GPS telemetry



US HIGHWAY 93, ARIZONA, USA

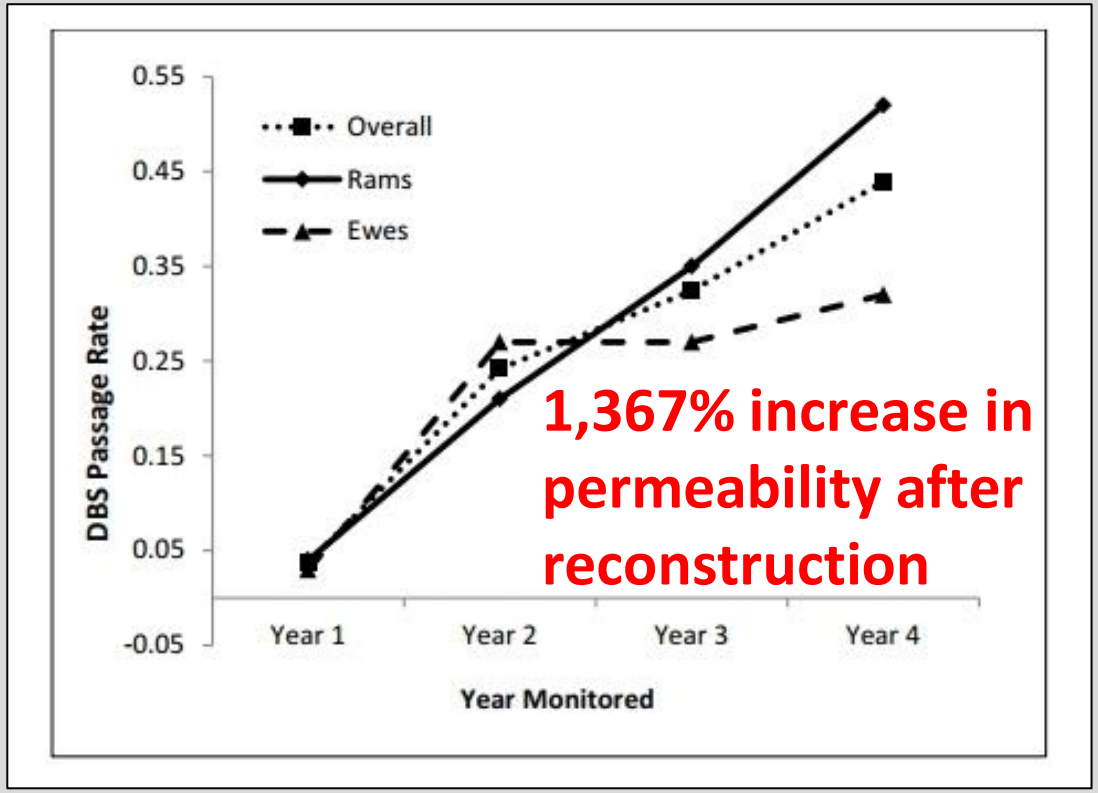
Phased reconstruction (30 km) with camera monitoring and GPS telemetry (2011-2014)

- 3 overpasses **5,862 crossings (90%)**
- 2 underpasses **474 crossings (7%)**
- 3 box culverts **195 crossings (3%)**
- Funnel fencing

Strong preference by bighorn sheep for overpasses

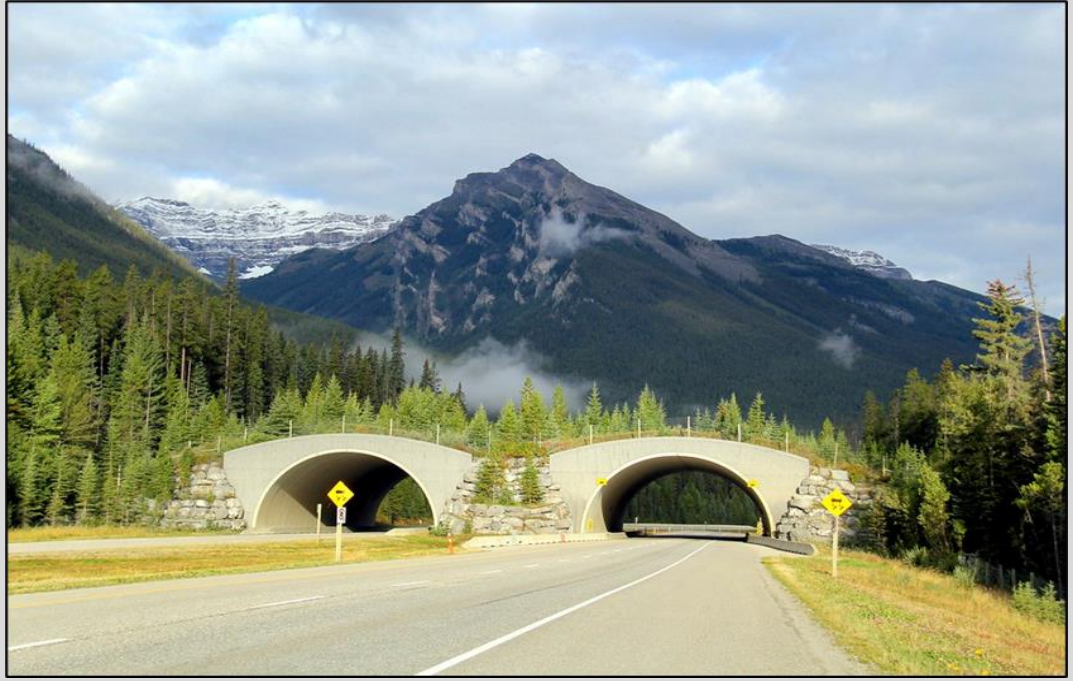
Bighorn Sheep Highway Permeability

- Before-construction (2-lane) at-grade permeability – **0.03** crossings/approach
- Year 4 After-construction (4-lane) – **0.44** crossing/approach - **1,367% increase**
- Traffic has little impact on crossings at overpasses compared to at-grade crossings



TRANS-CANADA HIGHWAY, ALBERTA, CANADA

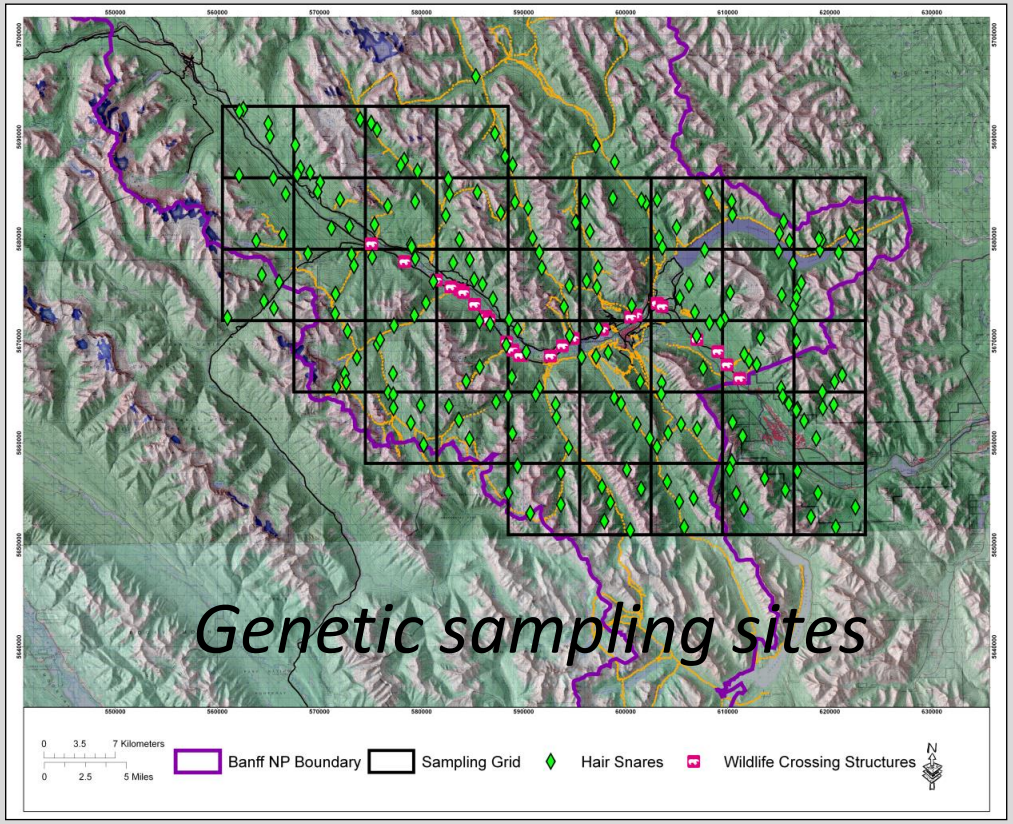
- 38 underpasses (bridges, metal pipes, culverts) and 6 overpasses (reconstruction)
- **152,154** crossings of passage structures by 11 large mammal species
- Longest continuous monitoring study in the world (1996–2014)



Genetic/Population-Level Benefits of Wildlife Passage Structures

Grizzly bear populations across western North America genetically isolated by highways (Proctor et al. 2012)

Graphics courtesy Tony Clevenger



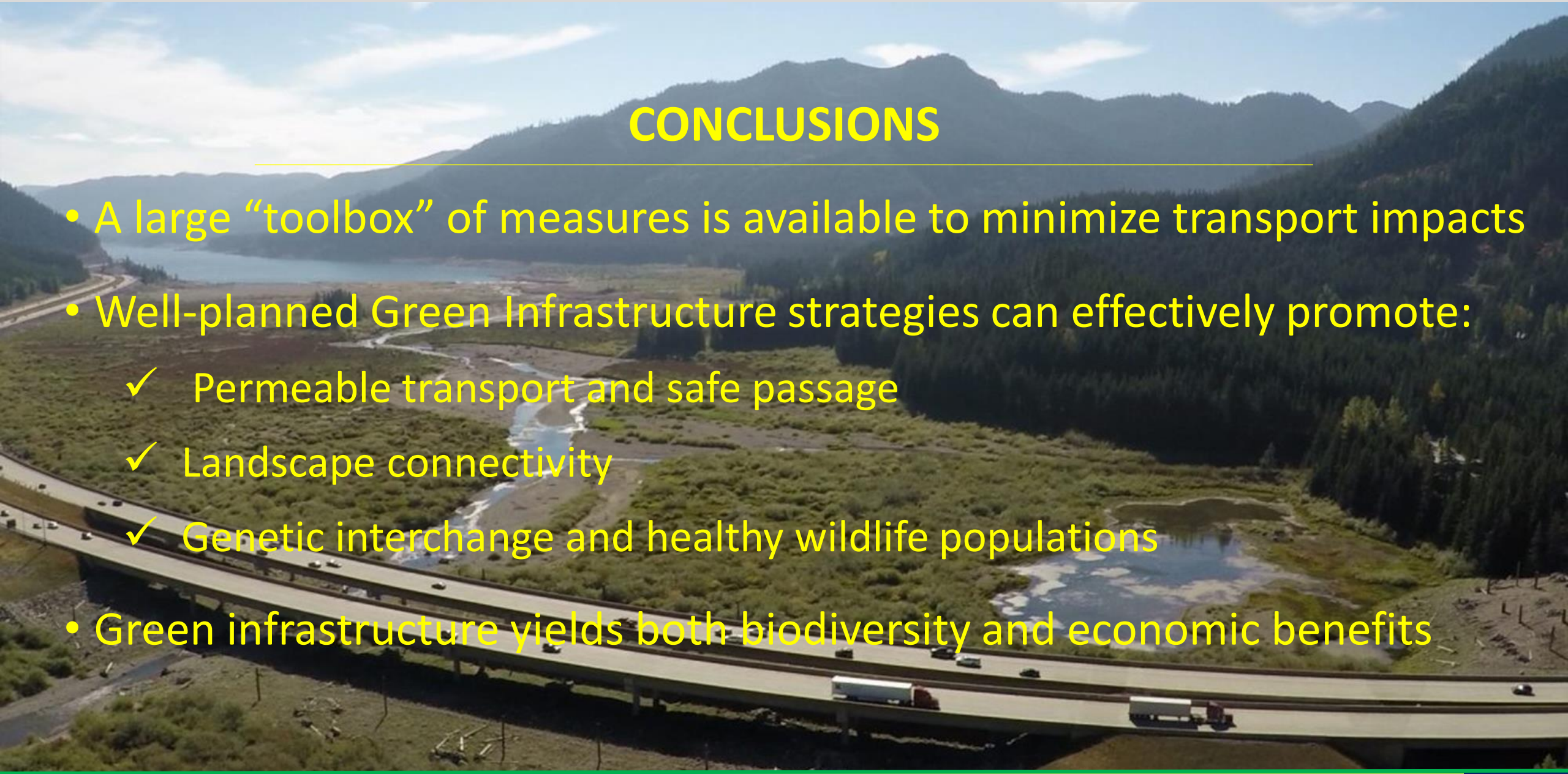
First evidence of benefit of passage structures in promoting sufficient gene flow to prevent genetic isolation within adjacent grizzly bear population (Sawaya et al. 2013)

GREEN INFRASTRUCTURE MITIGATIONS MAKE ECONOMIC SENSE

- **Benefits from mitigations that reduce wildlife-vehicle collisions -**
  Can exceed project costs in 5-10 years

- **Preservation of Ecosystem Services**
  Ecosystem Service Values (Turner et al. 2007):
  - ✓ Proactive conservation approaches (e.g., mitigated transport) = **$217,356/sq. km²/year**
    versus
  - ✓ Reactive approaches (e.g., unmitigated transport, unregulated lateral access) = **$76,057/km²/year**

- **Preservation of Natural Capital assets** –
  Supports Ecotourism and other sustainable activities



CONCLUSIONS

- A large “toolbox” of measures is available to minimize transport impacts
- Well-planned Green Infrastructure strategies can effectively promote:
  - ✓ Permeable transport and safe passage
  - ✓ Landscape connectivity
  - ✓ Genetic interchange and healthy wildlife populations
- Green infrastructure yields both biodiversity and economic benefits