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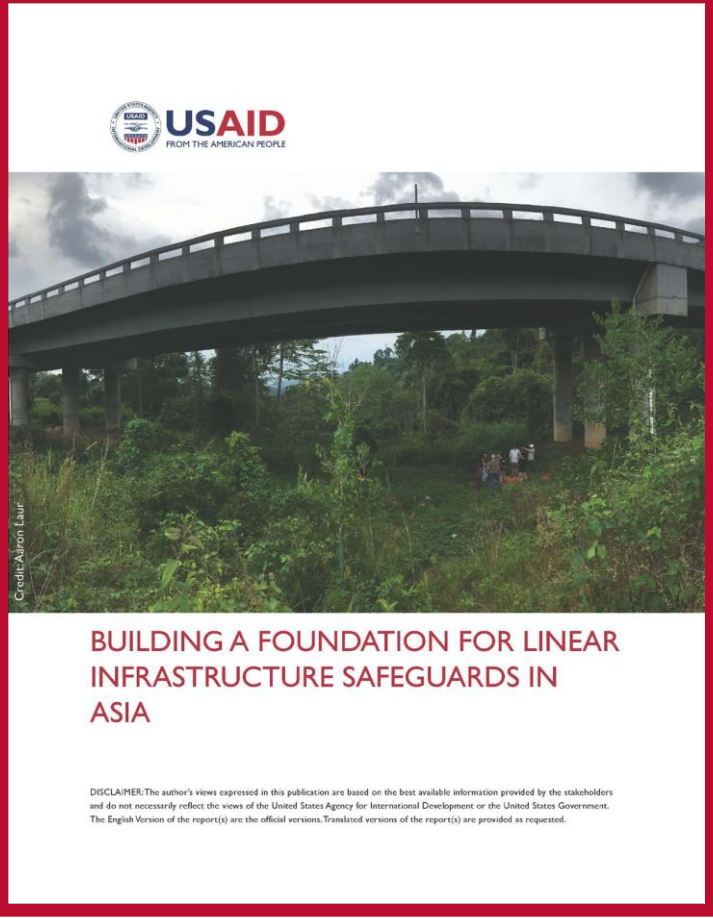
MODULE 1: LINEAR INFRASTUCTURE AND BIODIVERSITY IN ASIA

PRESENTATION 1: LISA PROJECT OVERVIEW and "THE BIG PICTURE"

PRESENTATION 2: SCIENCE and SOLUTIONS, THE STATE OF KNOWLEDGE IN ASIA

PRESENTATION 1: “THE BIG PICTURE”

LINEAR INFRASTUCTURE
&
ECOLOGICAL CONNECTIVITY
BIODIVERSITY - WILDLIFE
CLIMATE CHANGE



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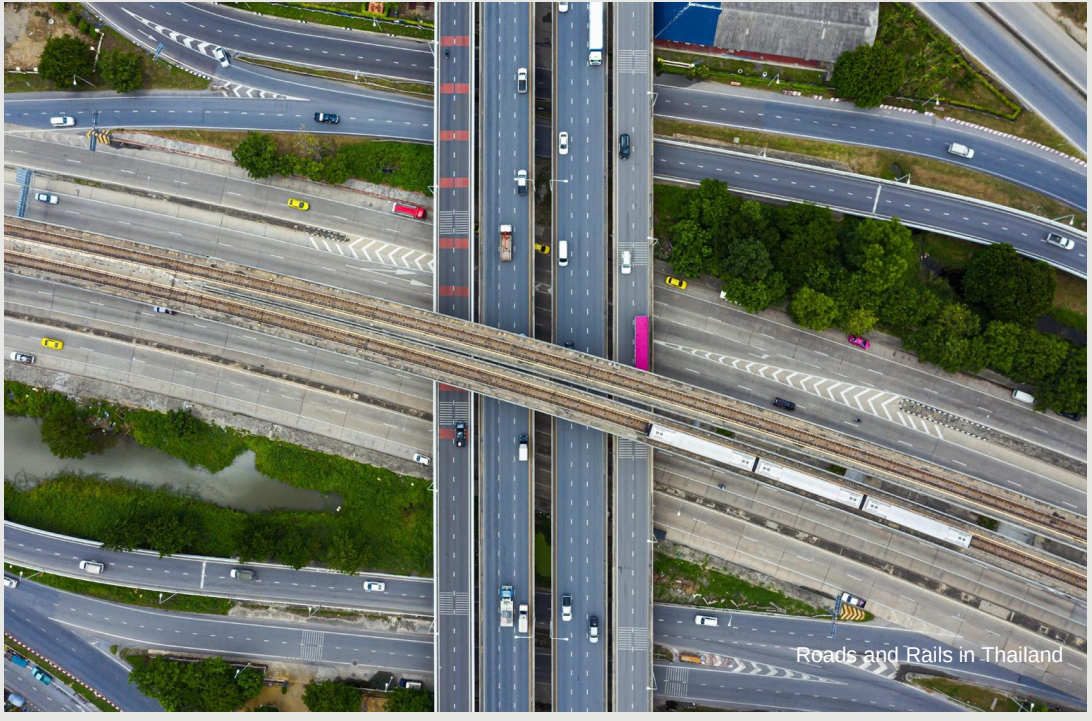
A PAVED PLANET, by 2050

- 25 million km of new road lanes

- 300,000 km new railway tracks

Dulac, J. 2013. Global transport infrastructure requirements, Estimating road and railway infrastructure capacithy and costs to 2050. IEA, Paris, France.



Roads and Rails in Thailand

Currently worldwide: 33.5 million km of roads

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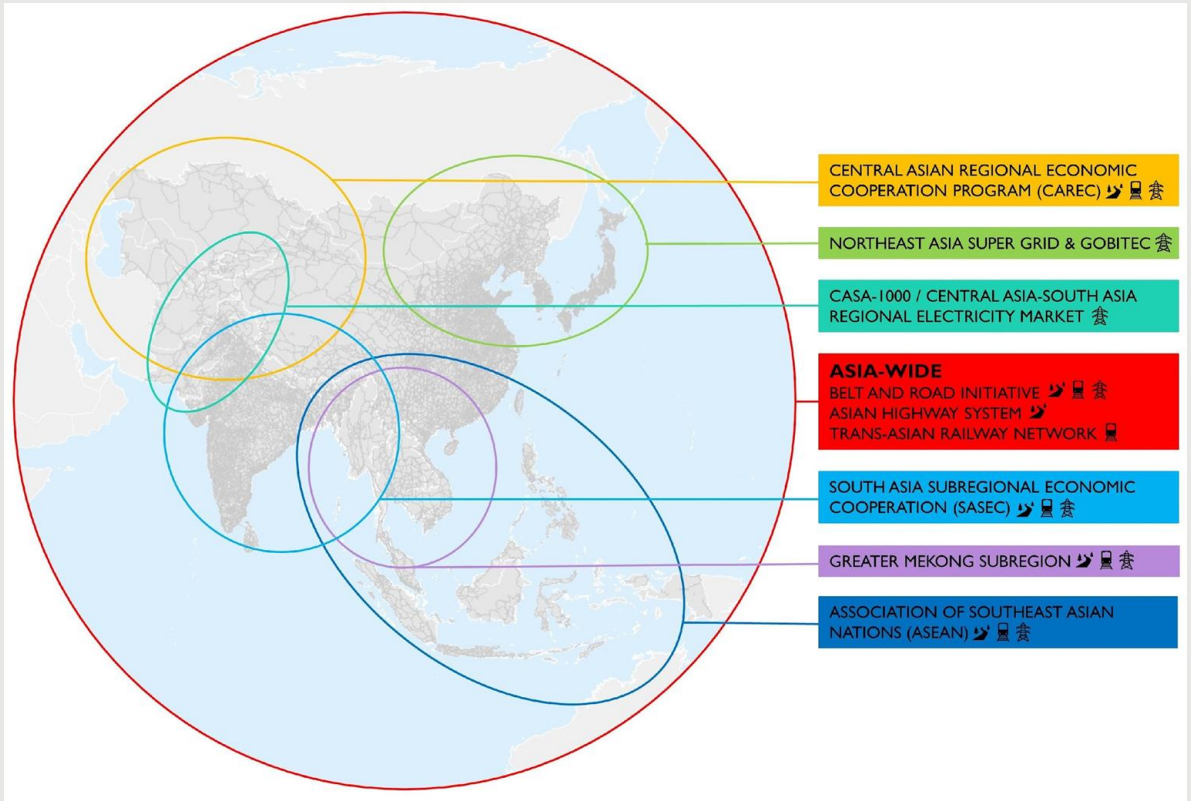
AN ELECTRIFIED GLOBE

Projected Global Growth
High Voltage Power Lines
(>70 kV):

2015: 0.99 million km
Future: Increase by 2.5 times

Deetman, S., de Boer, H. S., Van Engelenburg, M., van Der Voet, E., & van Vuuren, D. P. (2021). Projected material requirements for the global electricity infrastructure–generation, transmission and storage. Resources, Conservation and Recycling, 164, 105200.

Asia's International Initiatives - Coordinated LI Expansion



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BENEFITS OF LI DEVELOPMENT

- Supports economic development
- Increases access to markets
- Improves health, access to care
- Supports trade and tourism
- Increases economic efficiencies
- Catalyzes economic opportunities

Credit: USAID

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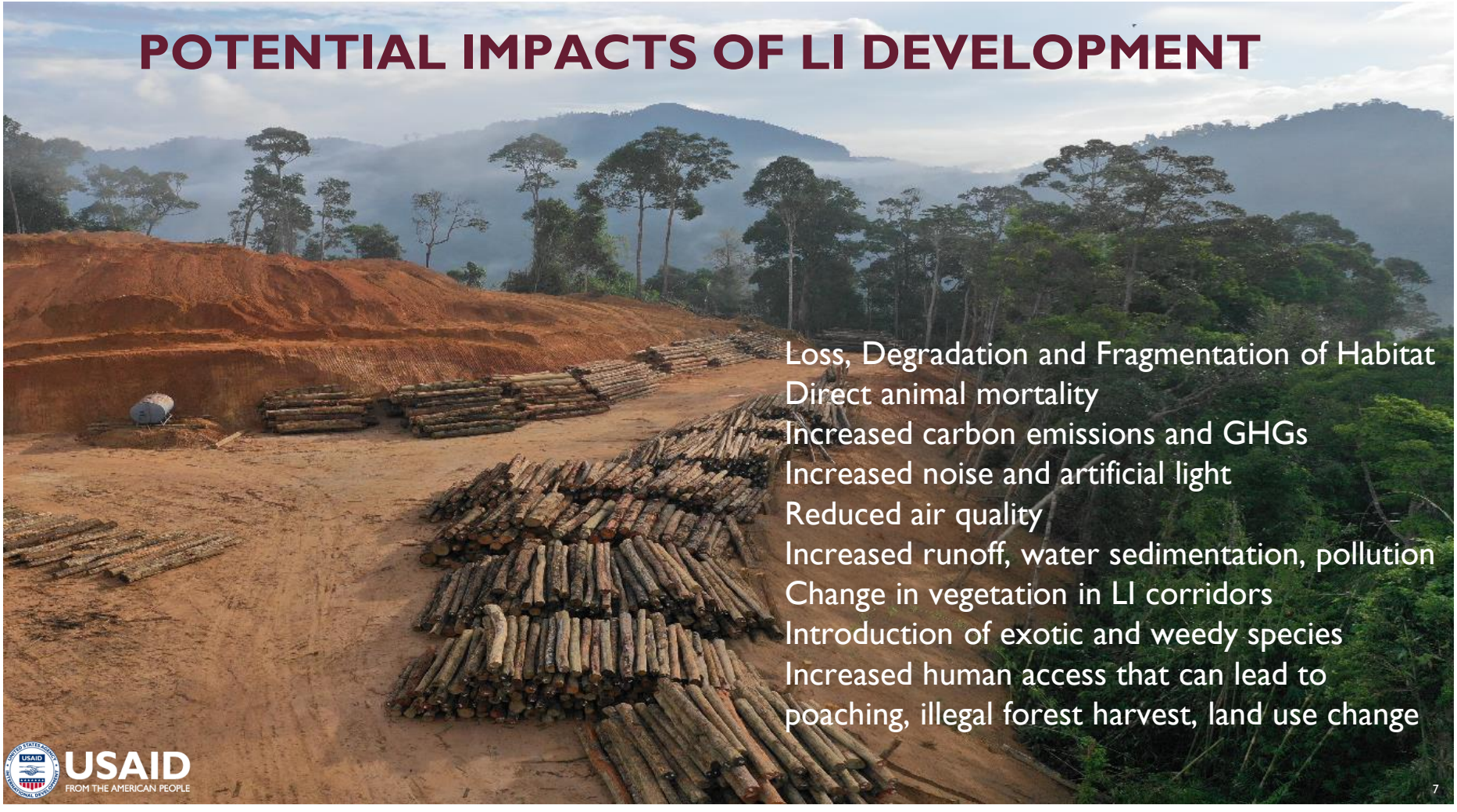
POTENTIAL IMPACTS OF LI DEVELOPMENT



Loss, Degradation and Fragmentation of Habitat
Direct animal mortality
Increased carbon emissions and GHGs
Increased noise and artificial light
Reduced air quality
Increased runoff, water sedimentation, pollution
Change in vegetation in LI corridors
Introduction of exotic and weedy species
Increased human access that can lead to poaching, illegal forest harvest, land use change

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EXTINCTION RISK HIGHEST IN FRAGMENTED LANDSCAPES TERRESTRIAL MOVEMENT OF WILDLIFE REDUCED BY 50% IN HUMAN MODIFIED LANDS

Crooks et al. 2017. Quantification of habitat fragmentation reveals extinction risk in terrestrial mammals. PNAS, 114, 7635–764
Tucker et al. 2018. Moving in the Anthropocene, Global reductions in terrestrial mammalian movements. Science 2018: 359: 466-469

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CONNECTIVITY, ANIMALS & CLIMATE CHANGE

Many studies find significant shifts in species distributions in response to climate change

- Animals can respond to climate change in three ways:
  - Move
  - Adapt
  - Die
- Top Strategy: increase connectivity between natural areas and provide lands that animals can migrate along, such as riparian areas, to reach good habitat

Gerik-Jeli Hwy Underpass, Malaysia. Credit: Rob Ament

Heller and Zaveleta. 2009. Biodiversity management in the face of climate change: A review of 22 years of recommendations. Biological Conservation, 142, 14-32

Keeley et al. 2018. New concepts, models, and assessments of climate-wise connectivity. *Environ. Res. Lett.* 13 (2018) 073002

PROVEN INFRASTRUCTURE SOLUTIONS FOR WILDLIFE

Southern Bhutan
National Highway 2

Nagpur, India
National Highway 44

Yunnan Province, China
Simao-Xiaomengyang
Espressway (G213)

THE LISA PROJECT

By the numbers

300+	LI experts responding to the Lisa Project survey on capacity
28	Asian countries
24+	LISA Project specialists in policy, ecology, finance, transport planning, economics
14	Months
5	Representative countries – India, Nepal, Bangladesh, Thailand, Mongolia (assessment)
4	Reports (annexes) – Literature Review, Spatial Analyses, Case Studies, Capacity Assessment
3	Modes of linear infrastructure – roads, railways, power lines
1	COVID pandemic

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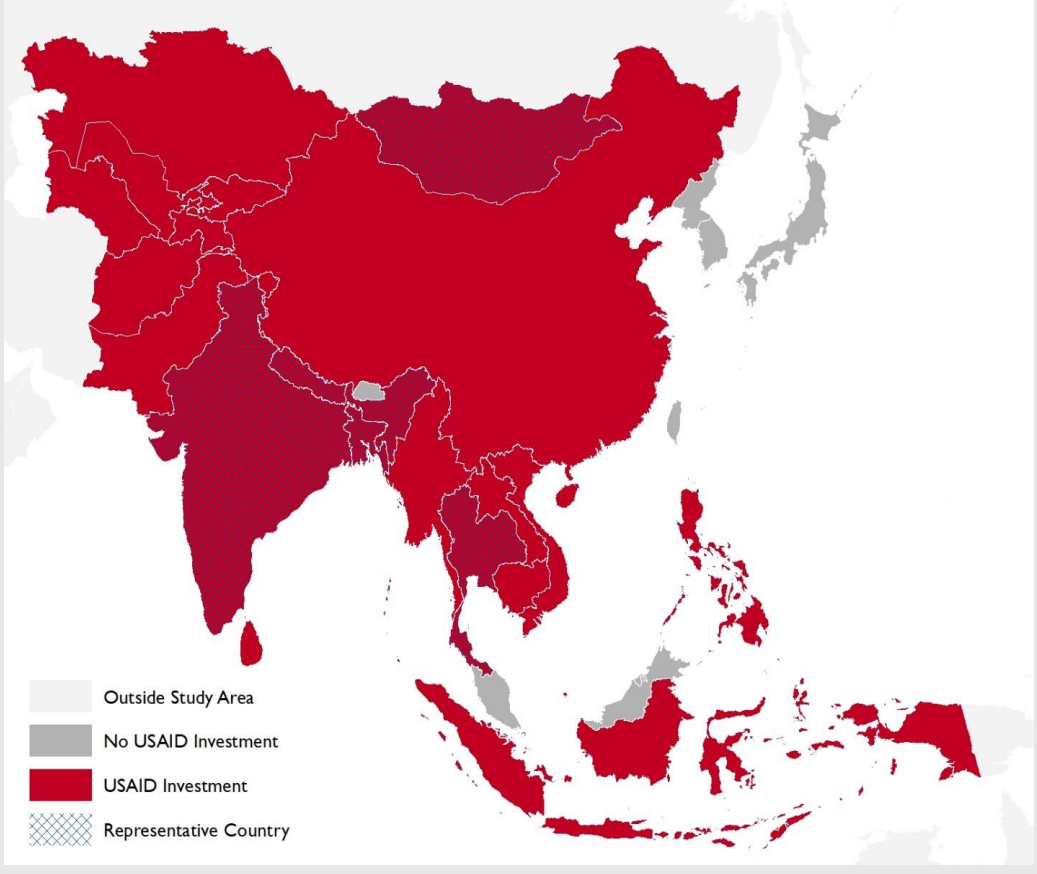
28 ASIAN COUNTRIES IN LISA PROJECT



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LISA PROJECT SCOPE

Linear Infrastructure Focus

Roads

Rails

Power Transmission Lines

Photo: Nilanga Jayasinghe/ WWF US

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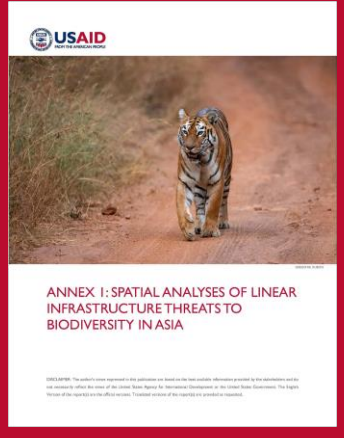
LISA PROJECT TASKS

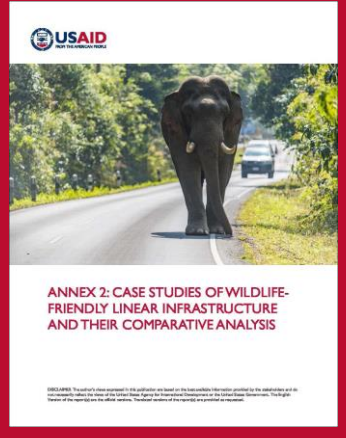
Conduct	Conduct spatial analyses of LI projects most likely to impact biodiversity and critical habitats
Synthesize	Synthesize research to understand the impacts of LI on wildlife and critical habitats
Compile	Compile case studies of exemplary wildlife-friendly LI projects and provide cautionary examples
Examine	Examine capacities regarding policies, regulations and resources for adopting LI safeguards
Identify	Identify opportunities and barriers for implementing biodiversity safeguards in key countries
Develop	Develop training materials for a capacity building program

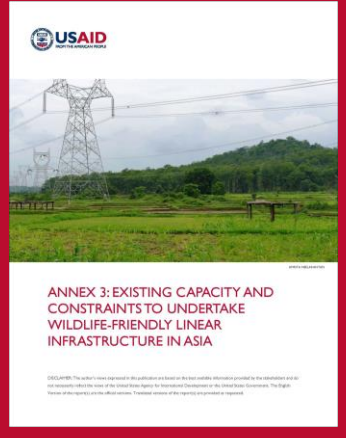
RESULTS OF THE LISA PROJECT

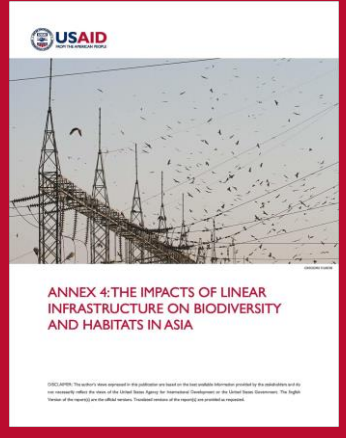
THE FOUR ANNEXES to THE FINAL REPORT

Annex 1: Spatial Analyses
Annex 2: Case Studies
Annex 3: Capacity Assessment
Annex 4: Literature Review









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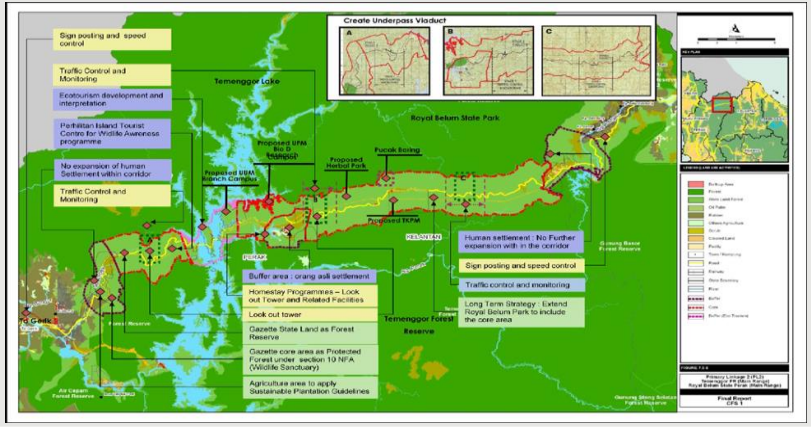
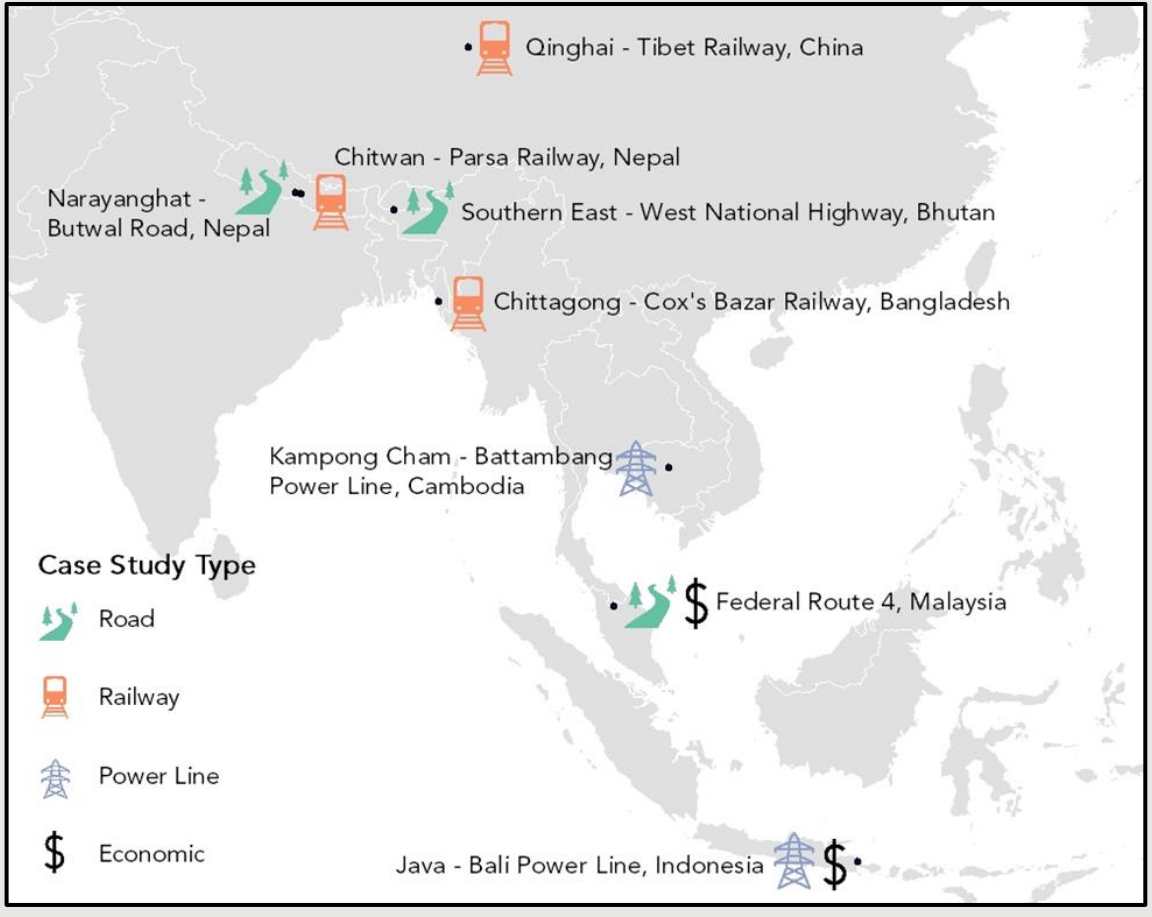
IDENTIFYING IMPORTANT BIODIVERSITY LANDSCAPES (ANNEX 1)

1. Asia wide spatial analysis
2. Fine-scale spatial analyses
   - Tiger
   - Snow leopard
   - Goitered gazelle and khulan (wild ass)
   - Saiga antelope
   - Birds and powerlines – multiple species
   - Use of roadkill data – multiple species
3. Reviewed exemplary spatial analyses of projected impacts (11)



CASE STUDIES and COMPARATIVE ANALYSIS (ANNEX 2)



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CAPACITY ASSESSMENT (ANNEX 3)

Goal: Examine capacities regarding policies, regulations and resources for adopting LI safeguards and identify barriers to their implementation

- Asia-wide Assessment
- A 5-Nation Assessment

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NATIONAL - LEVEL CAPACITY ASSESSMENTS (ANNEX 3)

Goal: Help articulate where there may be pitfalls and barriers to biodiversity safeguard implementation due to a lack of capacity.

- Methods:
  - Interviews (with experts and key decision-makers or employees)
  - Electronic surveys (300+ responses)

- Bangladesh
- India
- Mongolia
- Nepal
- Thailand

CAPACITY ASSESSMENT (ANNEX 3): CONSTITUENT GROUPS

- Industry: Planners, Consultants, Engineers, Professional Associations
- Government, Ministries and LI Agencies
- Nongovernmental Organizations
- International Finance Institutions

CAPACITY ASSESSMENT: IDENTIFYING BARRIERS TO IMPLEMENTING WILDLIFE SAFEGUARDS (ANNEX 3)

Used survey questions to identify barriers:

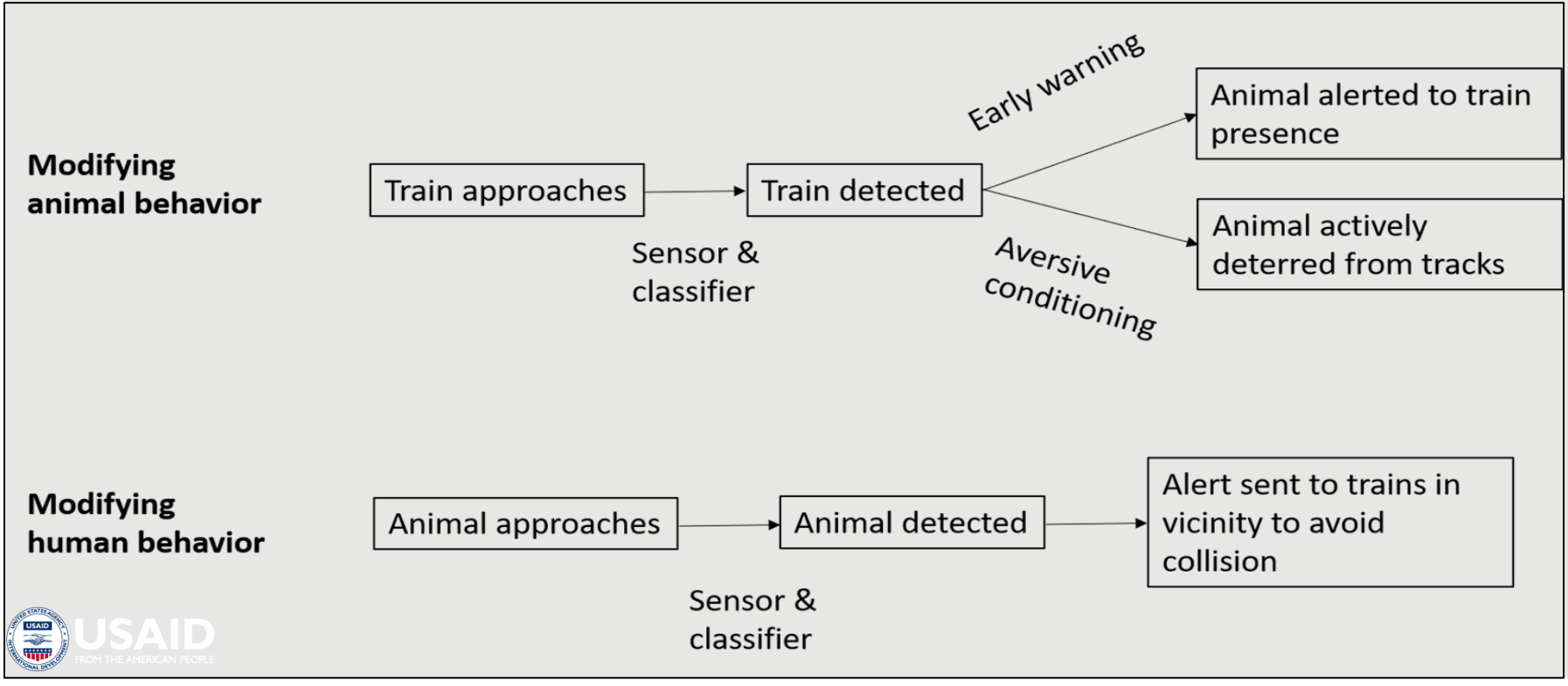
- What part(s) of the project development process is your institution typically involved in?
- What part(s) of the linear infrastructure project development process are of greatest concern for ensuring that adequate wildlife safeguards are implemented?

Project Development Process

LITERATURE REVIEW (ANNEX 4)

PROMISING TECHNOLOGIES FOR RAILWAYS

Conceptual mechanism: underlying technology-based mitigation of wildlife-train collisions



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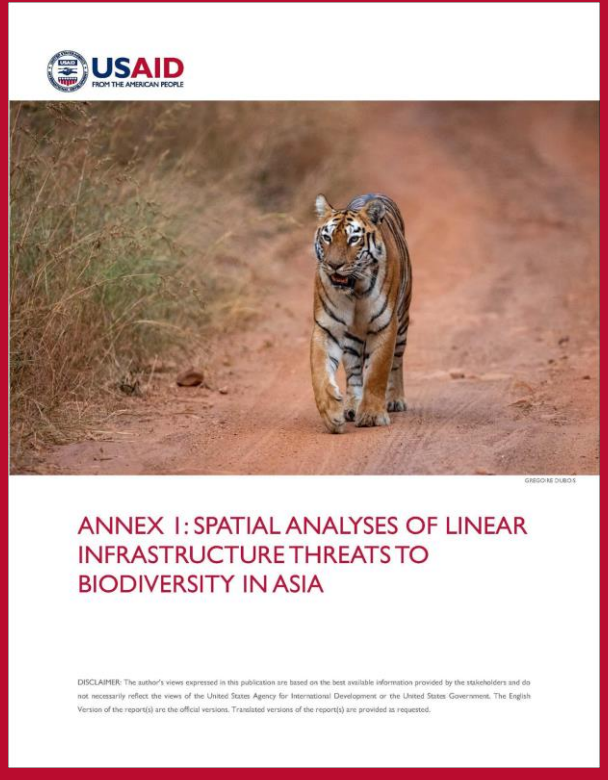
THE LISA PROJECT

BIODIVERSITY AND LINEAR INFRASTRUCTURE: Annex 1: Spatial Analyses



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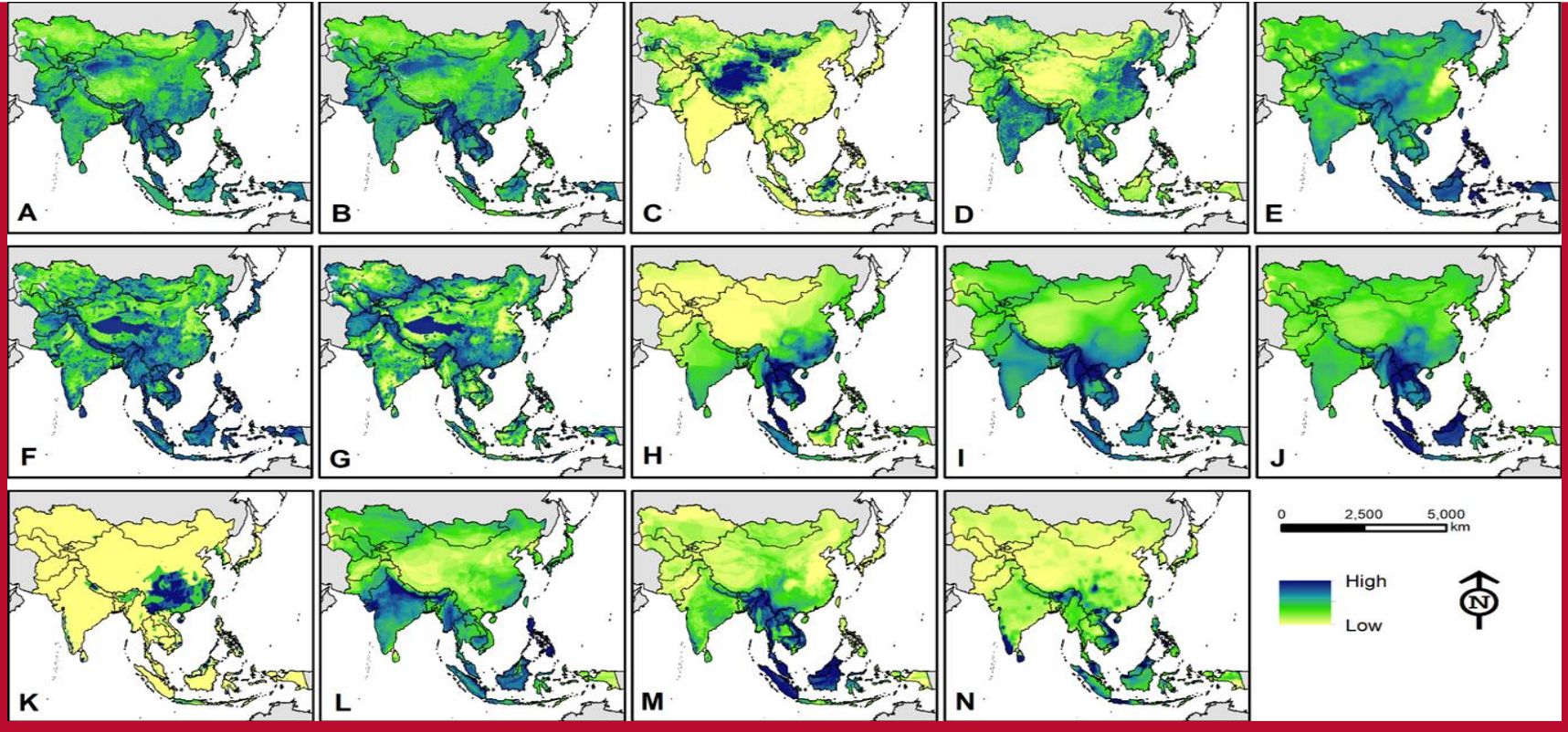

14 LAYERS

Figure 1: Biodiversity layers considered in analysis. (A) Abundance-based biodiversity intactness. (B) Richness-based biodiversity intactness. (C) Ecoregion intactness. (D) Human modification. (E) Mammal community intactness. (F) Global priority areas for protected area expansion. (G) National priority areas for protected area expansion. (H) Amphibian species richness. (I) Bird species richness. (J) Mammal species richness. (K) Threatened amphibian species richness. (L) Threatened bird species richness. (M) Threatened mammal species richness. (N) Weighted endemism including global endangerment. Layers B, D, H, I, and J were eventually removed from analysis to reduce redundancy among layers.

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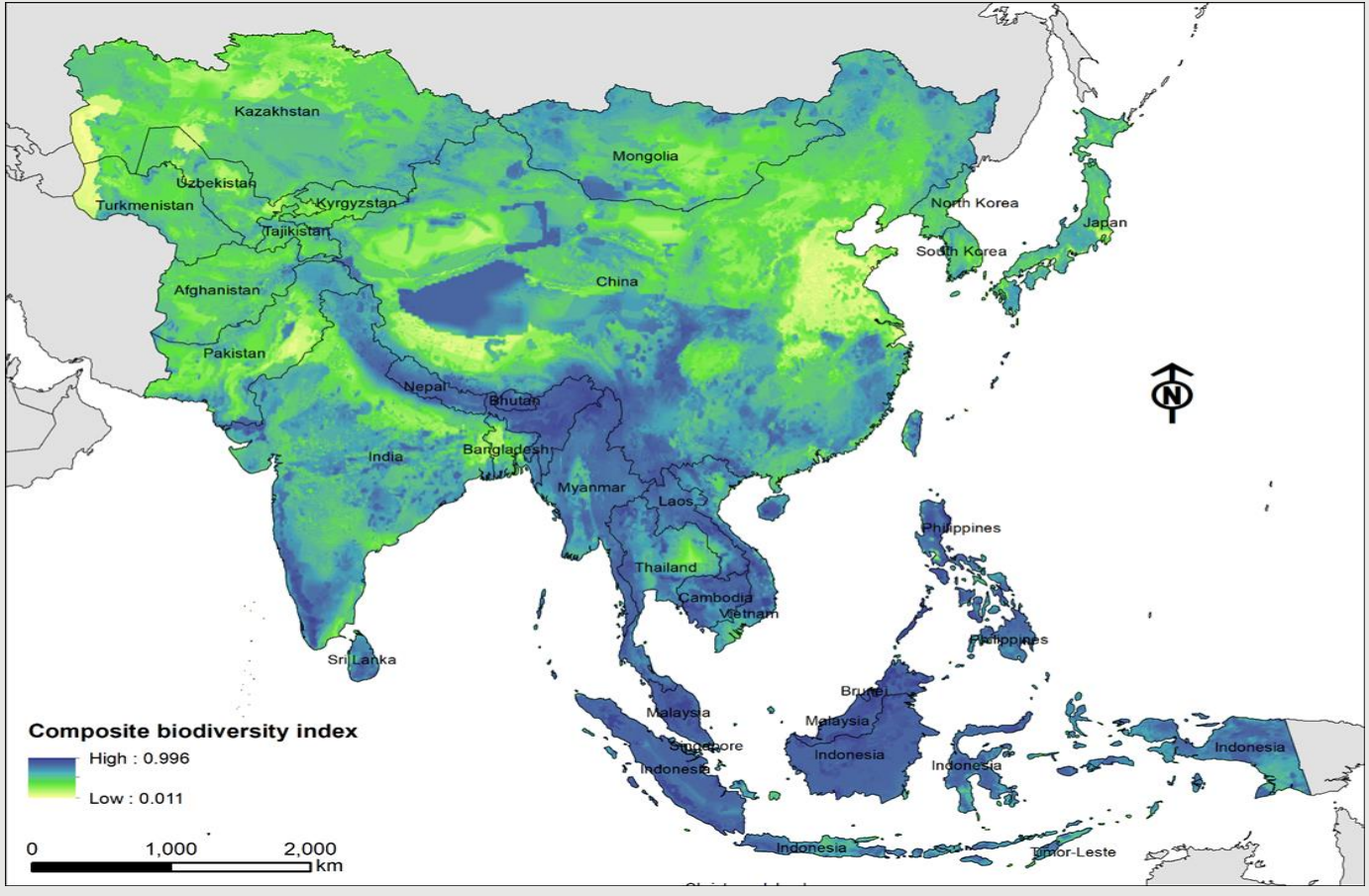
FINDINGS: COMPOSITE BIODIVERSITY INDEX



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FINDINGS: BIODIVERSITY RICH LANDSCAPES

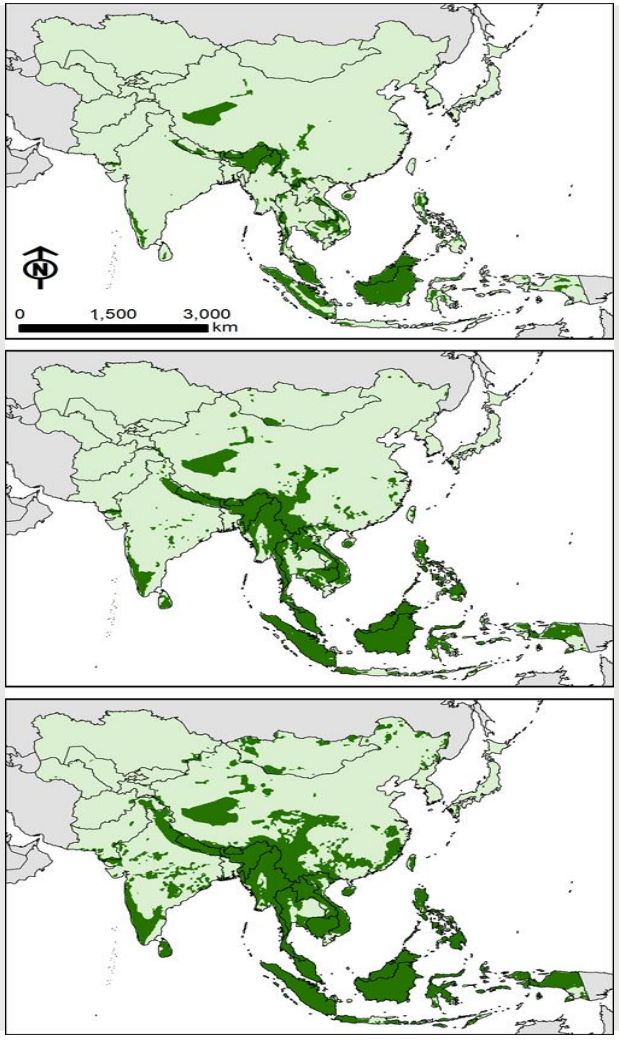

Figure 5: Continental-scale large biodiversity cores (dark green patches), assuming a quantile threshold of 0.9 (top panel), 0.8 (middle panel), or 0.7 (bottom panel) for defining high biodiversity value.

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FINDINGS: BIODIVERSITY RICH AREAS BY REGION

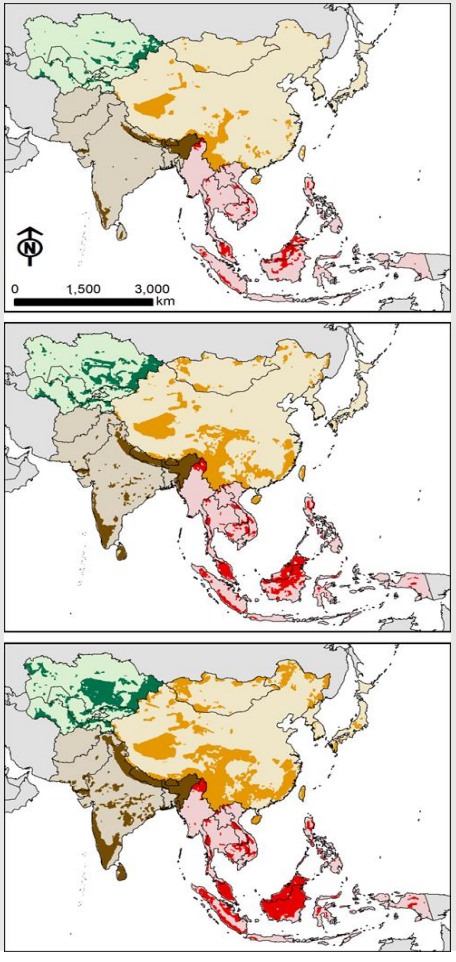

Figure 6: Regional-scale large biodiversity cores, assuming a quantile threshold of 0.9 (top panel), 0.8 (middle panel), or 0.7 (bottom panel) for defining high biodiversity value. Dark-shaded patches indicate cores and light-colored background shading distinguishes regions (green = Central Asia, orange = East Asia, brown = South Asia, red = Southeast Asia).

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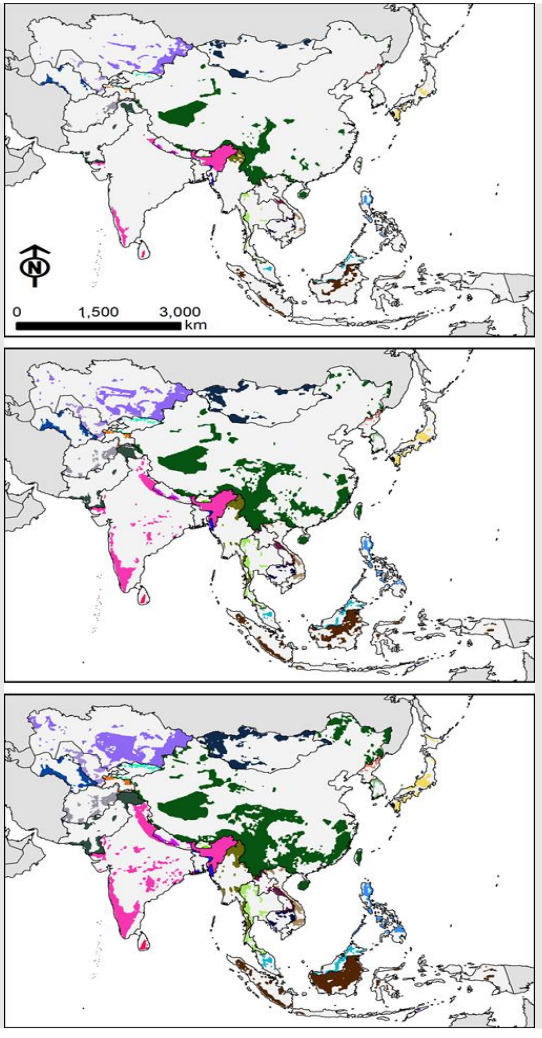
NATIONAL-BASED BIODIVERSITY

Figure 7: National-scale large biodiversity cores, assuming a quantile threshold of 0.9 (top panel), 0.8 (middle panel), or 0.7 (bottom panel) for defining high biodiversity value. Different colors are used to distinguish among cores in different countries.



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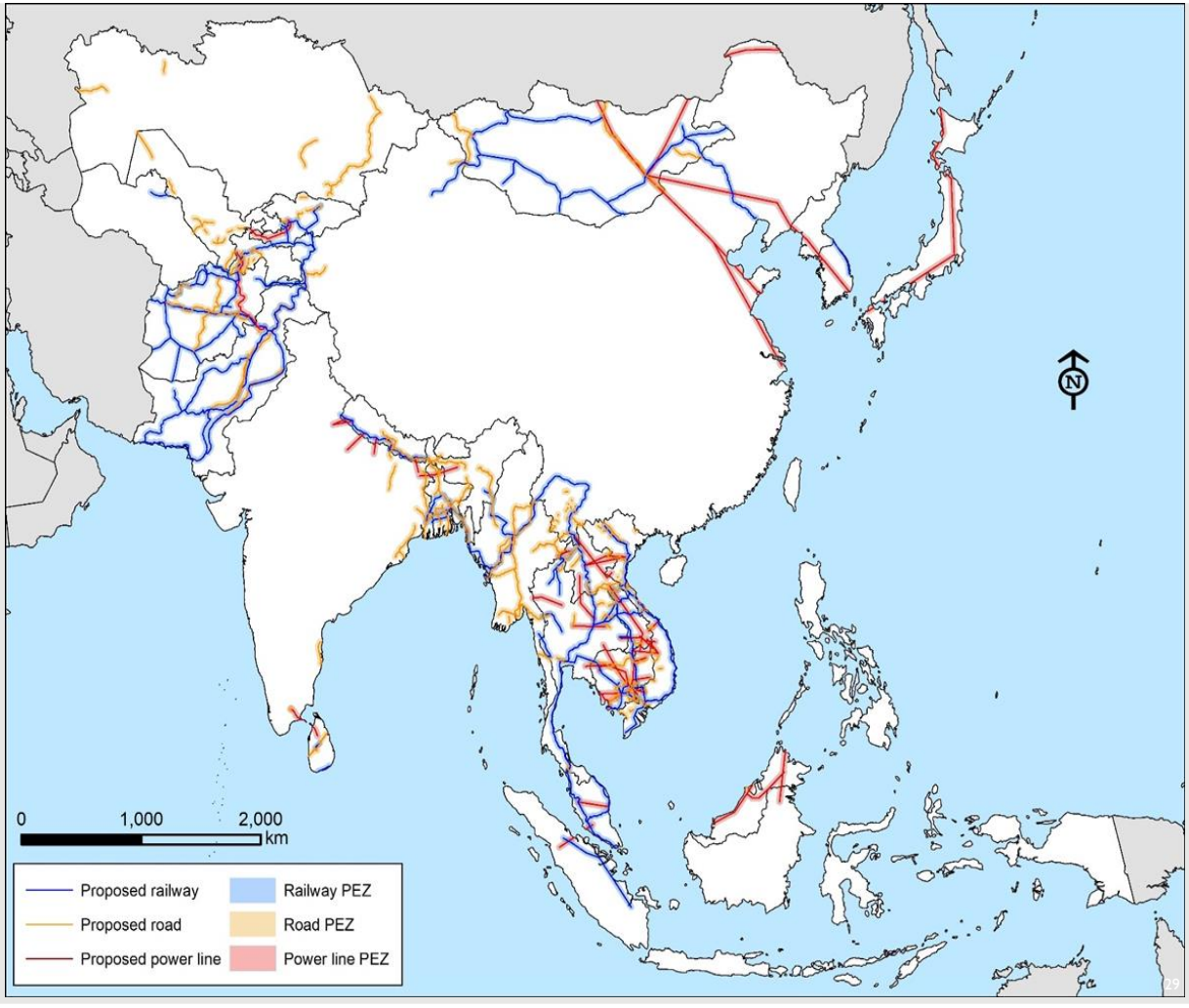
ASSESSING THE POTENTIAL IMPACT OF LI ON BIODIVERSITY

Mapped proposed LI development from major LI Initiatives

- ~ 2/3 new routes
- ~ 1/3 upgrades

- More than 81,000 km of proposed LI
  - Rail: 35, 698 km
  - Road: 27,919 km
  - Power Line: 17, 991 km



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FINDINGS: BIODIVERSITY and FUTURE LI CONFLICT AREAS

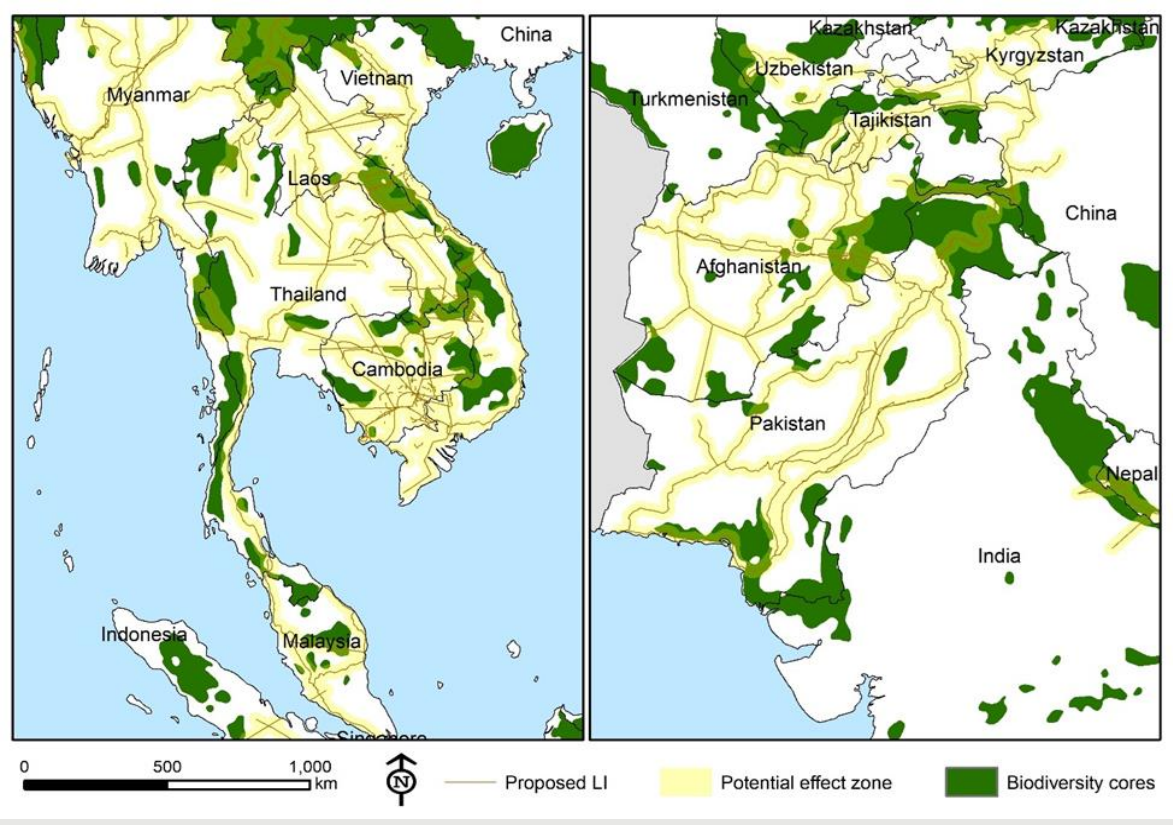

Figure 10: Overlap between potential effect zones (PEZs) of proposed LI routes and biodiversity core areas within selected regions of Asia. Biodiversity cores shown are based on top 20% of CBI values at the national scale. LI routes shown include all three modes (roads, railways, power lines).

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Protected Areas and Future LI via International Initiatives

TABLE 8: OVERLAP BETWEEN POTENTIAL EFFECT ZONES (PEZS) OF PROPOSED LI ROUTES AND PROTECTED AREAS (IUCN CATEGORIES 1A AND 1B)

LI MODE	NO. OF PAS WITHIN PEZ	AREA OF OVERLAP (KM^2)	PROPORTION OF TOTAL PA AREA WITHIN PEZ
Railway	156	9,119	0.028
Road	184	6,254	0.019
Power line	132	13,014	0.041
All LI models	363	25,295	0.079

Fine-scale Analysis: NH 37 near Kaziranga NP, Assam, India

Credit: Rob Ament

Credit: Rob Ament

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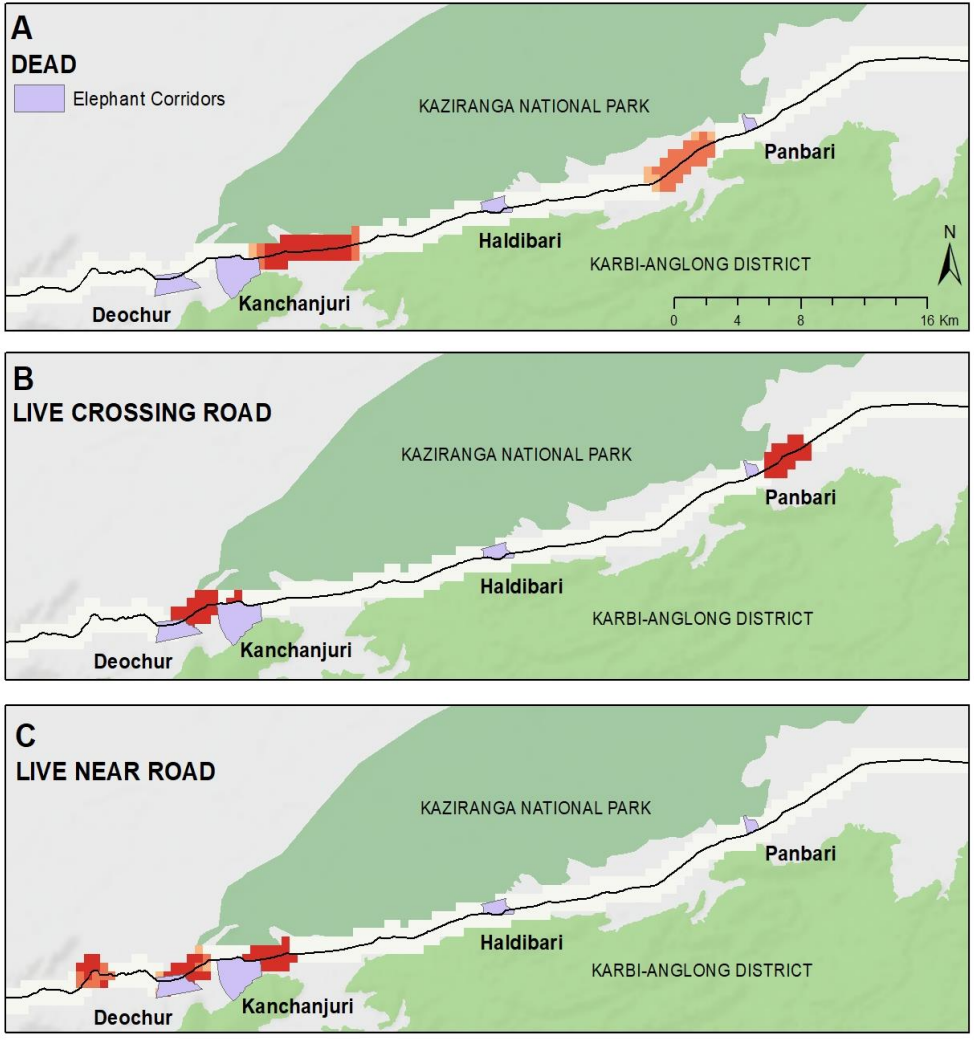
Example: Fine-scale analyses

ANALYSIS 3: MITIGATING IMPACTS TO WILDLIFE DURING THE EXPANSION OF NATIONAL HIGHWAY 37 IN ASSAM, INDIA

TABLE 11: THE NUMBER OF ANIMALS OBSERVED IN EACH TAXONOMIC CATEGORY BY STATUS (DEAD, ALIVE CROSSING ROAD, ALIVE NEAR ROAD) ALONG A 60-KM SECTION OF NH-37 BORDERING KAZIRANGA NATIONAL PARK FROM NOVEMBER 2018 THROUGH MARCH 2020

	DEAD	ALIVE CROSSING ROAD	ALIVE NEAR ROAD	TOTAL
Herptile	330	0	0	330
Bird	195	1	0	196
Meso-carnivore	27	0	37	64
Primate	3	40	57	100
Ungulate	2	115	591	708
Other Mammal	25	0	0	25
Total	582	156	685	1423



RESULTS OF NH 37 ANALYSIS

Figure 13: The results of four optimized hotspot analyses where darker red indicates a greater density of observations and white indicates areas that were not statistically significant hotspots. A) Hotspots of dead animals. B) Hotspots of live animals crossing the road. C) Hotspots of live animals near the road. Purple polygons are elephant corridors identified by Menon et al. (2017)

GOOD NEWS

Exemplary pre-construction spatial analyses

Country	Focal Species	Roads	Railways	Power Lines	Authors and Date
Indonesia	None	Y	Y		Alamgir et al. 2019
Indonesia	None	Y		Y	Sloan et al. 2019
Malaysia	None	Y			Sloan et al. 2019
India	Tigers	Y	Y		Pariwakam et al. 2018
Cambodia	Bengal Floricans			Y	Mahood et al. 2018
Myanmar	Clouded leopards	Y	Y		Kaszta et al. 2020
Nepal	Snow leopards	Y			WWF 2018
India	Tigers	Y			Thatte et al. 2018
Malaysia	Clouded leopards	Y	Y		Kaszta et al. 2019
Laos	None	Y			Danyo et al. 2018
Nepal	None	Y	Y		Sharma et al. 2018

FINDINGS OF FINE SCALE SPATIAL ANALYES: SUGGESTED IMPROVEMENTS

- expand geographic coverage within Asia, particularly in East and Central Asia;
- expand taxonomic coverage to include more studies of focal species other than large mammals, particularly carnivores
- cumulative effects and secondary effects may not be receiving adequate consideration in spatial analyses
- increase emphasis on LI modes other than roads, particularly power lines
- involve more staff from government agencies and multilateral development banks
- Existing analyses at the global or continental scale have focused largely on LI projects associated with China's Belt and Road Initiative (BRI), they need to combine other regional economic development initiatives (e.g., SASEC, CAREC, ASEAN) and national and regional LI development to have a more complete understanding

ANNEX 4: SPATIAL ANALYSIS RECOMMENDATIONS

Use both coarse- and fine-scale spatial analyses, each play an important role in characterizing threats to biodiversity from LI and designing and prioritizing safeguards.

- Coarse-scale studies can inform the selection of priority areas at larger scales to avoid or minimize impacts
- Fine-scale studies for individual LI projects help identify mitigation or compensation strategies and their implementation for species and habitats.

Extensive power line development is proposed across Asia, and much of it is in areas of high biodiversity, yet it is the least studied of the 3 LI modes.

Spatial approaches for estimating impacts of proposed LI are very diverse. There is no single best approach – rather, approaches are context-specific and constrained by the availability and quality of biodiversity data and LI data.

QUESTION AND ANSWER SESSION

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ROB AMENT: rament@largelandscapes.org

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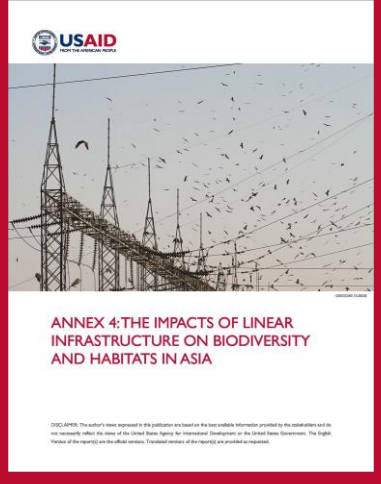
PRESENTATION 2
SCIENCE and SOLUTIONS,
THE STATE OF KNOWLEDGE IN ASIA



MODULE 1, PRESENTATION 2

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Dr. Aditya Gangadharan, LISA Consulting Ecologist

Conservation innovations | Programme development | On-ground impact

MODULE 1, PRESENTATION 2

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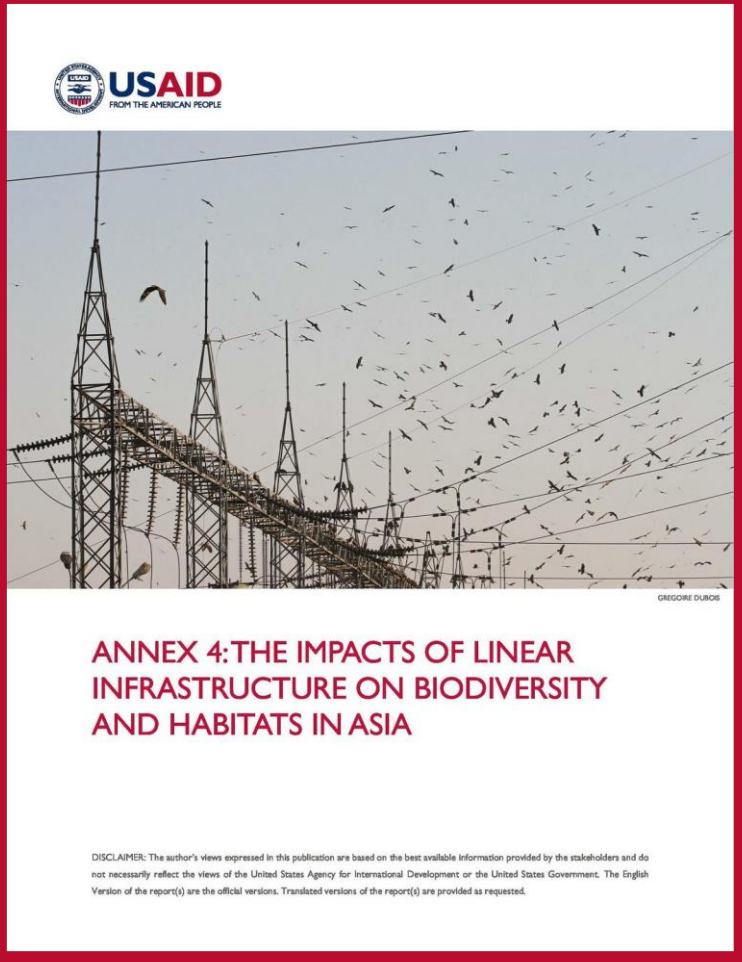
Dr. Chaitanya Krishna
Energy and Ecology Consultant

PRESENTATION 2

SCIENCE AND SOLUTIONS: THE STATE OF KNOWLEDGE IN ASIA



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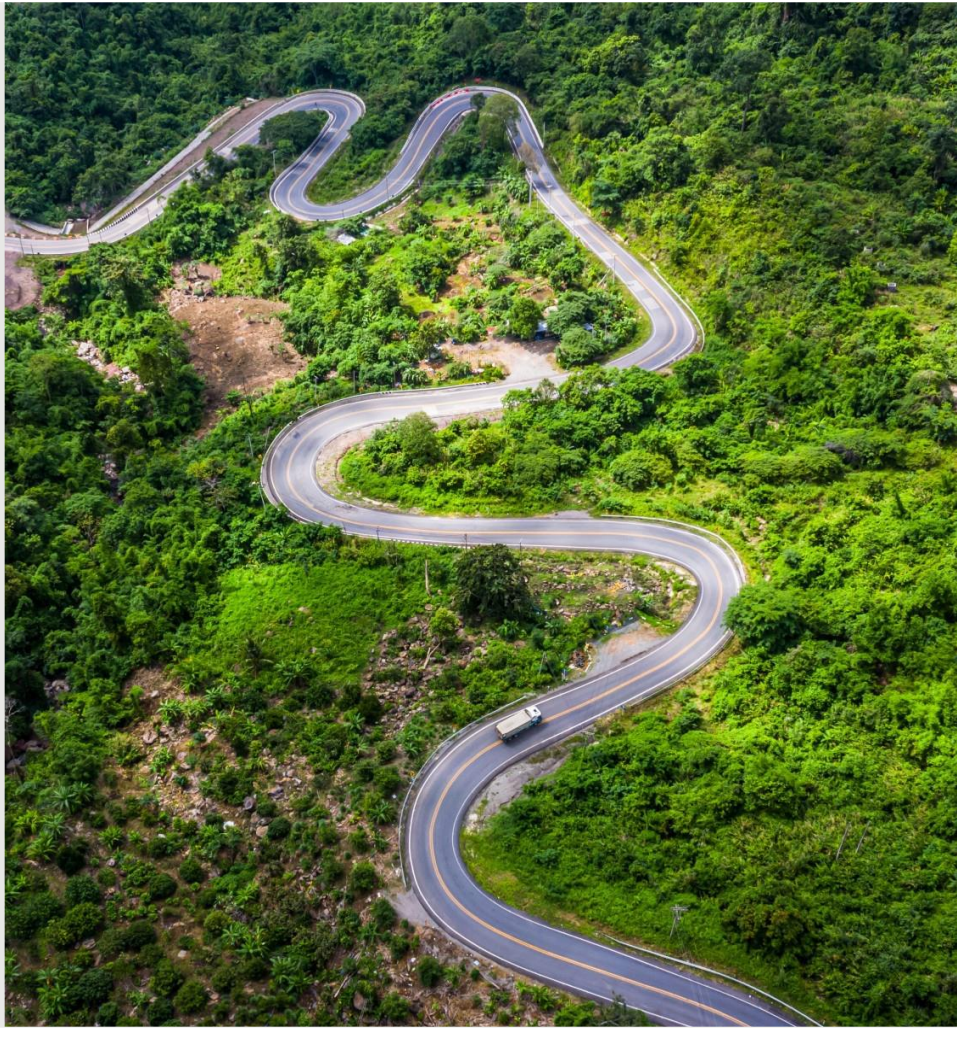
INTRODUCTION

LITERATURE REVIEW OBJECTIVES

- Determine current state of knowledge about linear infrastructure impacts on wildlife in Asia
- Evaluate effectiveness of existing mitigation measures

MODES

Roads



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MODES

Roads

Railways

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MODES

Roads

Railways

Power Lines

Credit : Wikimedia Commons / P Jeganathan

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METHODS

- Systematic search on Web of Science
- Formulaic equation
- Peer-reviewed literature published between 2000-2020
- Search results were further analyzed and pruned
- Final set of relevant papers
- Papers were broadly categorized – impacts and/or mitigation

DIRECT IMPACTS

- Mortality or injury to wildlife at relatively small spatial scales (a single railway line, few roads, power lines in an area)

INDIRECT IMPACTS

- Movement barriers
- Changes in habitat use/behavior
- Catalyzing human access & impact
- Local habitat loss or degradation

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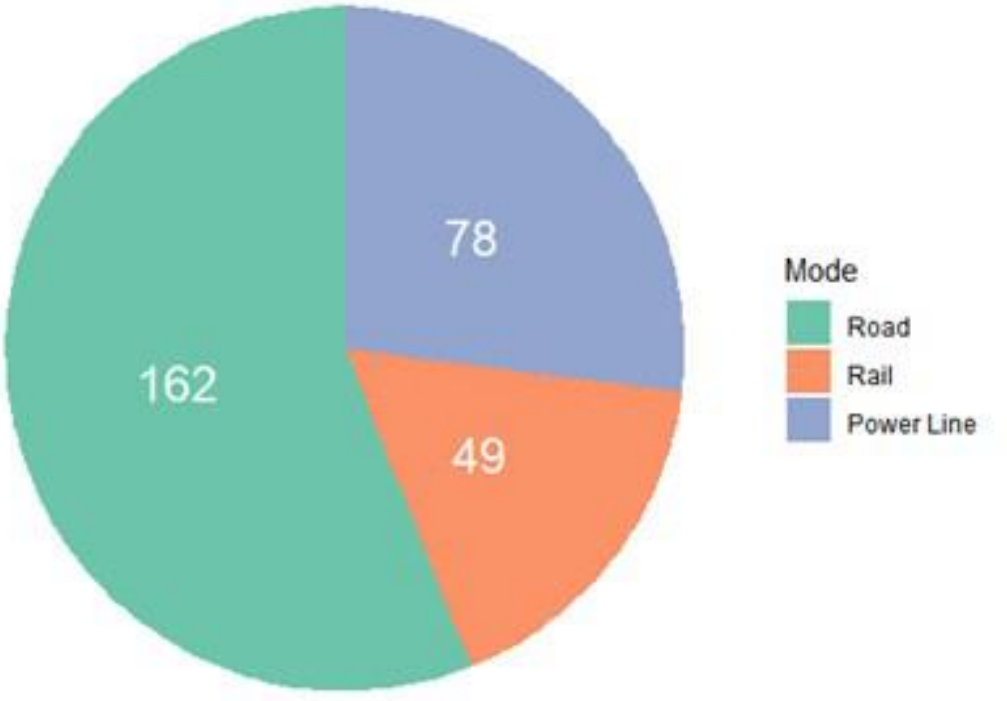
POPULATION IMPACTS (consequences of direct or indirect effects at large scales)

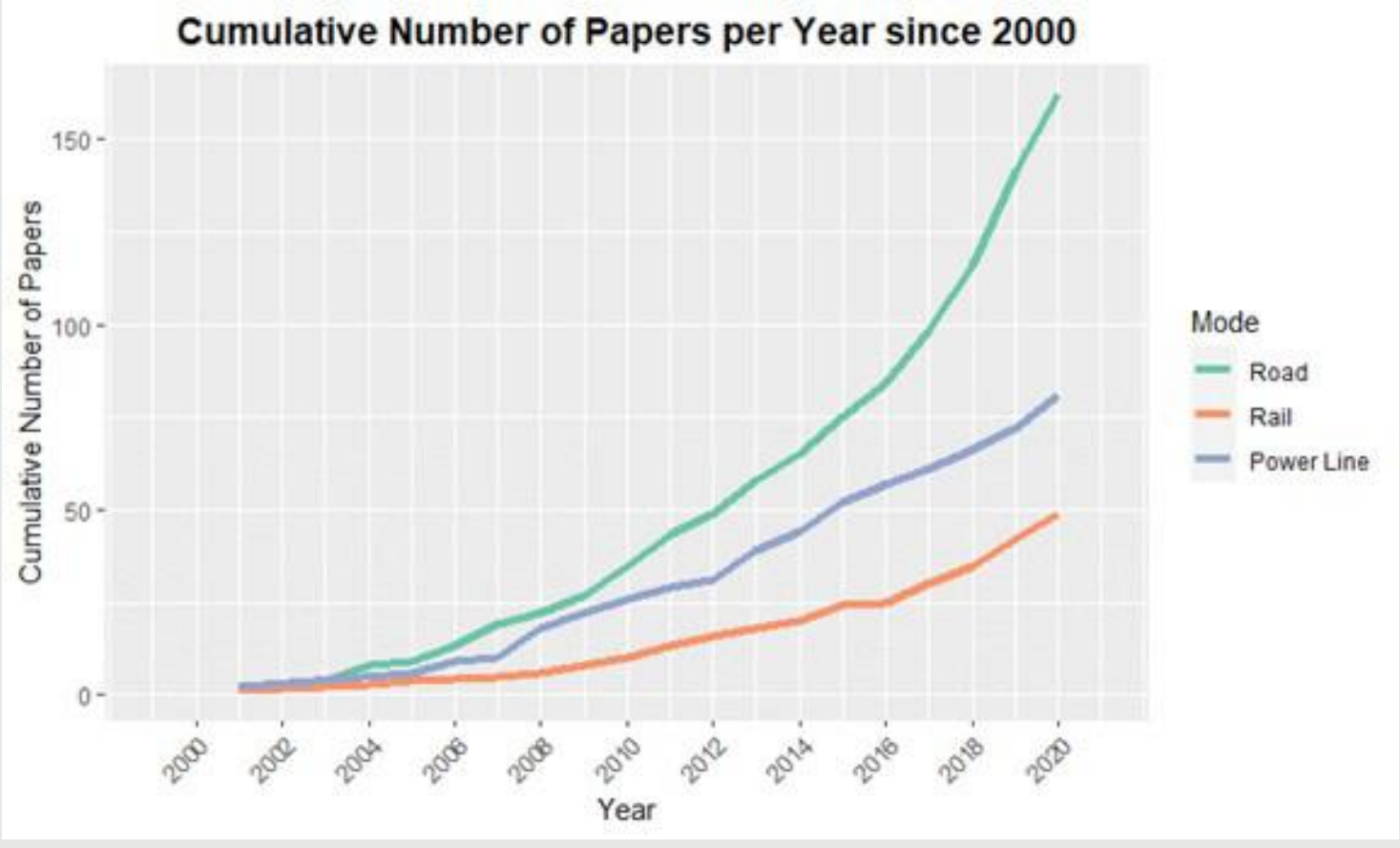
- Demographic rates and fitness related variables
- Genetic structure
- Large scale changes in habitat use / distribution /abundance
- Changes in community structure

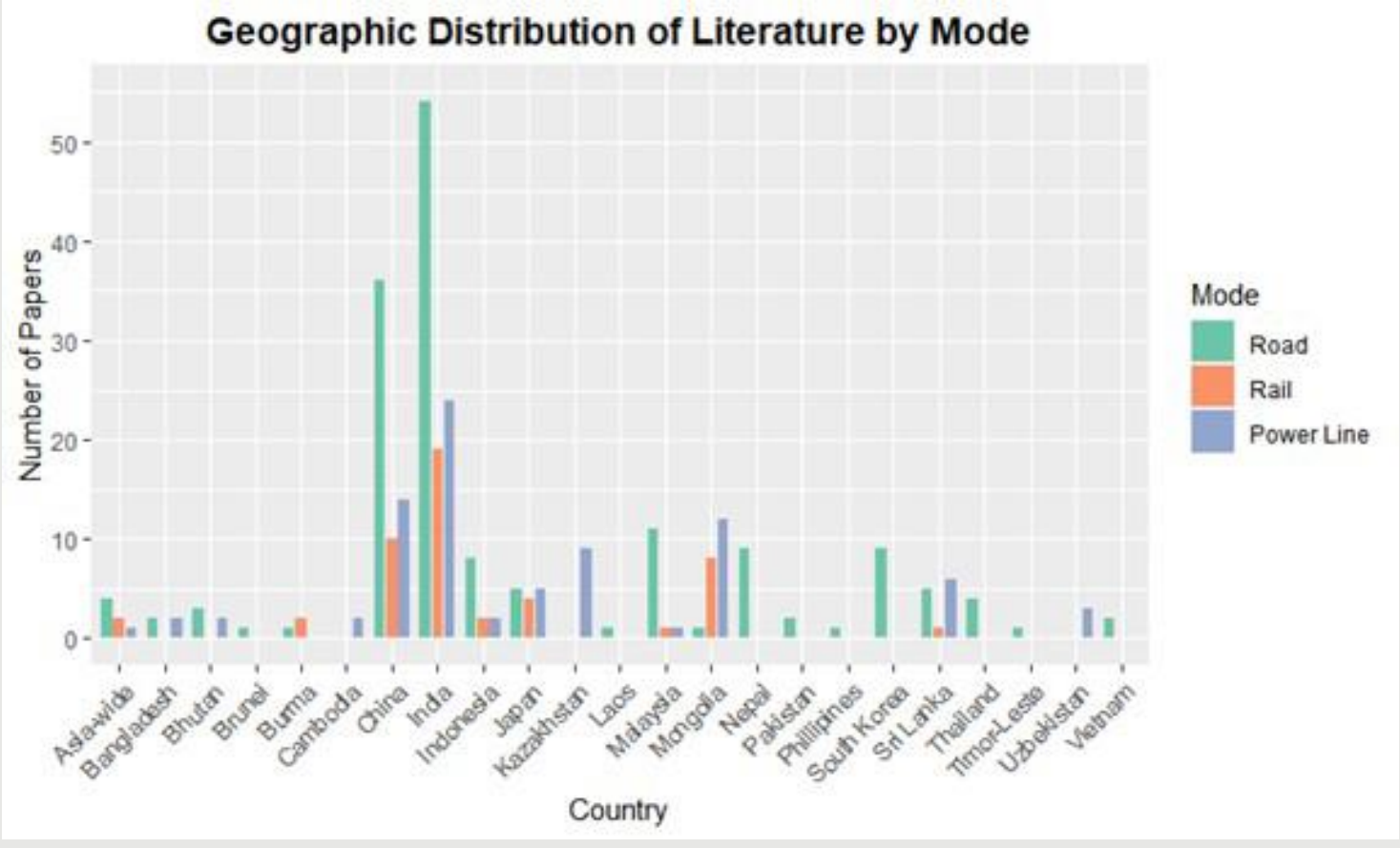
MITIGATION MEASURES

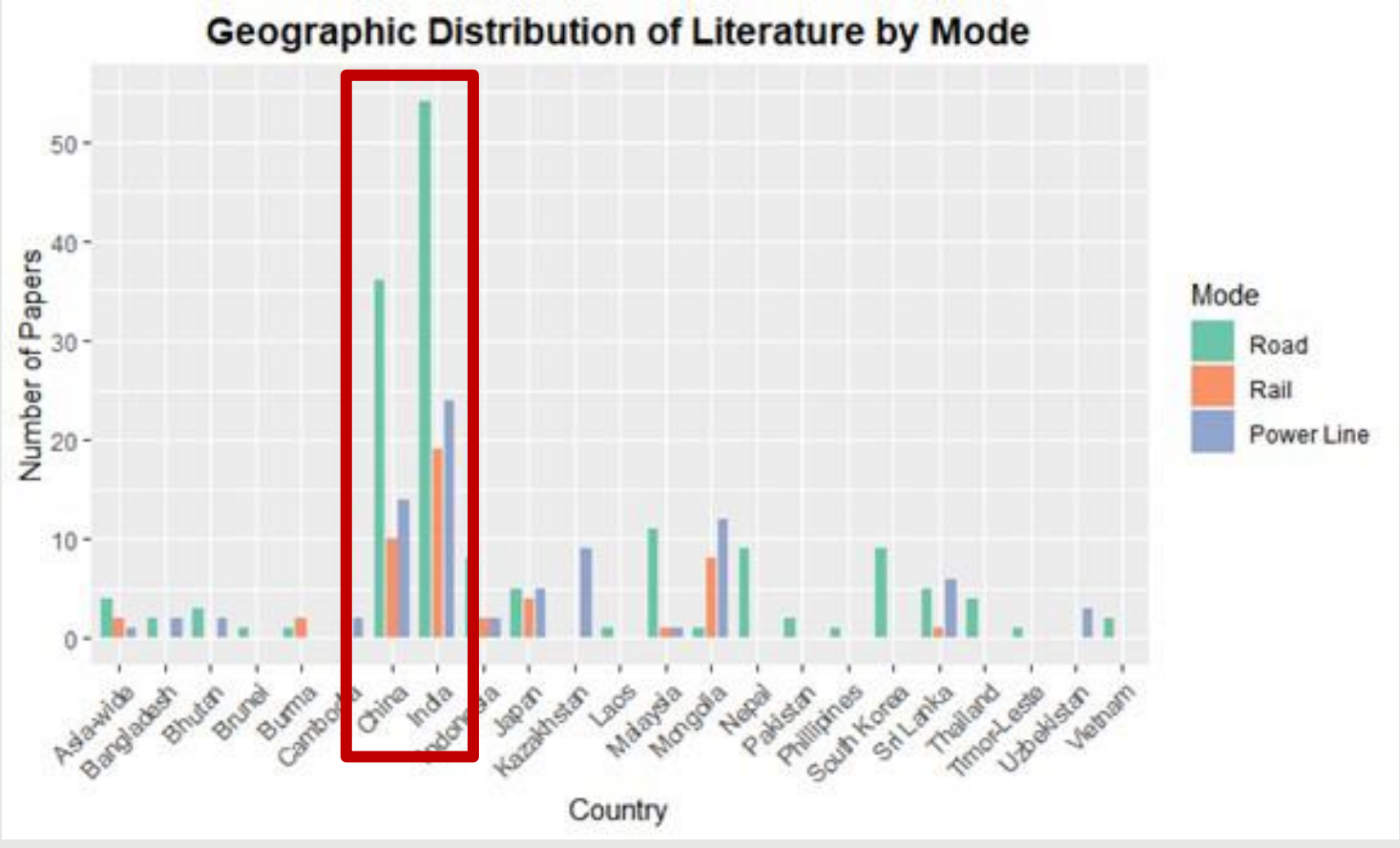
- Structural separation
- Change animal behavior
- Change human behavior

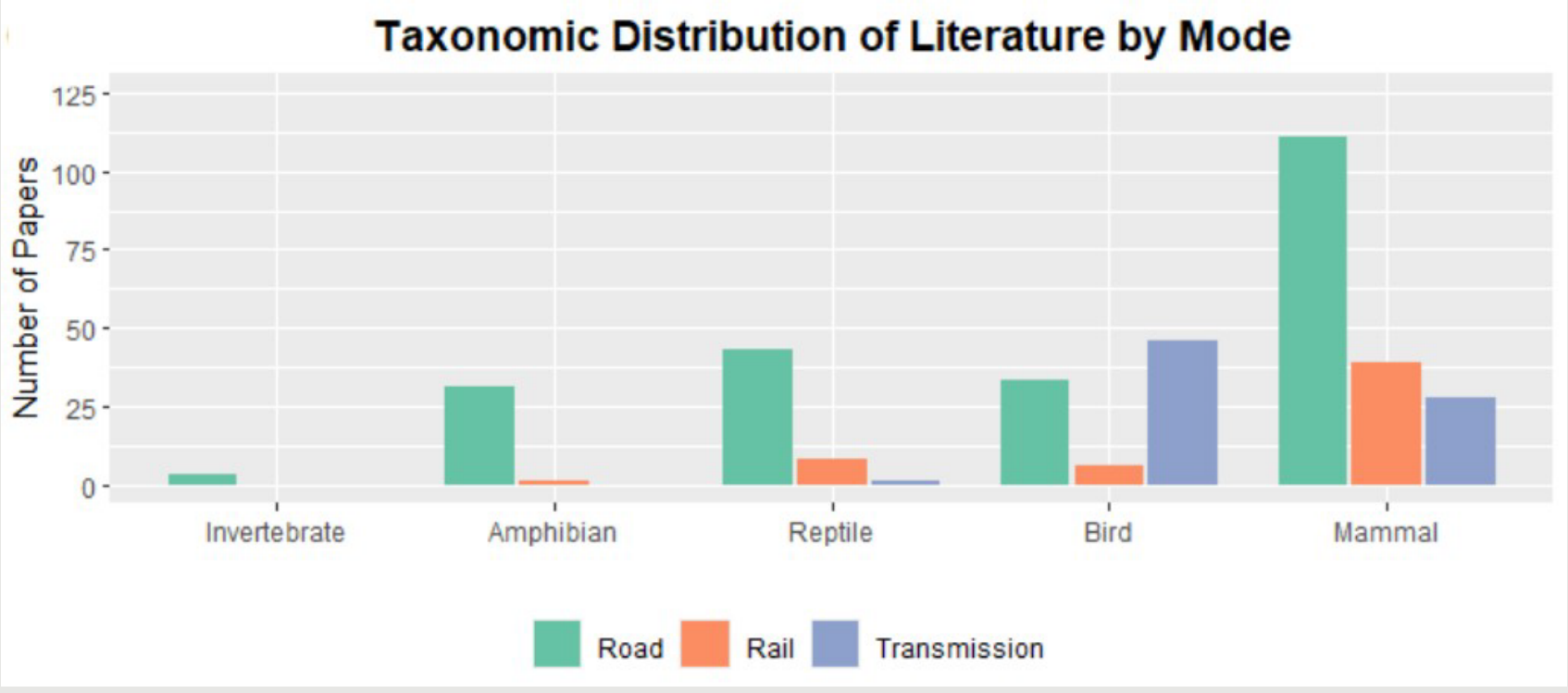
Number of Peer-Reviewed Papers by Mode




Cumulative Number of Papers per Year since 2000
Cumulative Number of Papers
150
100
50
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Year
Mode
Road
Rail
Power Line


Geographic Distribution of Literature by Mode
Number of Papers
0
10
20
30
40
50
Asia-wide
Bangladesh
Bhutan
Brunei
Burma
Cambodia
China
India
Indonesia
Japan
Kazakhstan
Laos
Malaysia
Mongolia
Nepal
Pakistan
Philippines
South Korea
Sri Lanka
Thailand
Timor-Leste
Uzbekistan
Vietnam
Country
Mode
Road
Rail
Power Line


Geographic Distribution of Literature by Mode
Number of Papers
0
10
20
30
40
50
Asia-wide
Bangladesh
Bhutan
Brunei
Burma
Cambodia
China
India
Indonesia
Japan
Kazakhstan
Laos
Malaysia
Mongolia
Nepal
Pakistan
Philippines
South Korea
Sri Lanka
Thailand
Timor-Leste
Uzbekistan
Vietnam
Country
Mode
Road
Rail
Power Line


Taxonomic Distribution of Literature by Mode
Number of Papers
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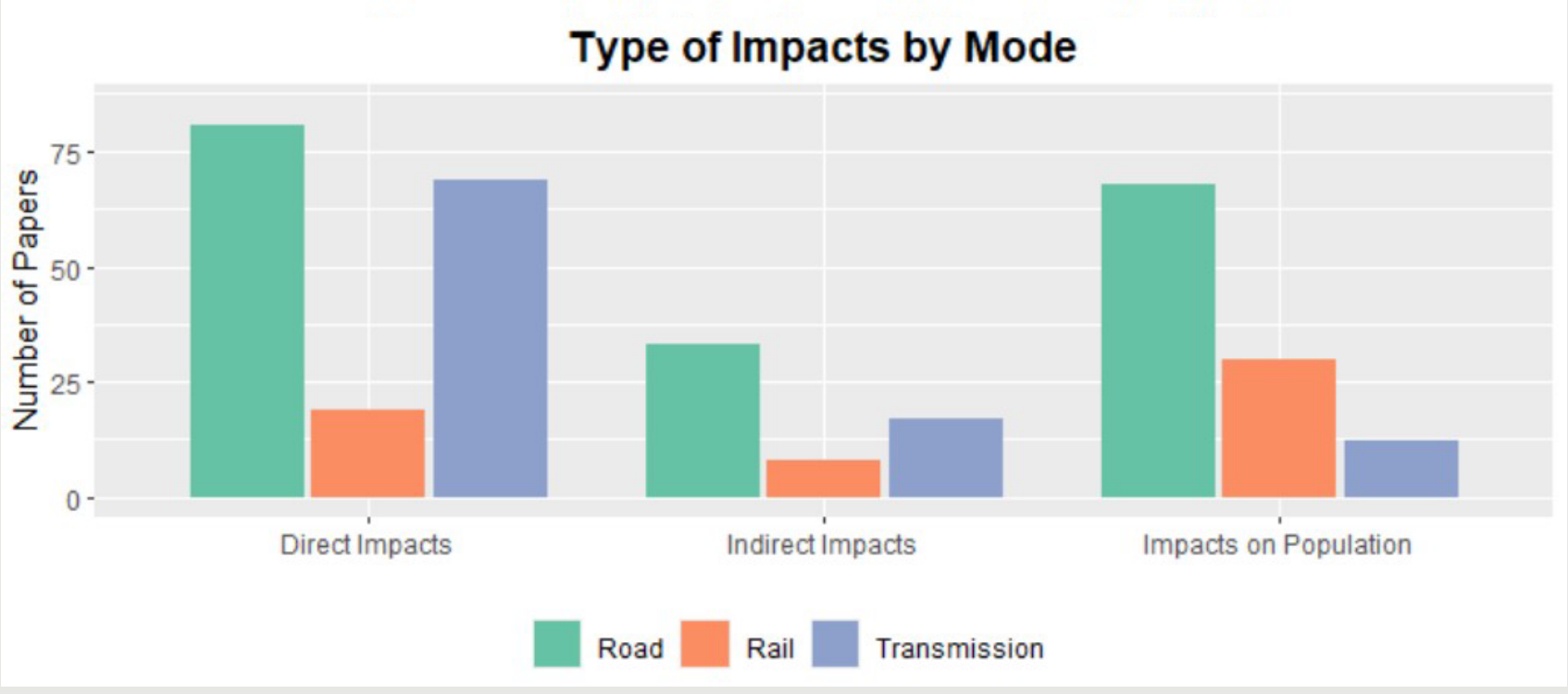
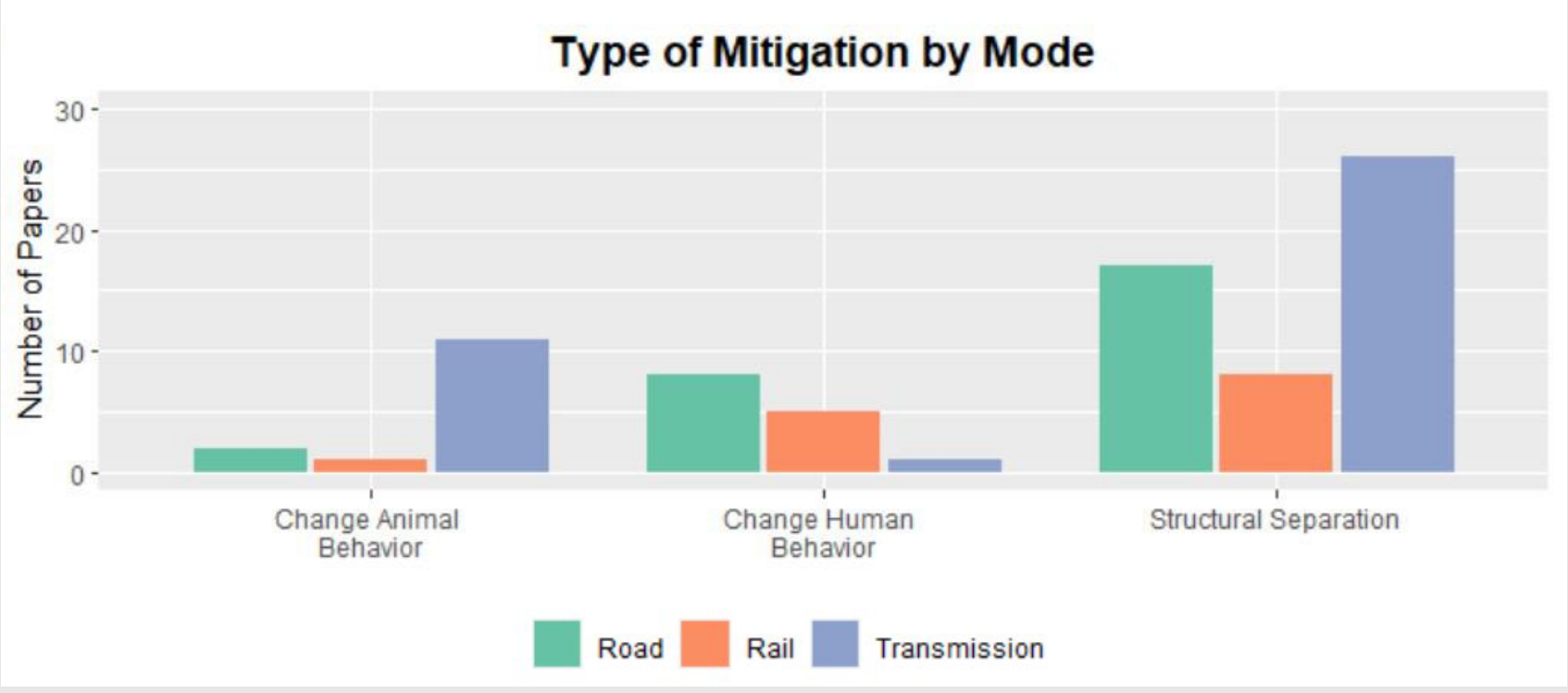
100
75
50
25
0
Invertebrate
Amphibian
Reptile
Bird
Mammal
Road
Rail
Transmission


Type of Impacts by Mode
Number of Papers
75
50
25
0
Direct Impacts
Indirect Impacts
Impacts on Population
Road
Rail
Transmission


Type of Mitigation by Mode
Number of Papers
30
20
10
0
Change Animal Behavior
Change Human Behavior
Structural Separation
Road
Rail
Transmission

MODES IN PARALLEL


Credit : Rezaul Karim

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MODES IN PARALLEL

- Assess cumulative impacts
- Integrated solutions

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ROADS

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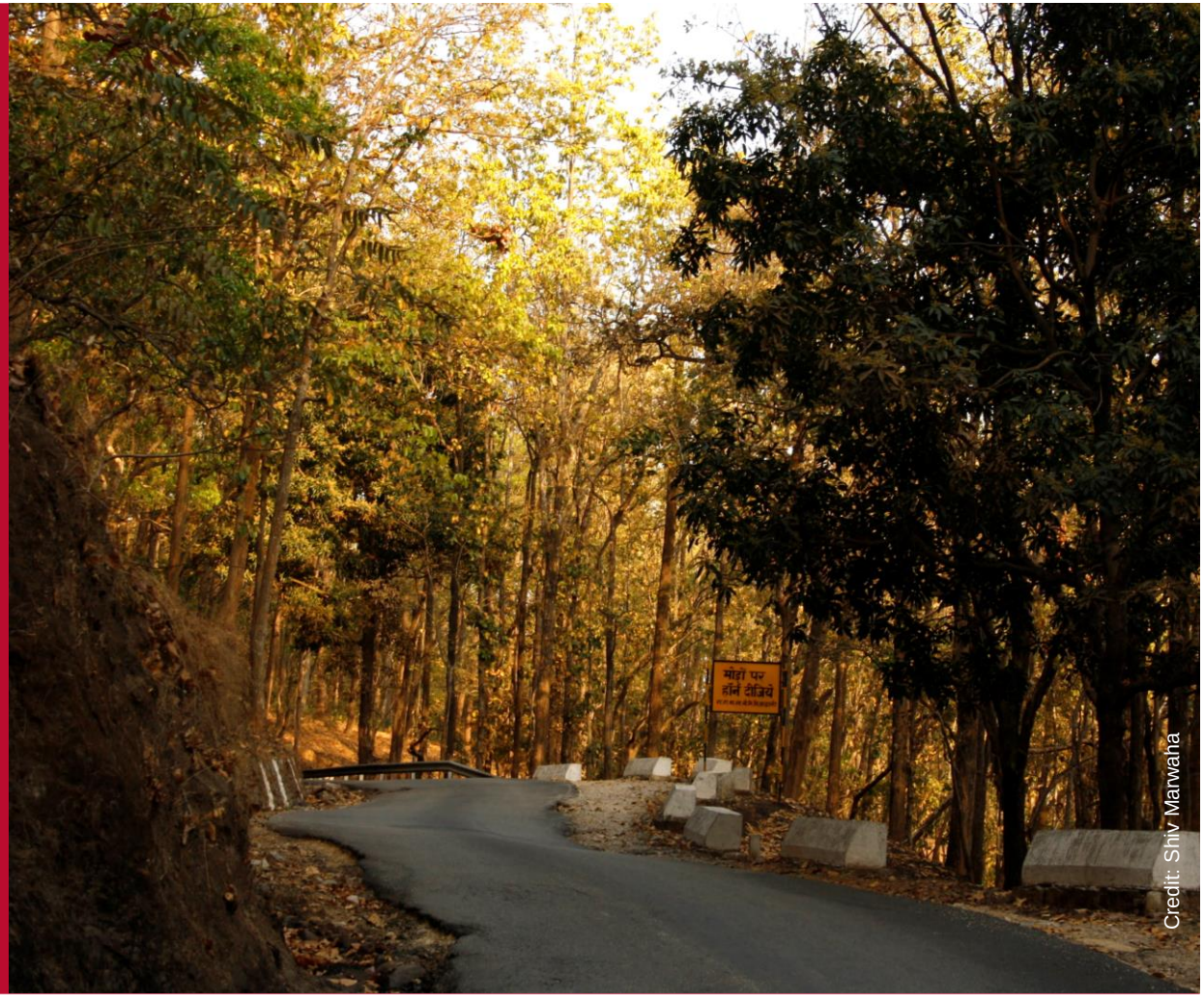

ROAD IMPACTS

Direct
Indirect
Population

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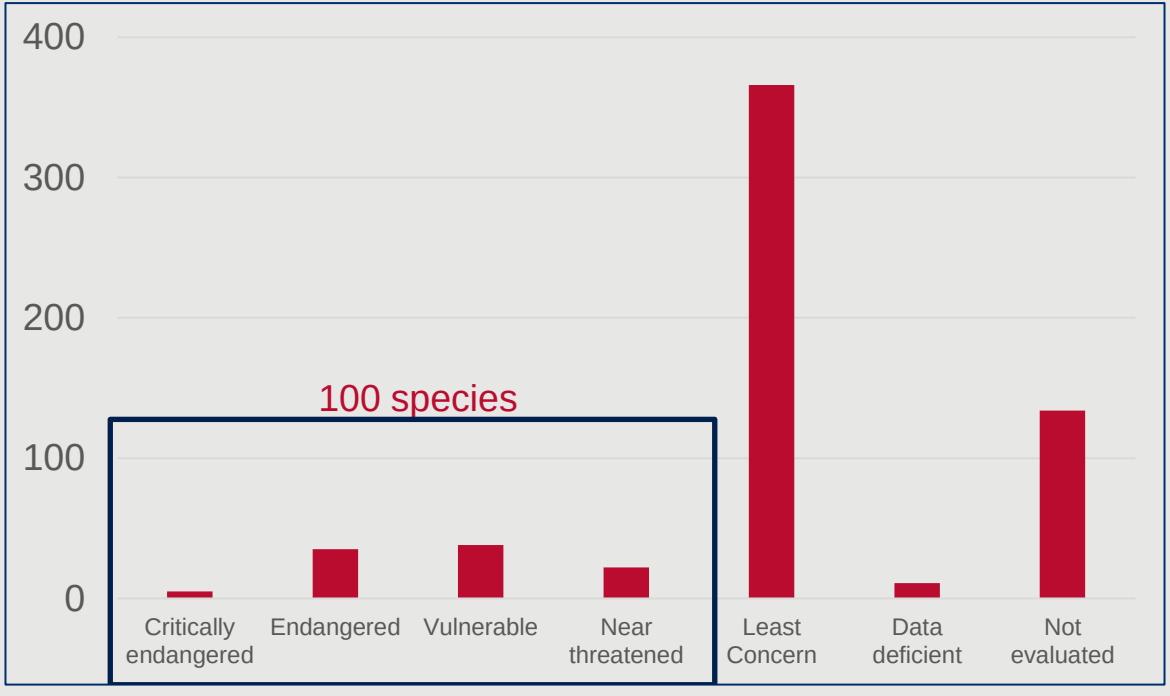
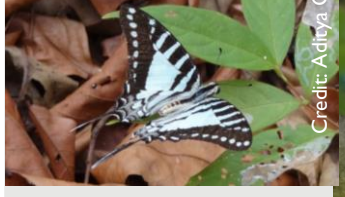
DIRECT IMPACTS on individuals or at small scales

- Death or injury from
  - Collision with vehicles
  - Infrastructure immediately associated with roads

611 species documented in direct impacts





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Can number in the hundreds of thousands

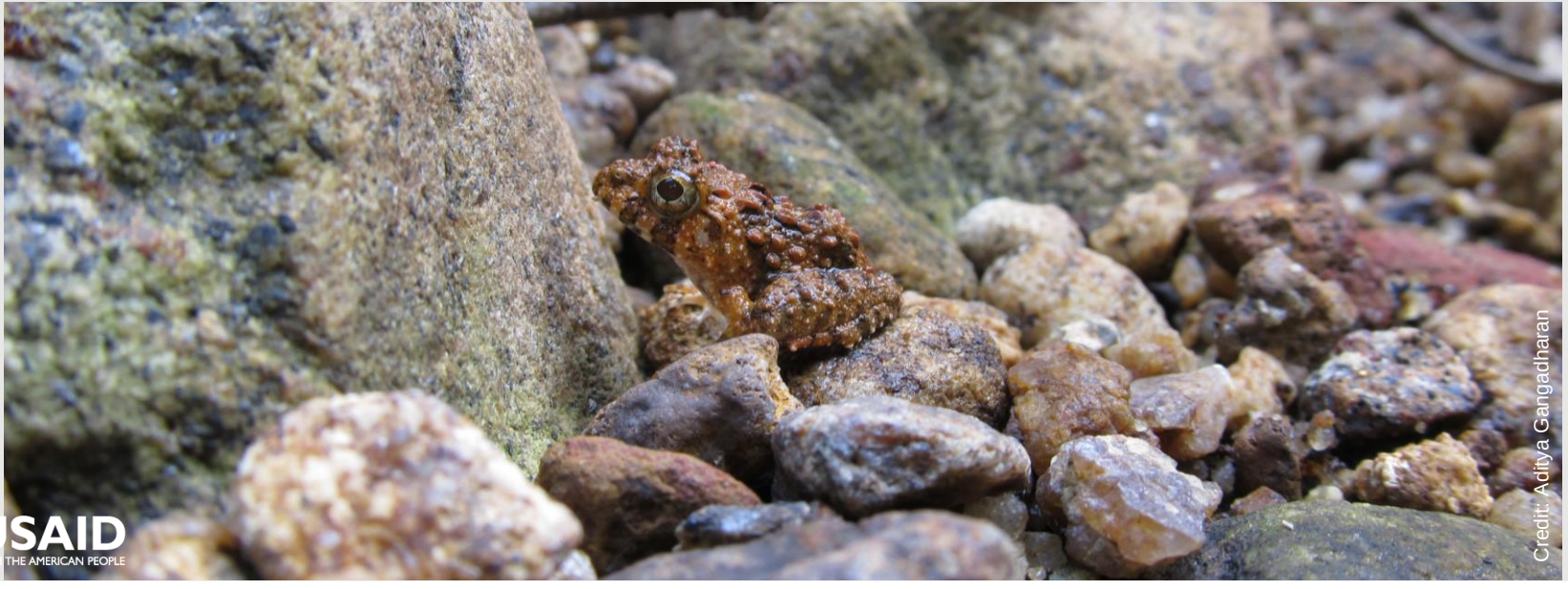
Credit: Alpsdake, https://commons.wikimedia.org/wiki/File:Nyctereutes_procyonoides_viverrinus.jpg

100,000 – 370,000 in 1998 in Japan

Saeki & McDonald. 2004. Biol. Cons. 118:559-571.

FACTORS THAT INFLUENCE COLLISIONS

- Animal habitat preferences
- Activity patterns/periods



Credit: Aditya Gangadharan

FACTORS THAT INFLUENCE COLLISIONS

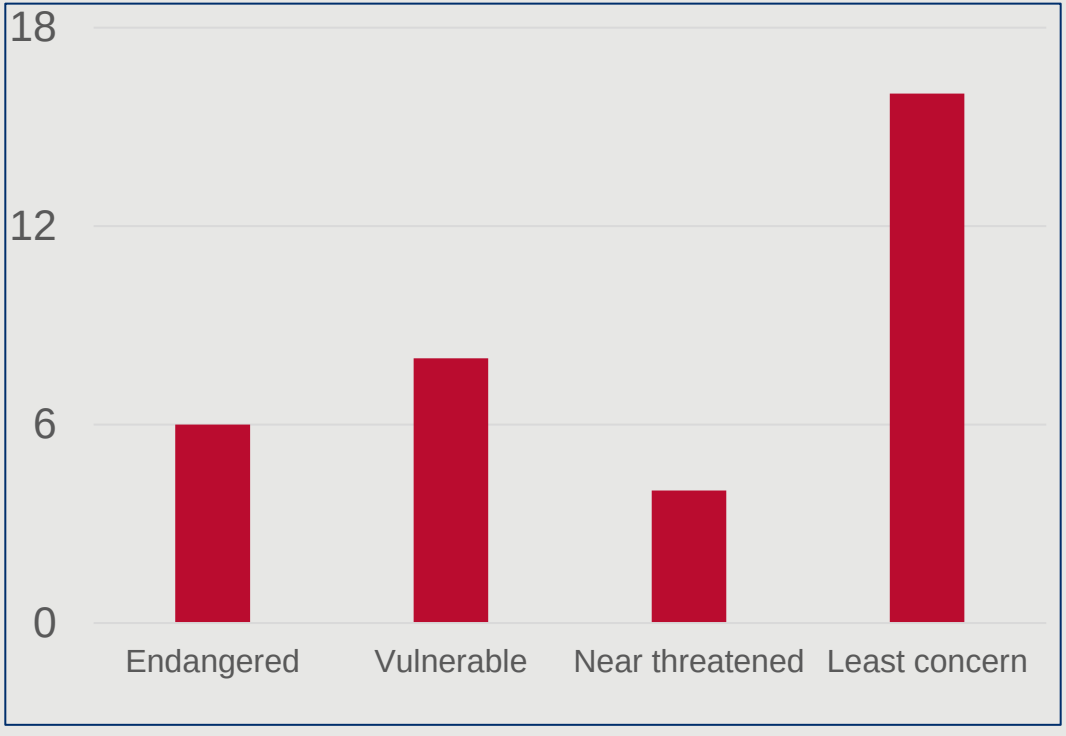
- Road physical characteristics
  - Traffic, lanes
- Driver behavior
  - Speed, avoidance

Credit: Aditya Gangadharan

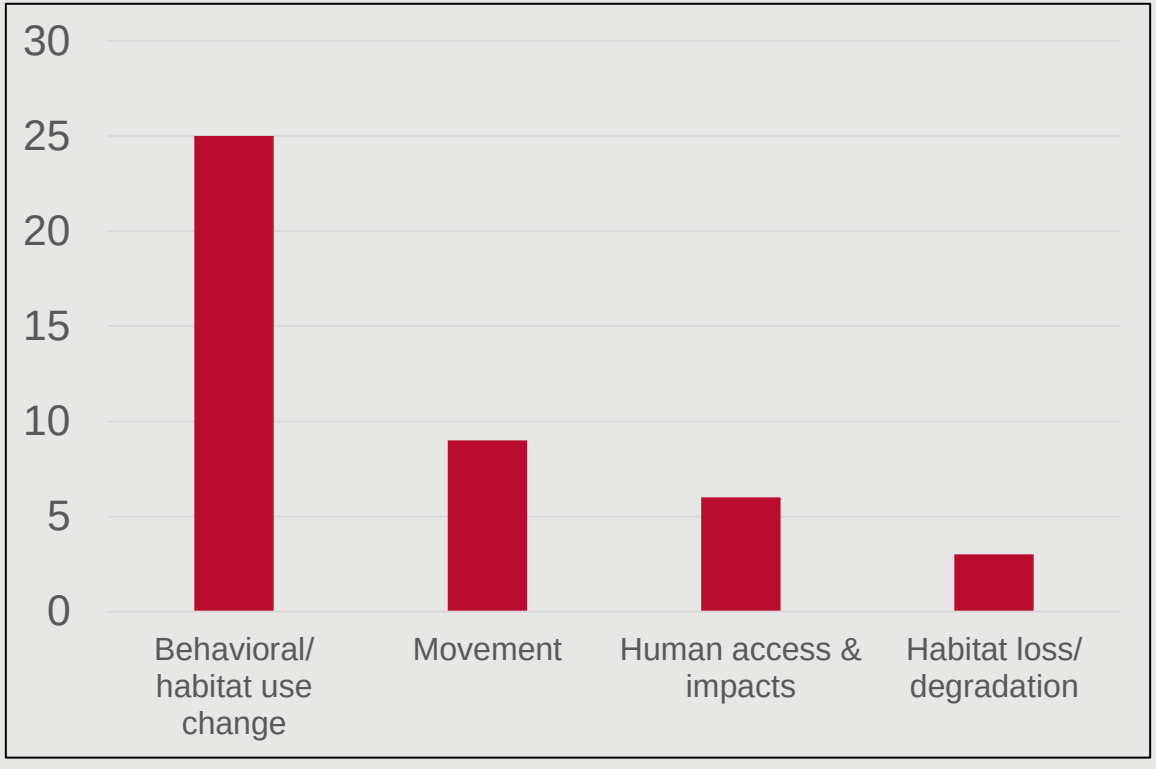
INDIRECT IMPACTS on individuals or at small scales

- Local habitat loss or degradation
- Catalyzing human access & impact
- Changes in habitat use/behavior
- Movement barriers

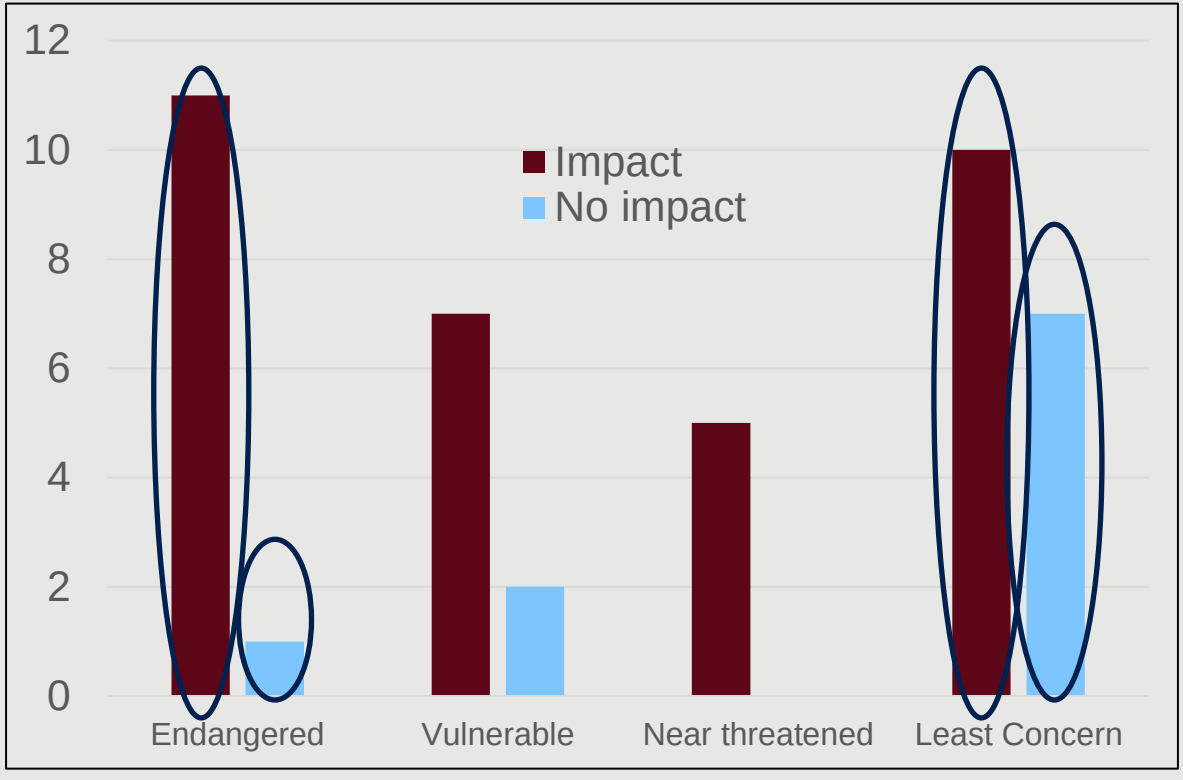
Indirect impacts studies for 34 species



Changes in behavior/habitat use are studied most

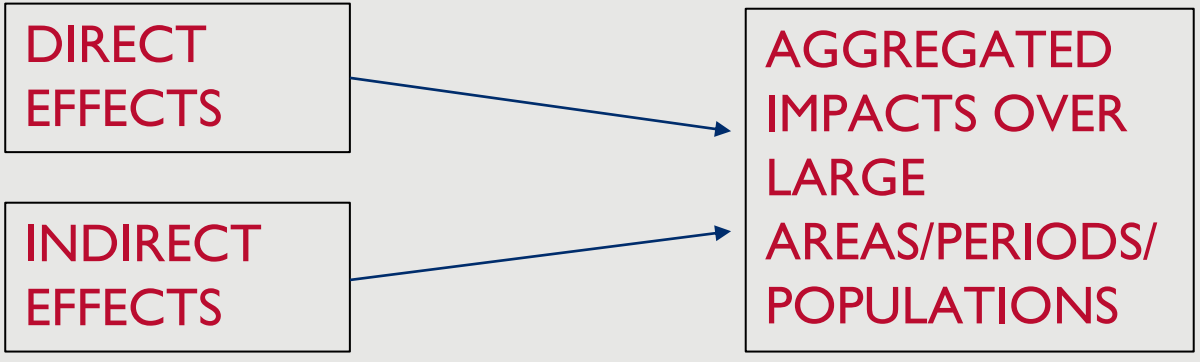


33 studies show impact, 10 show no impact

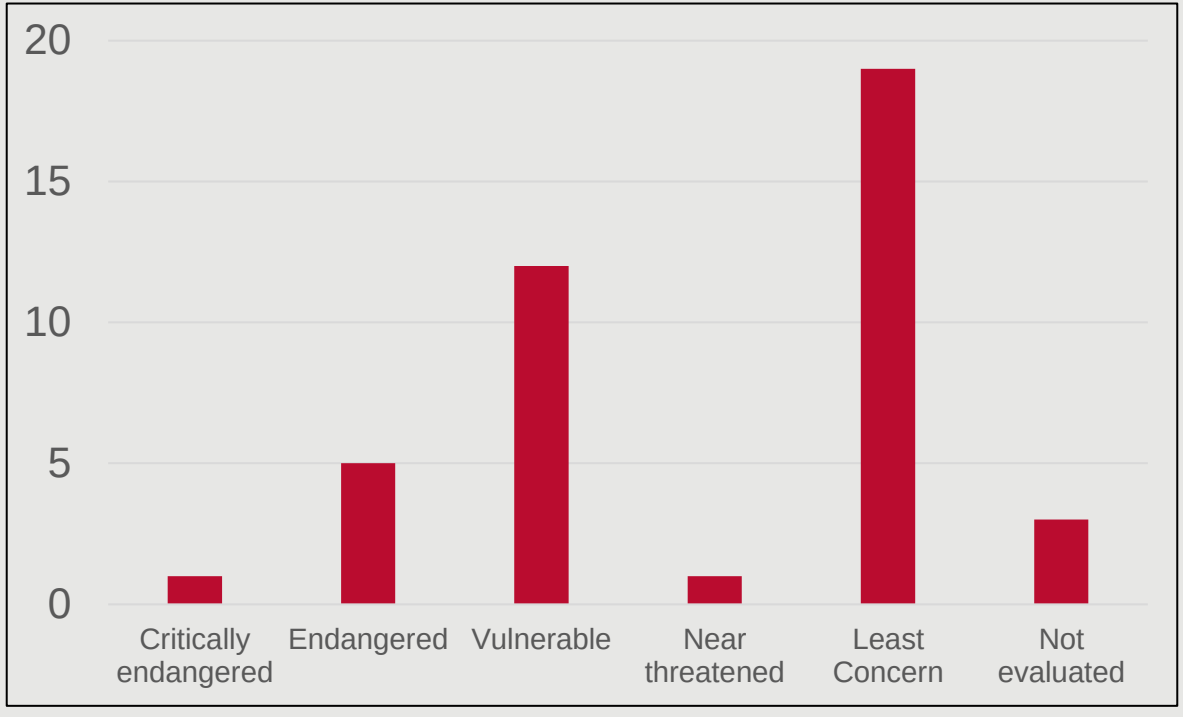


POPULATION IMPACTS (consequences of direct or indirect effects at large scales)

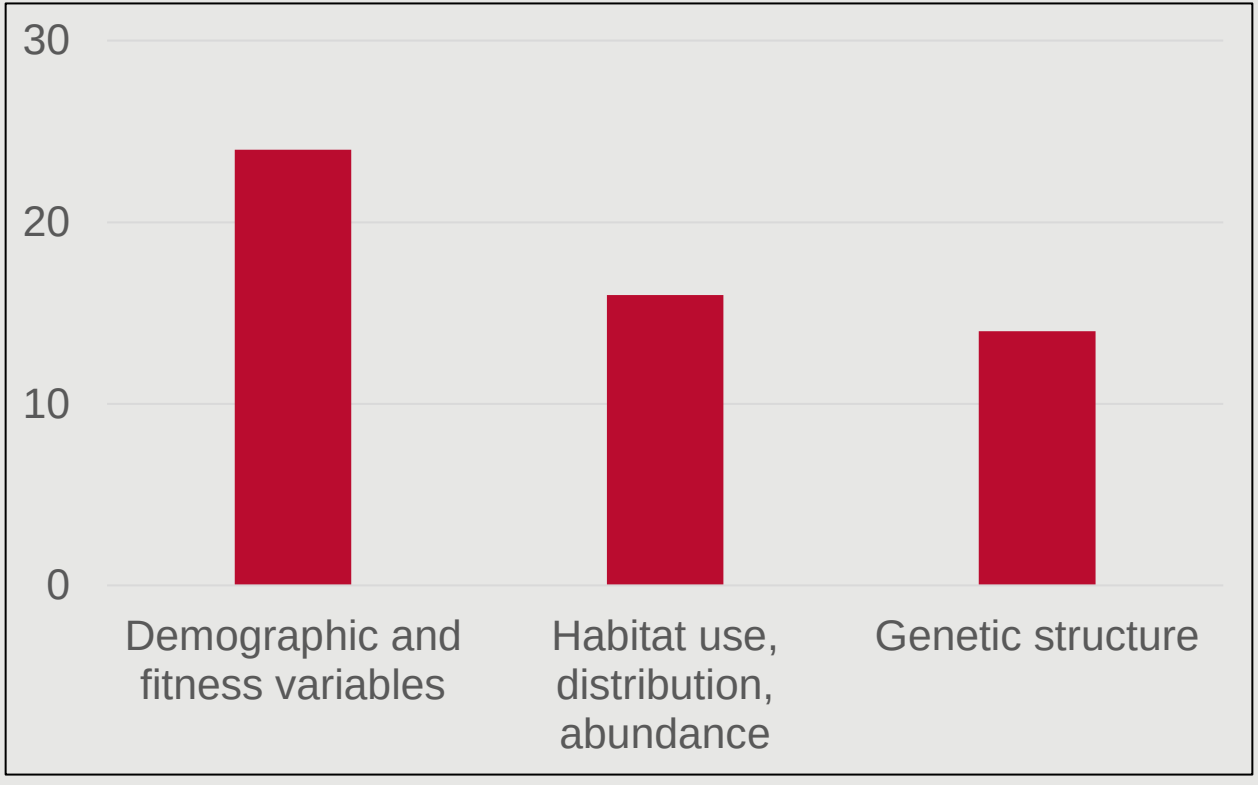
- Large scale changes in habitat use/distribution/abundance
- Demographic rates and fitness related variables
- Genetic structure
- Changes in community structure



Population impacts studied for 41 species



Demographic variables studied most



46% higher mortality rate for males

Pragatheesh. 2011. JoTT.3:1656-1662.

*when corrected for local abundance

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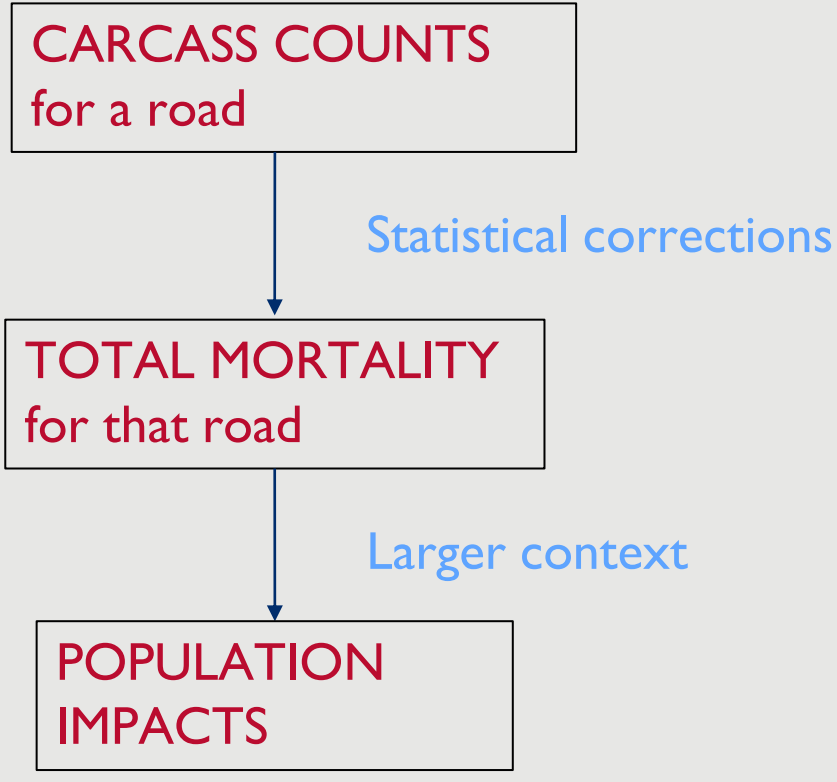
How much do roadkills impact populations?

Credit: Raju Kasambe
https://commons.wikimedia.org/wiki/File:Blackbuck_Antilope_cervicapra_Roadkill_Karahja_Lad_Maharashtra_03.jpg

Robust extrapolation



Robust extrapolation is rare

CARCASS COUNTS
for a road

TOTAL MORTALITY
for that road

POPULATION
IMPACTS

KEY FINDINGS: ROAD IMPACTS

- Tens/hundreds of thousands of vertebrate mortalities
- Threatened species particularly impacted
- Mammals studied more than others
- Lack of ‘big picture’ approach

ROAD MITIGATION

Animal behavior
Human behavior
Structural separation

ANIMAL BEHAVIOR MODIFICATION (2 studies)

- Repel animals from road area
  - Repellents, aversive conditioning

Credit: NPS/Emily Mesner

ANIMAL BEHAVIOR MODIFICATION (2 studies)

- Repel animals from road area
  - Habitat management, diversionary feeding
- Little documented exploration of such methods in Asia

HUMAN BEHAVIOR MODIFICATION (8 studies)

- Modify traffic volume
  - Road closures (specific times)

Credit: Ranjithsiji
https://commons.wikimedia.org/wiki/File:Forest_Check_Post_Karakkad.JPG

HUMAN BEHAVIOR MODIFICATION (8 studies)

- Modify behavior of individual drivers
  - Speed bumps, signages, clear verge
  - Preventing feeding

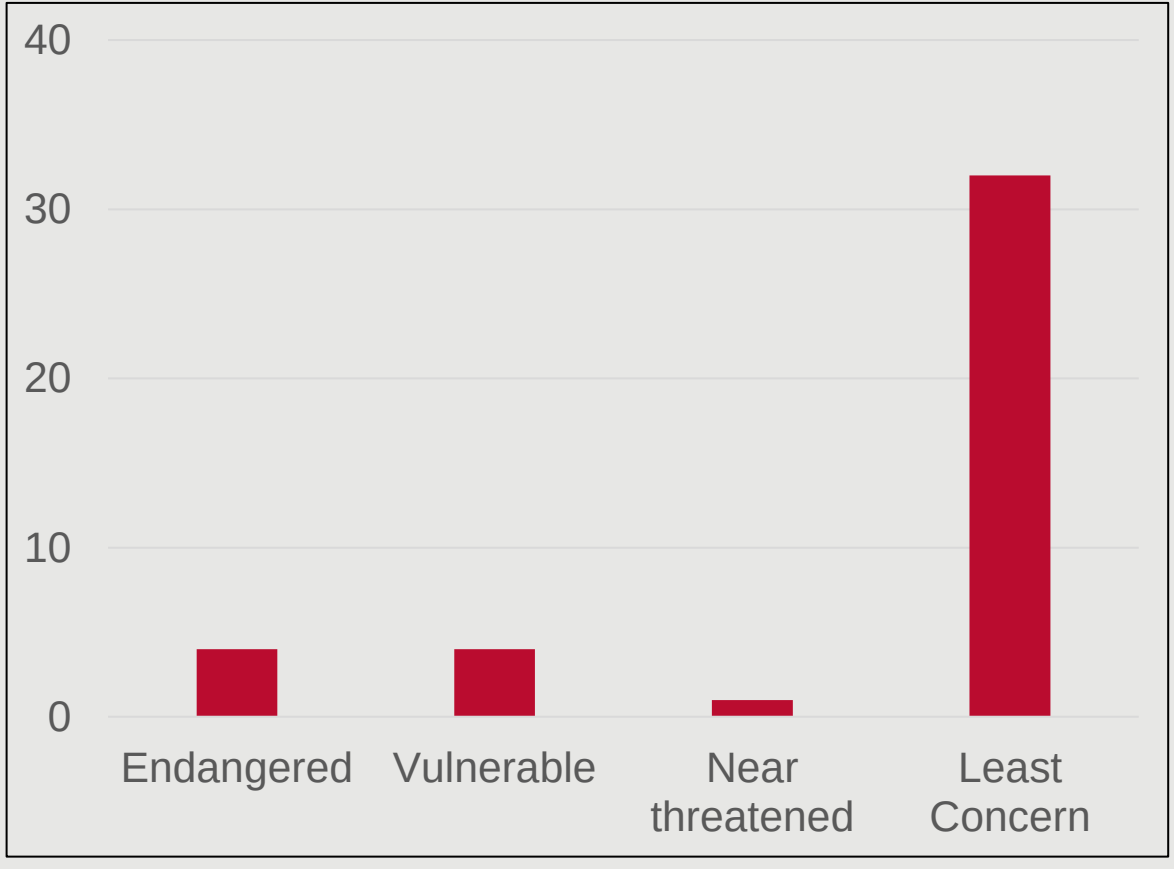
Credit: : Koustav Choudhuryc

Credit: Koustav Choudhuryc

STRUCTURAL SEPARATION of vehicles and wildlife (17 studies)

- Fencing along road
  - Reduce direct but increase indirect impacts
- Crossing structures + fencing
  - Vehicles pass above animal
  - Animals pass above vehicles

41 species documented using wildlife crossing structures



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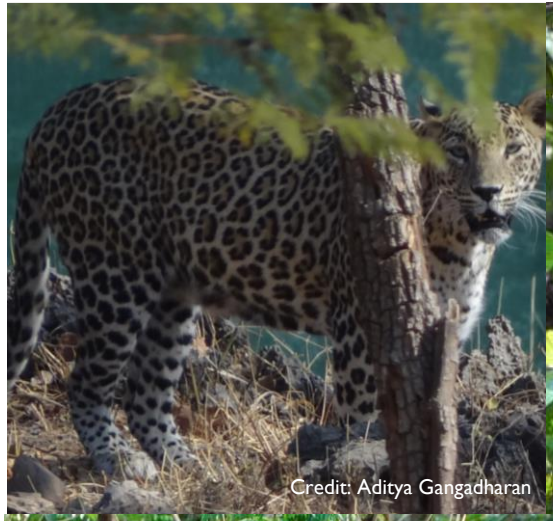
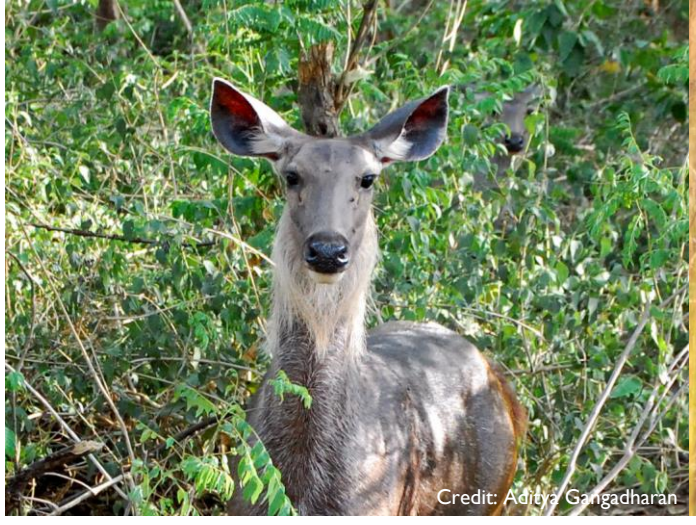

Credit: Aditya Gangadharan


Credit: Aditya Gangadharan


Credit: Aditya Gangadharan


Credit: Davidraju,
https://commons.wikimedia.org/wiki/File:Rusty_spotted_cat_1.jpg


Credit: Aditya Gangadharan


Credit: Gregoire Dubois


Credit: Gregoire Dubois

PLACEMENT is key

Credit: Karma Chogyel

KEY FINDINGS: ROAD MITIGATION

- More focus on impacts, less on mitigation
- Only 10 of 30 global mitigation methods document in Asia
- Need more robust evaluation of efficacy

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RAILWAYS

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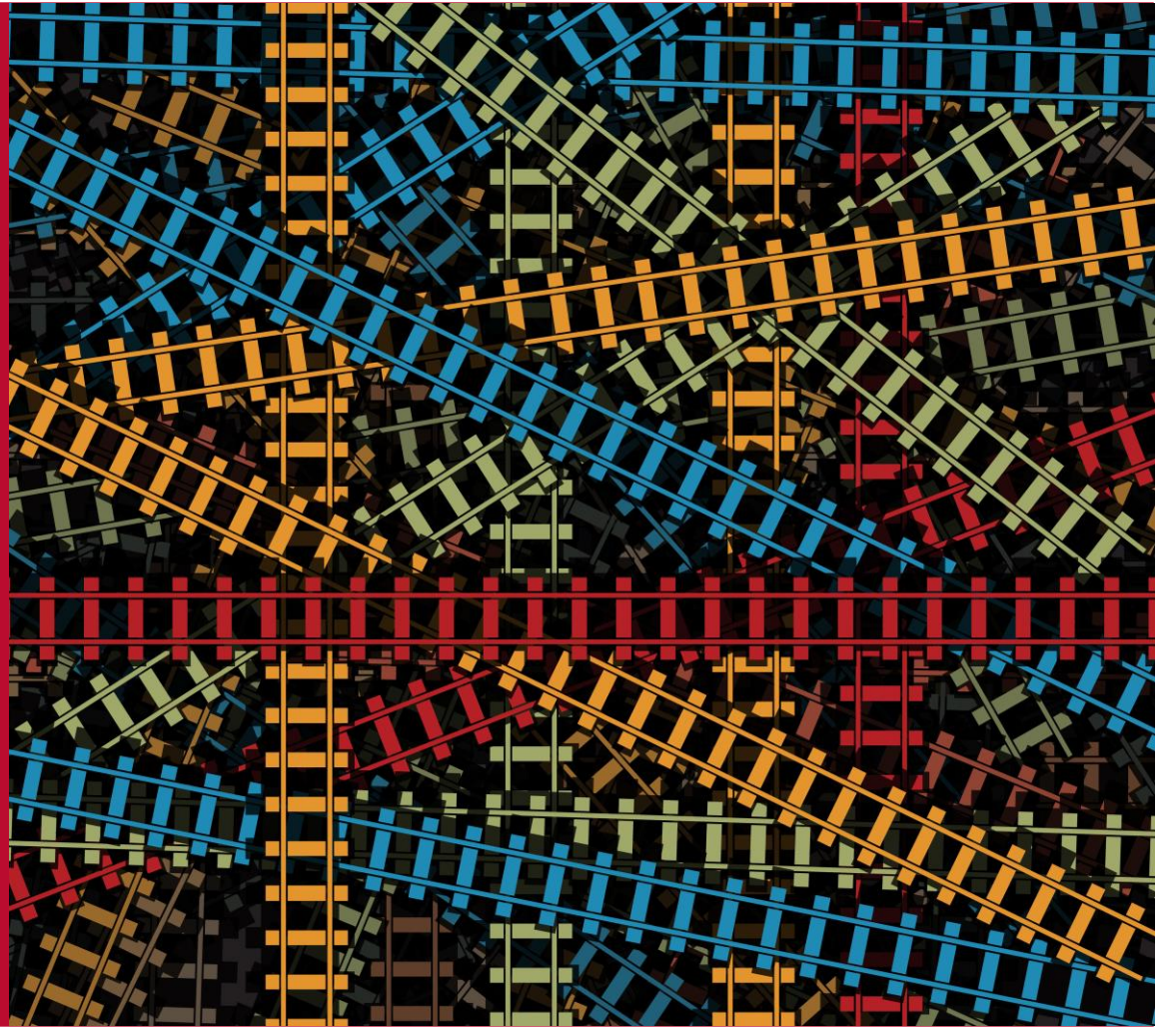
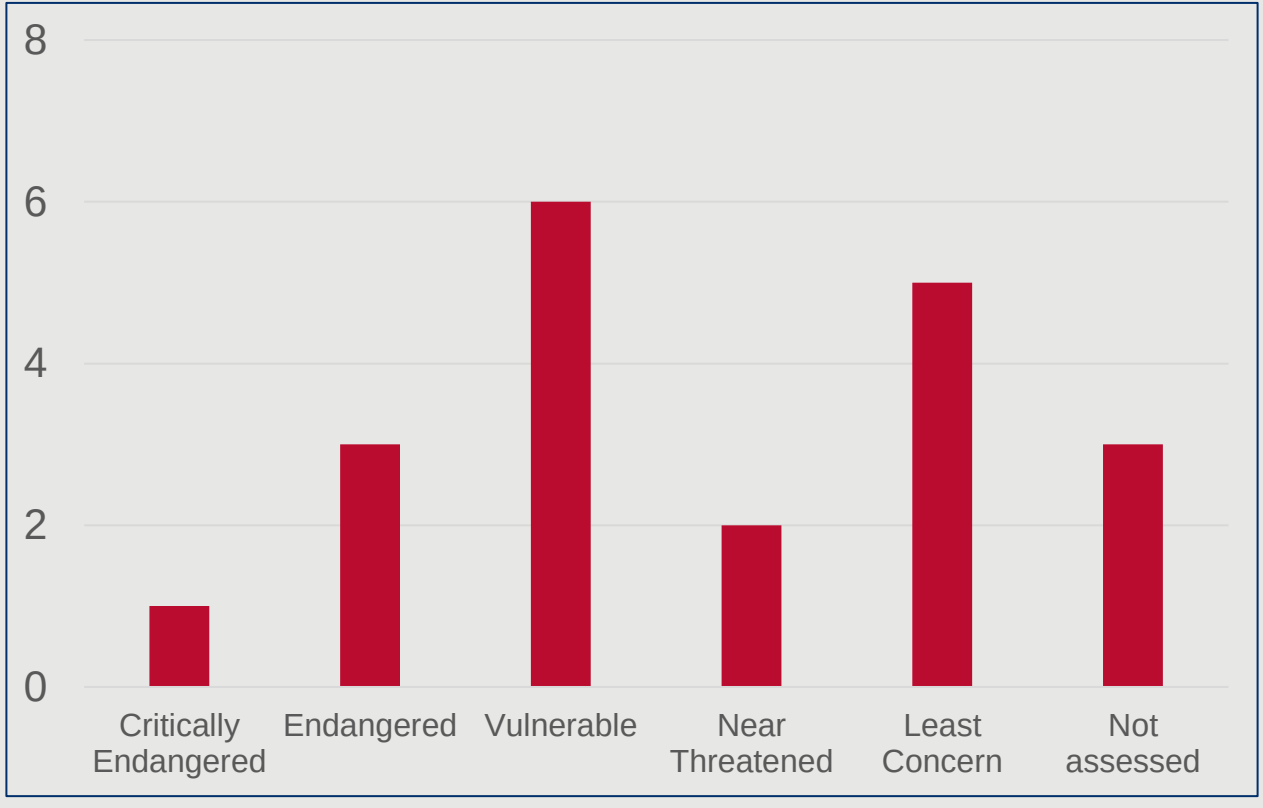


20 species documented in train strikes



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Factors that influence collisions

- Animal habitat preferences
- Activity patterns/ periods
- Movement
  - Across fragmented patches
  - Migration

Credit: Aditya Gangadharan

Factors that influence collisions

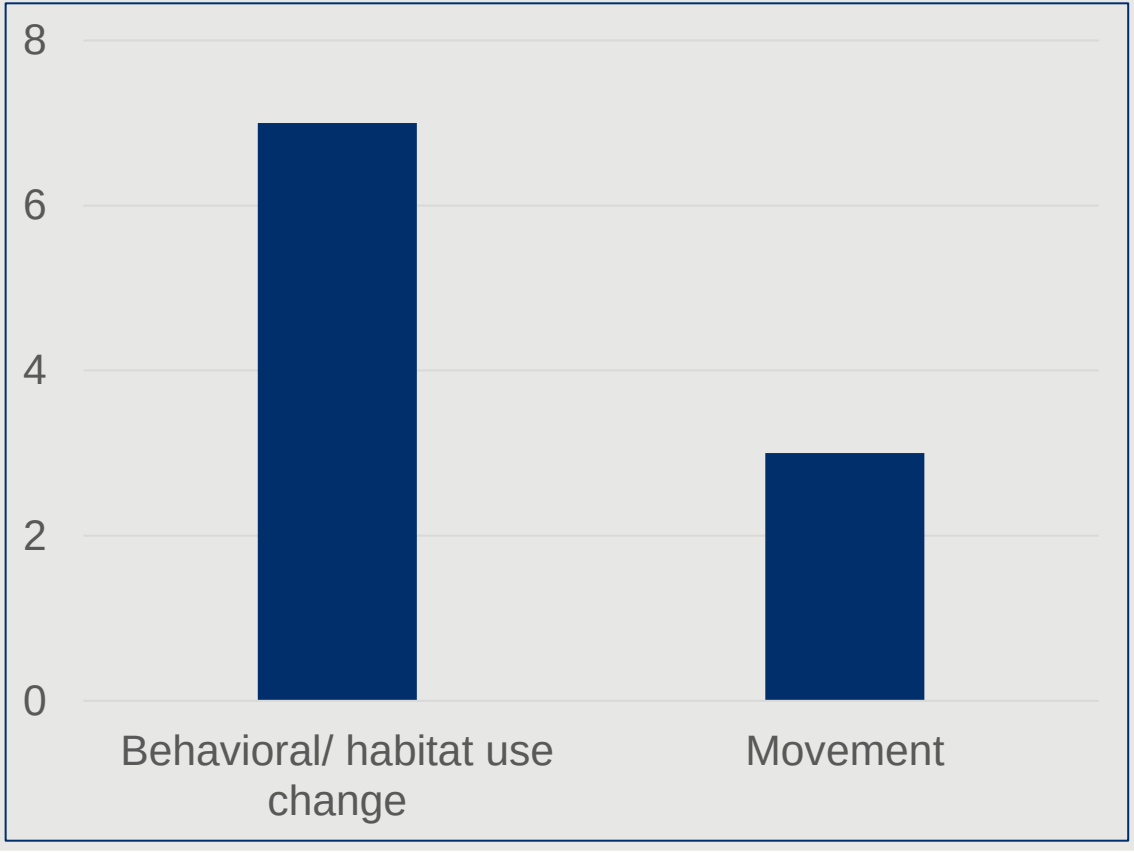
INDIRECT IMPACTS on individuals or at small scales

- Local habitat loss or degradation
- Catalyzing human access & impact
- Changes in habitat use/behavior
- Movement barriers

Indirect impact studies: many on migratory ungulates

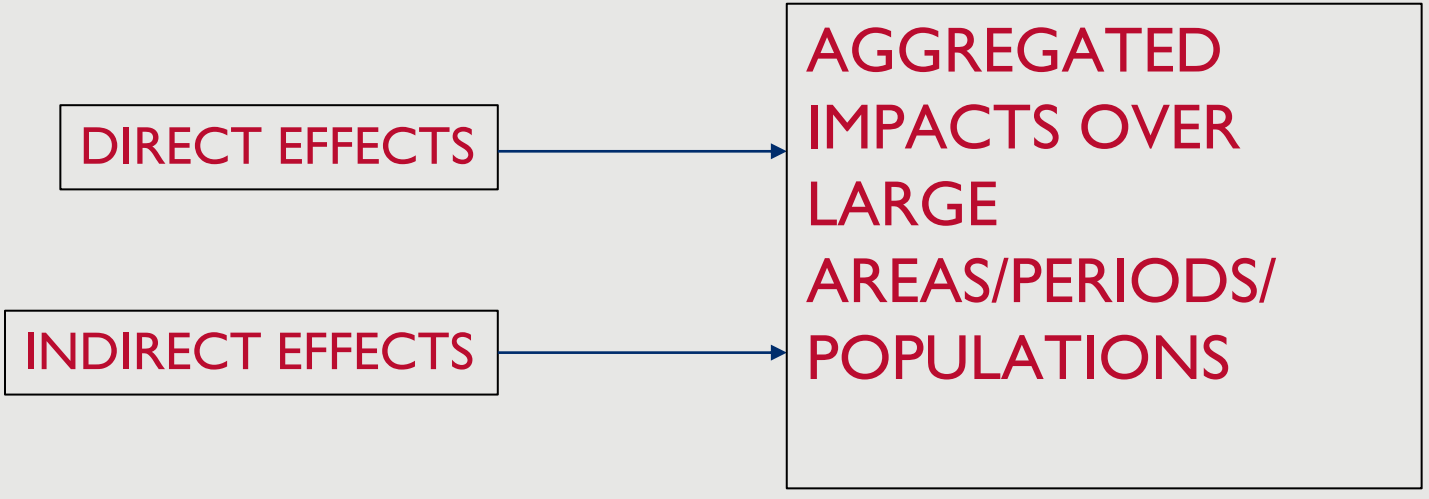
Credit: Wenjing Xu

Indirect impact studied for 8 species

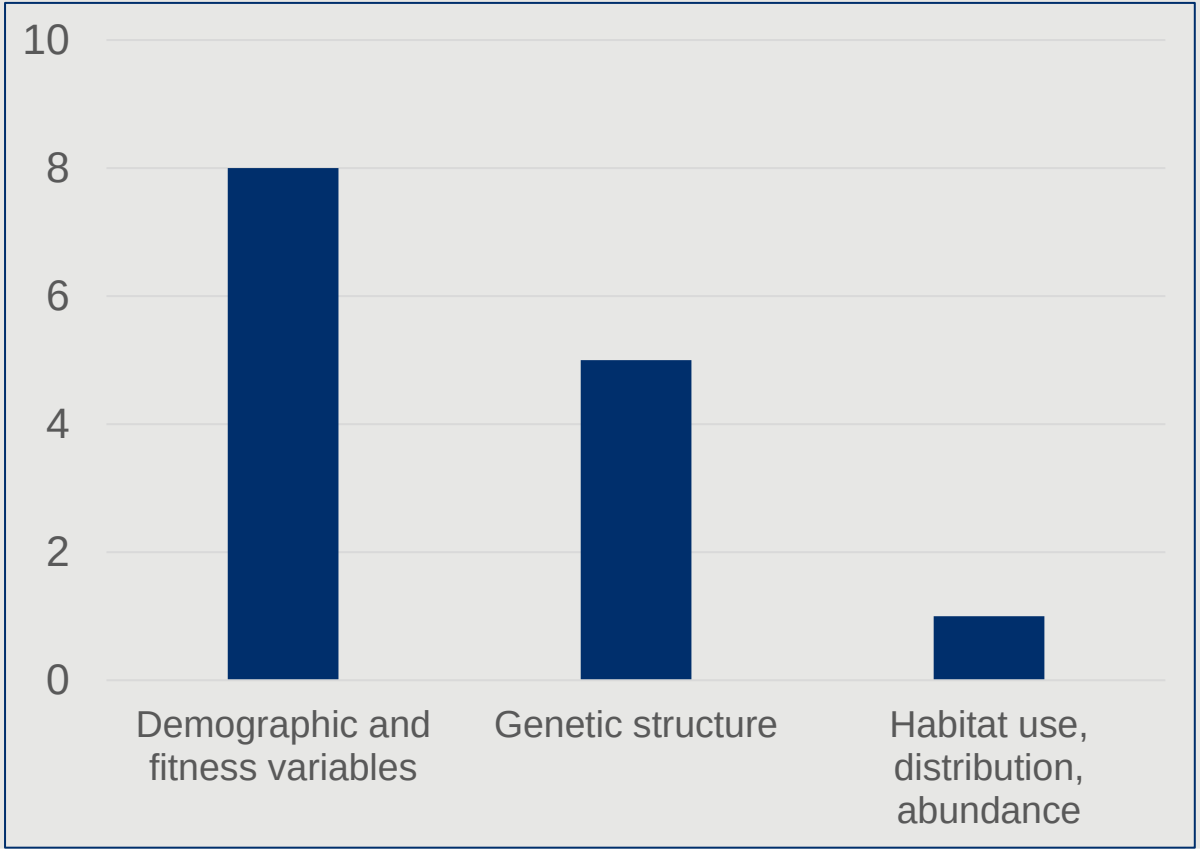


POPULATION IMPACTS (consequences of direct or indirect effects at large scales)

- Large scale changes in habitat use/distribution/abundance
- Demographic rates and fitness related variables
- Genetic structure
- Changes in community structure



Population impacts studied for 9 species



Asiatic wild ass: loss access to 17,000 sq. km of habitat

Kaczensky et al. 2011. Biol. Cons. 144:920-929

Credit: Sumeet Moghe, https://commons.wikimedia.org/wiki/File:Asiatic_Wild_Ass_herd.jpg

Males 2.5 X more vulnerable to train strikes

Roy & Sukumar in Borda de Agua (eds). 2017. Rail Ecology.

KEY FINDINGS: IMPACTS

- Why so few species documented in train strikes?
- Indirect impacts also less studied
- Demographic data surprisingly lacking

RAIL MITIGATION

Animal behavior
Human behavior
Structural separation

ANIMAL BEHAVIOR MODIFICATION (1 study)

- Repel animals from rail area
  - Visual repellents, aversive conditioning
  - Habitat management, diversionary feeding
- Anecdotal information available for elephants
  - But little rigorous testing

HUMAN BEHAVIOR MODIFICATION (5 studies)

- Trains differ from vehicles
  - Frequency
  - Trained drivers
- Modify behavior of individual drivers
  - Speed limits, signages, maintenance
  - Live patrolling & early warning

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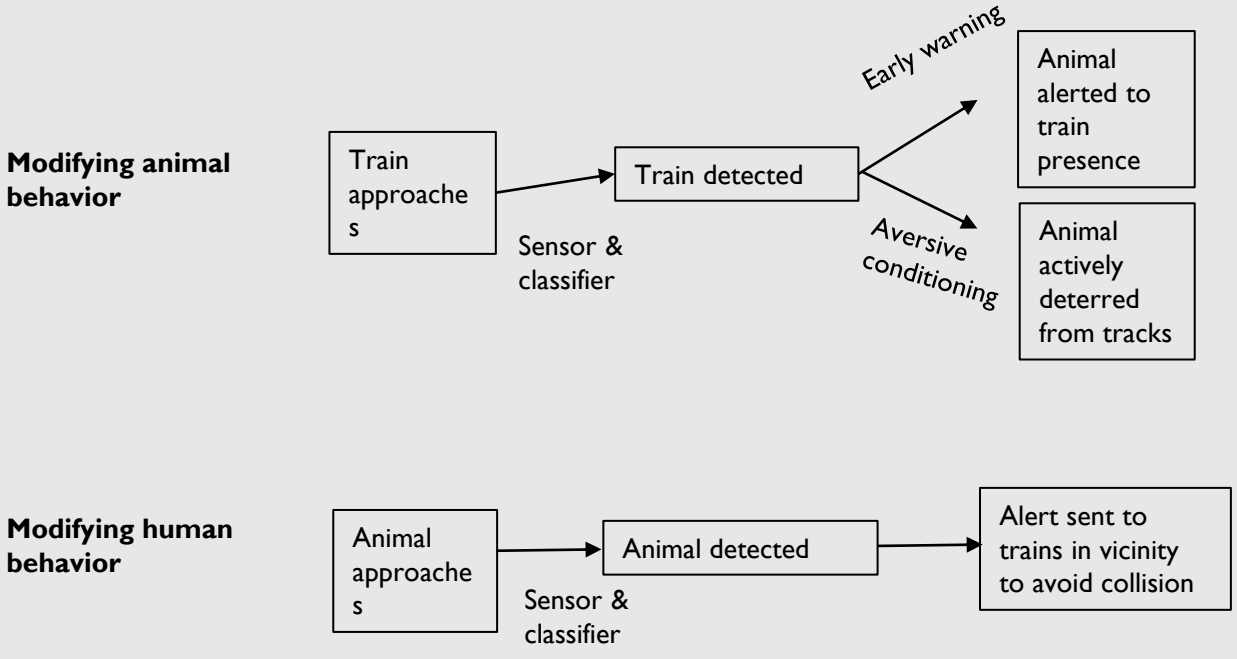
TECHNOLOGY OPTIONS



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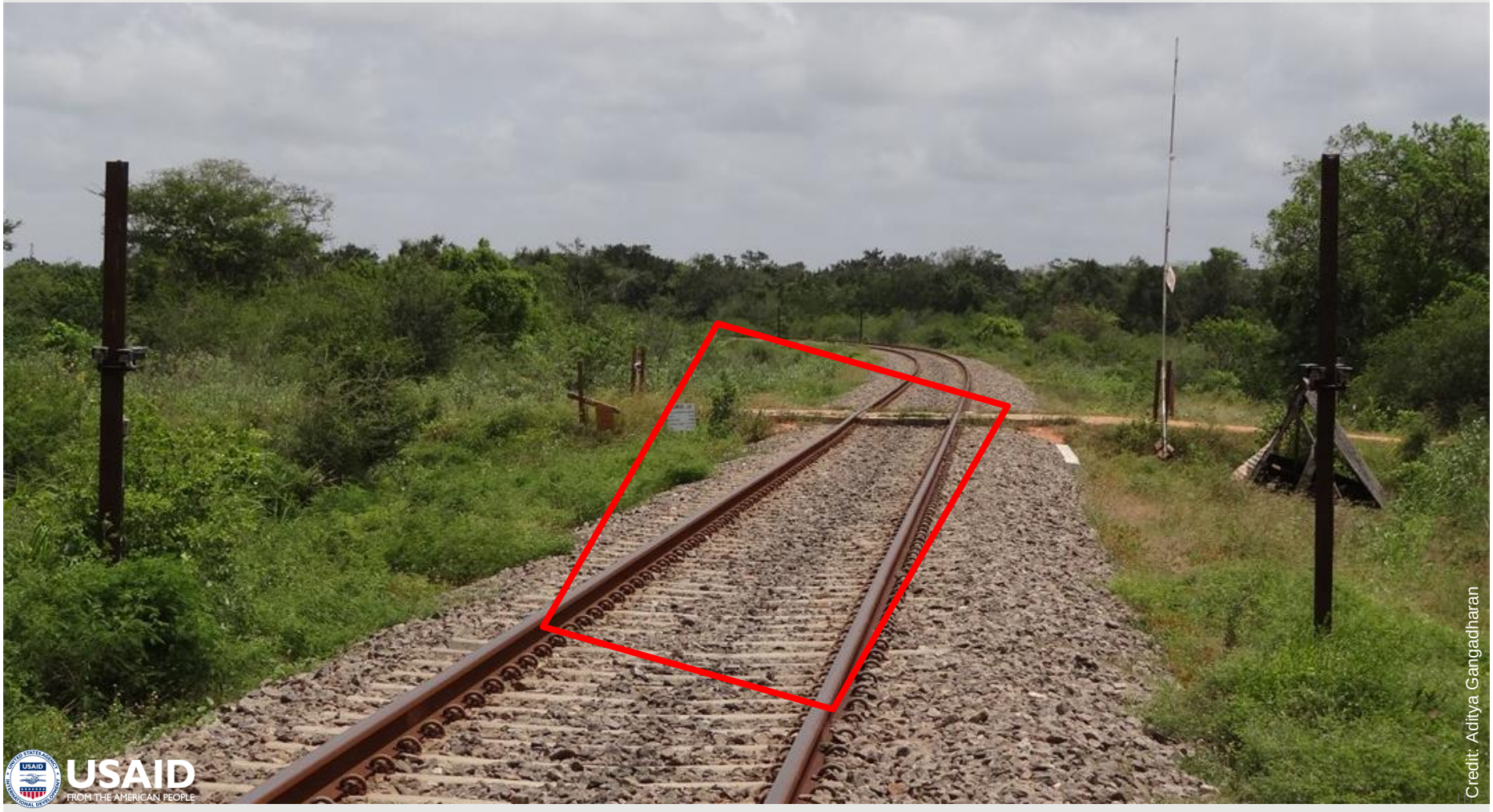
Credit: Aditya Gangadharan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Credit: Aditya Gangadharan

STRUCTURAL SEPARATION of trains and wildlife (8 studies)

- Fencing along road
  - Reduce direct but increase indirect impacts
- Crossing structures + fencing
  - Trains pass above animal
  - Animals pass above trains

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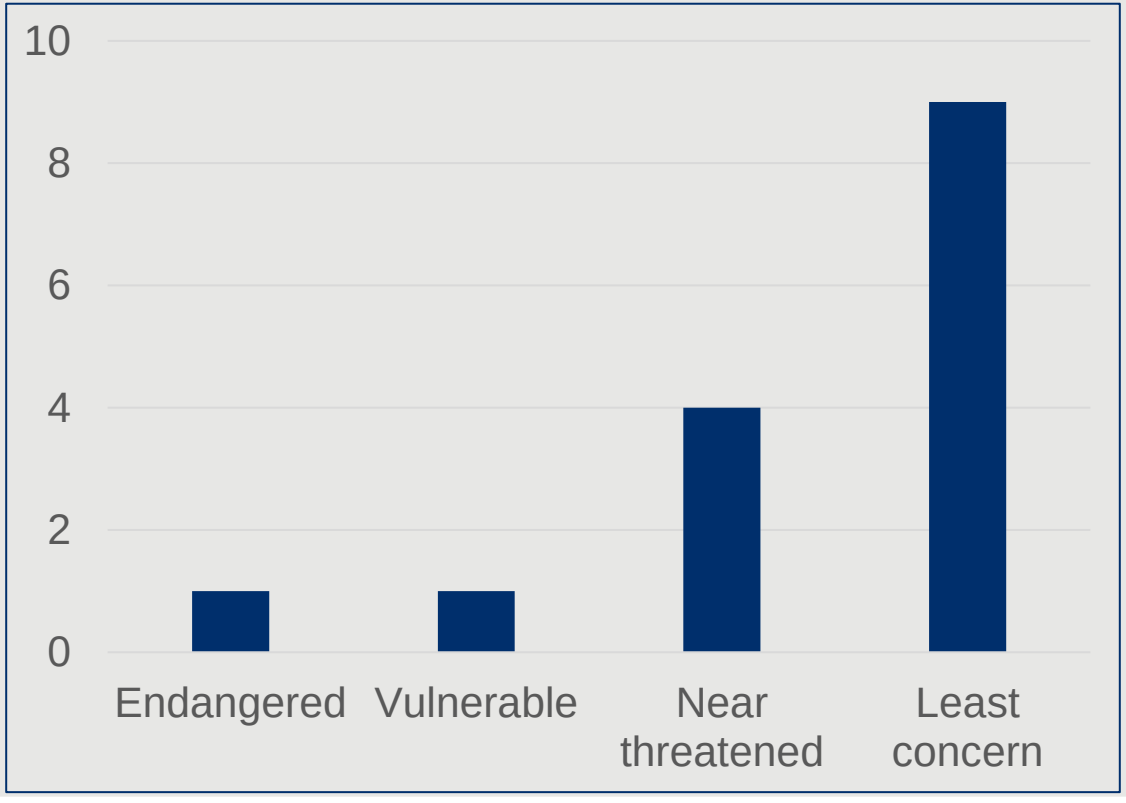
15 species documented using wildlife crossing structures



KEY FINDINGS: MITIGATION

- Better monitoring required for mitigation measures
- Animal and human behavior: practical application but little documentation

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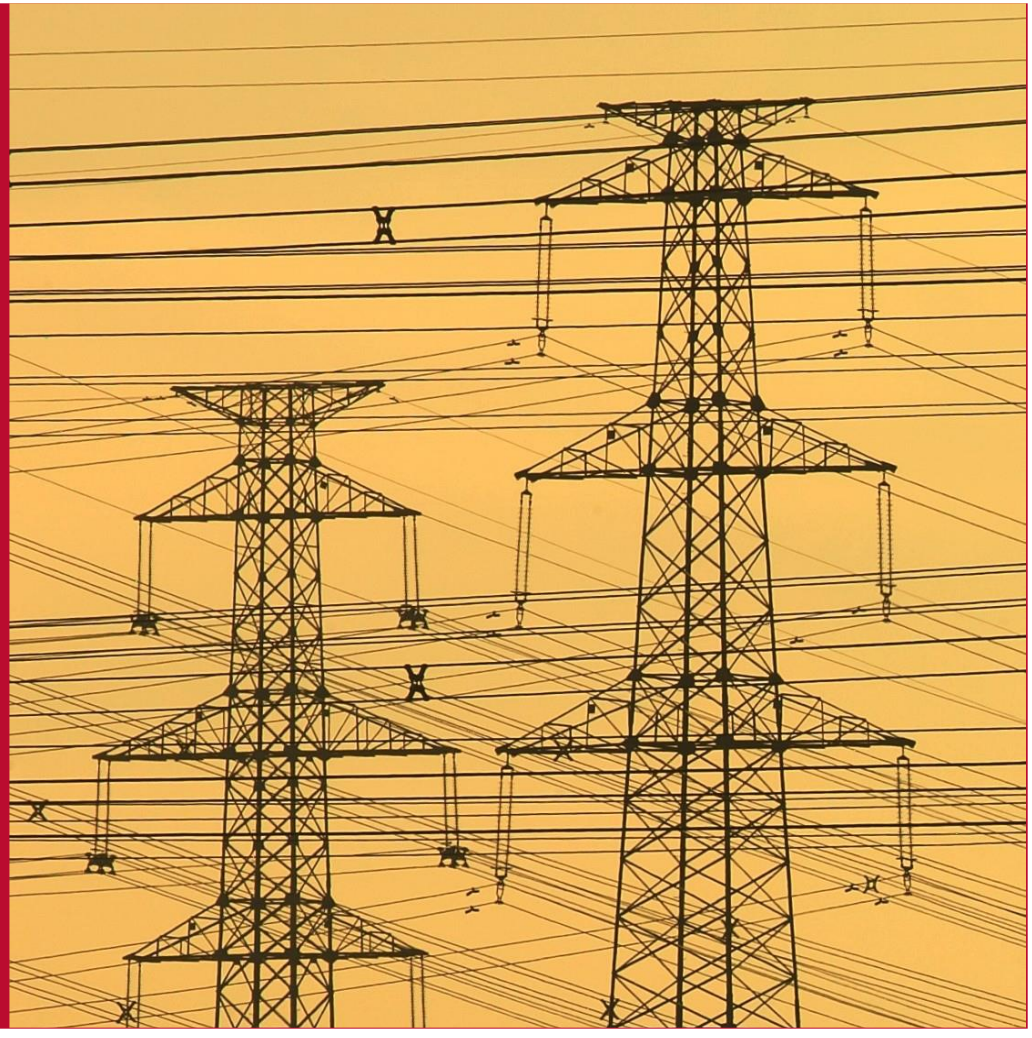
POWER LINES



POWER LINE IMPACTS

Direct
Indirect
Population

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DIRECT IMPACTS

- Death or injury from:
  - Electrocution

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DIRECT IMPACTS

- Death or injury from:
  - Electrocution
  - Collision

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DIRECT IMPACTS

IUCN Red List Status	Bird	Mammal	Total
Critically Endangered	2	2	4
Endangered	5	9	14
Vulnerable	7	4	11
Near Threatened	7	-	7
Least Concern	71	5	76
Total	92	20	112

1/3 of impacted species are threatened

AVIAN ELECTROCUTIONS

Credit : Gregoire Dubois

AVIAN ELECTROCUTIONS

- 92 species
- Occurs on power poles
- Raptors alone comprise >44% of electrocuted birds
- Corvids account for 33% of fatalities
- Fatalities vary over space and time

AVIAN ELECTROCUTIONS

- Factors affecting bird electrocutions
  - Power line voltage
  - Season, migratory period
  - Species-specific roosting, perching and nesting behaviour
  - Small mammal densities

Credit : Gregoire Dubois

COLLISIONS

- 35 species
- Migratory birds more vulnerable
- Waterbirds, waders, Columbids and Passerines are common fatalities
- Factors affecting bird collisions:
  - Siting
  - Power line voltage
  - Season, migratory period

Credit : Gregoire Dubois

MAMMAL ELECTROCUTIONS

- 20 species
- Factors affecting mammal electrocutions
  - Power line voltage
  - Orientation of electric wires
  - Proximity of trees to power lines

Credit : Wikimedia Commons / P Jeganathan

INDIRECT IMPACTS

- 2 studies
- Documented habitat loss and fragmentation

POPULATION IMPACTS

- 4 studies
- Juveniles are at higher risk
- <1% - 2.8% of local population

Credit : Chaitanya Krishna

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KEY FINDINGS: IMPACTS

- Direct impacts are predominantly documented
- More focus on electrocution impacts than collision
- Birds and mammals are most studied
- 32% of species impacted are threatened
- Rigorous assessments of indirect and population-level impacts lacking

POWER LINE MITIGATION

Change animal behavior
Structural separation

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CHANGE ANIMAL BEHAVIOR

- 1 study on bird flight diverters
- Mechanical efficiency of two kinds of bird diverters

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STRUCTURAL SEPARATION

- Mitigation of avian electrocutions
  - Devices that deter birds from perching
  - Devices that prevent contact with energized wires

STRUCTURAL SEPARATION

- Mitigation of primate electrocutions
  - Devices that deter primates from climbing power poles
  - Insulating wires

KEY FINDINGS: MITIGATION

- Central Asian focus

- Mitigation assessment of electrocution more common than collision
- Mitigation measures focus on structural separation as compared to changing animal behaviour
- Systematic documentation of mitigation effectiveness required

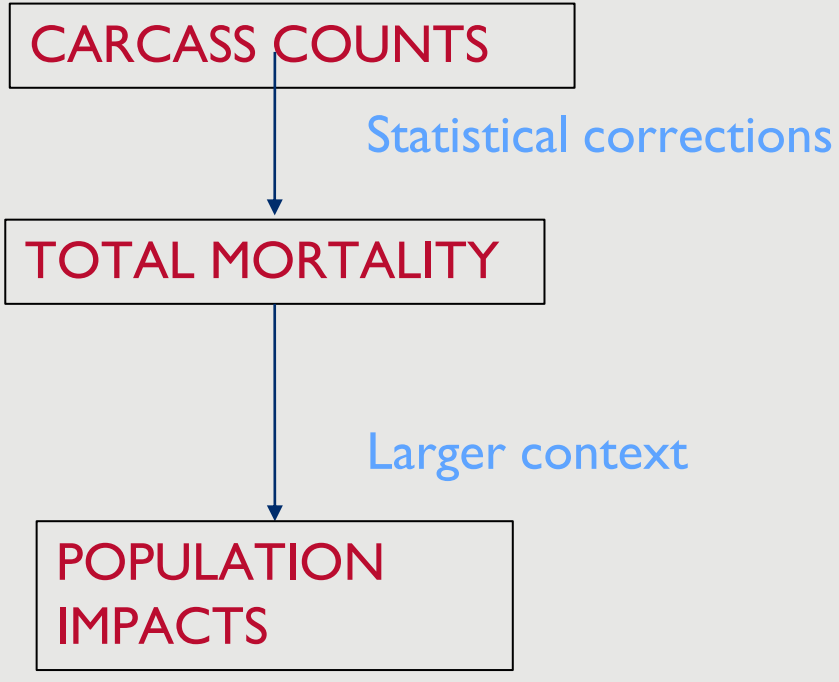
KEY KNOWLEDGE GAPS
Roads, railways, and power lines

Dr. Aditya Gangadharan

1. How many species are killed?

2. How to predict mortality hotspots & times?

3. How do mortalities influence population viability?

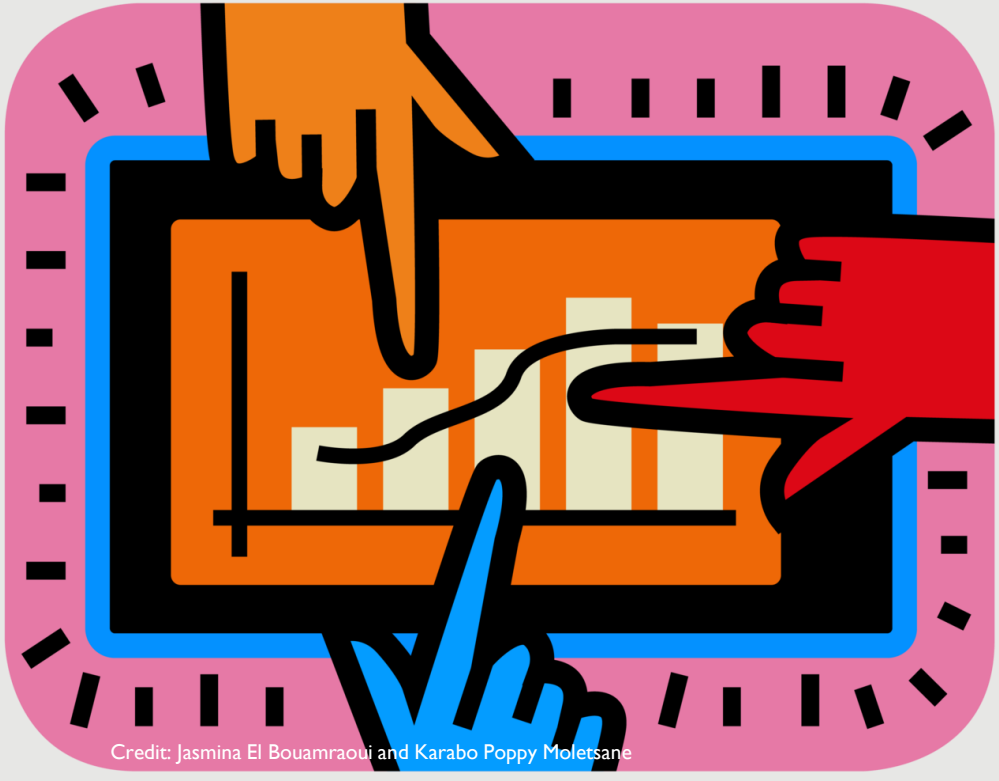


4. How much do indirect impacts scale up at population level?

5. How well do mitigation measures work?

6. How bad do cumulative impacts get?

7. Better access to data for planning infrastructure



Credit: Jasmina El Bouamraoui and Karabo Poppy Moletsane

QUESTION AND ANSWER SESSION

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THANK YOU

Wildlife Underpass, NH 54, India Credit: Rob Ament

CONTACT:

MARY MELNYK: mmelnyk@usaid.gov

ROB AMENT: rament@largelandscapes.org

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