PRESENTATION GIVEN AT LTC SPRING FORUM ENTITLED:

""INTEGRATING GEOSPATIAL AND FIELD-BASED SCIENCE TO ASSESS BIODIVERSITY CONSERVATION: A SPECIAL FORUM OF WOMEN RESEARCH LEADERS"

APRIL 2-3 & 15, 2009

UNIVERSITY OF WISCONSIN, MADISON, WI, USA

HOSTED BY

LAND TENURE SOCIETY

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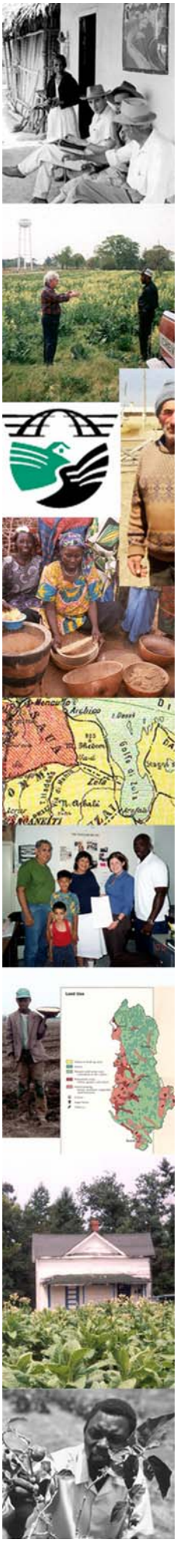

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Land Tenure Center

THE SHRINKING ARK

LARGE MAMMAL EXTINCTIONS IN INDIA

Krithi Karanth

LTC Spring Forum, Integrating geospatial and field-based science to assess biodiversity conservation.

♦♦♦♦♦♦♦♦

Provided by the **Land Tenure Center.** Comments encouraged:
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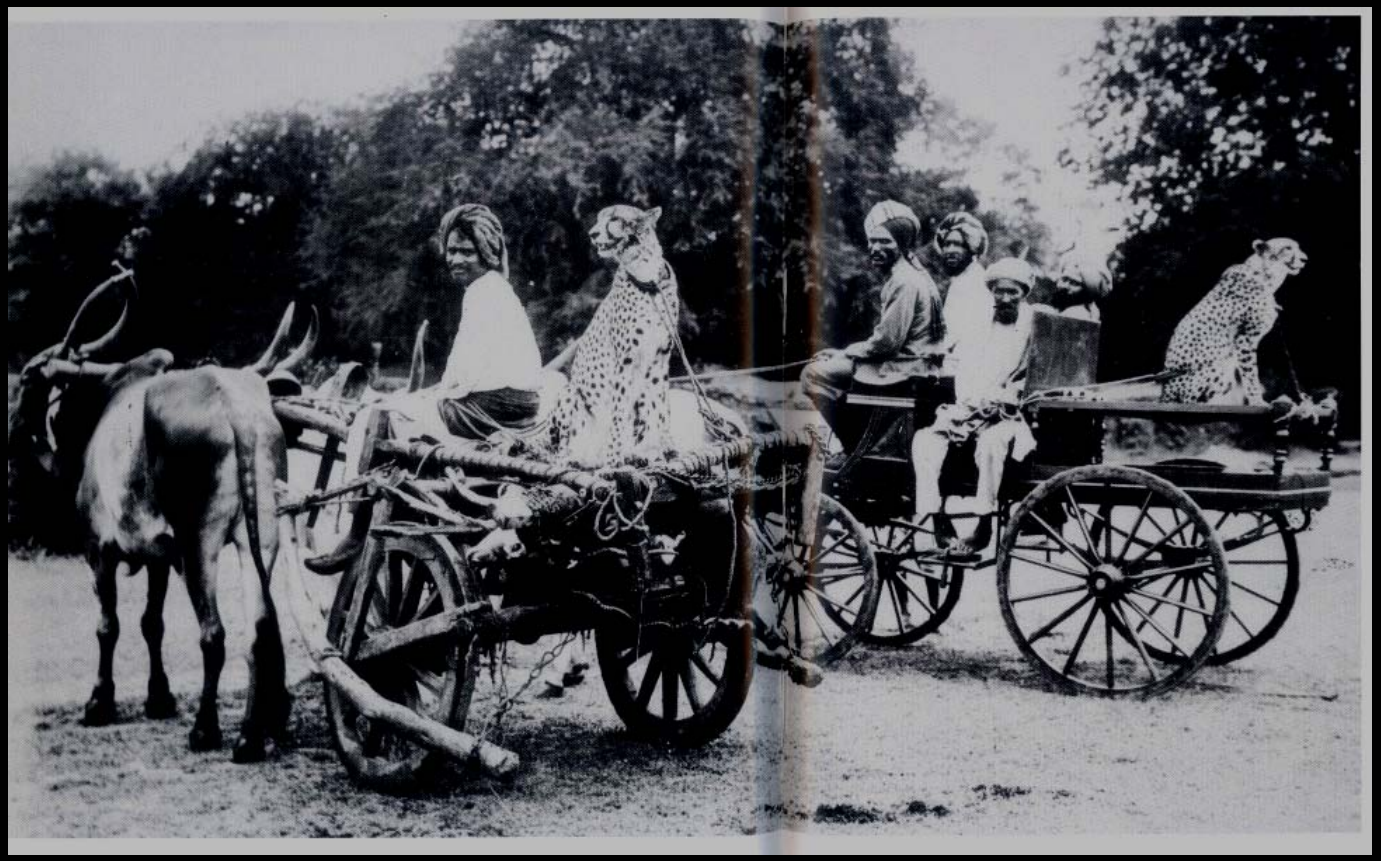
The Shrinking Ark: Large Mammal Extinctions in India



Krithi K. Karanth

Columbia University

Introduction

Mammals Worldwide

- **25%** close to extinction [1]
- **50%** disappeared from historical range [2]
- Causes [3]
  - Human perturbation
  - Endemism & rarity
  - Body size & other life history traits
  - Habitat requirements
  - Low densities

1. Ceballos et al. 2005, Schipper et al. 2008
2. Ceballos & Ehrlich 2002
3. Woodroffe & Ginsberg 1998; Channell & Lomolino 2000 a, b; Sanderson et al. 2003; Brashares 2003; Laliberte & Ripple 2004

Introduction

India is a Megadiversity country

1850:

~ 250 million people

~ 500 mammals, 2000 birds & 45,000 plants

2008:

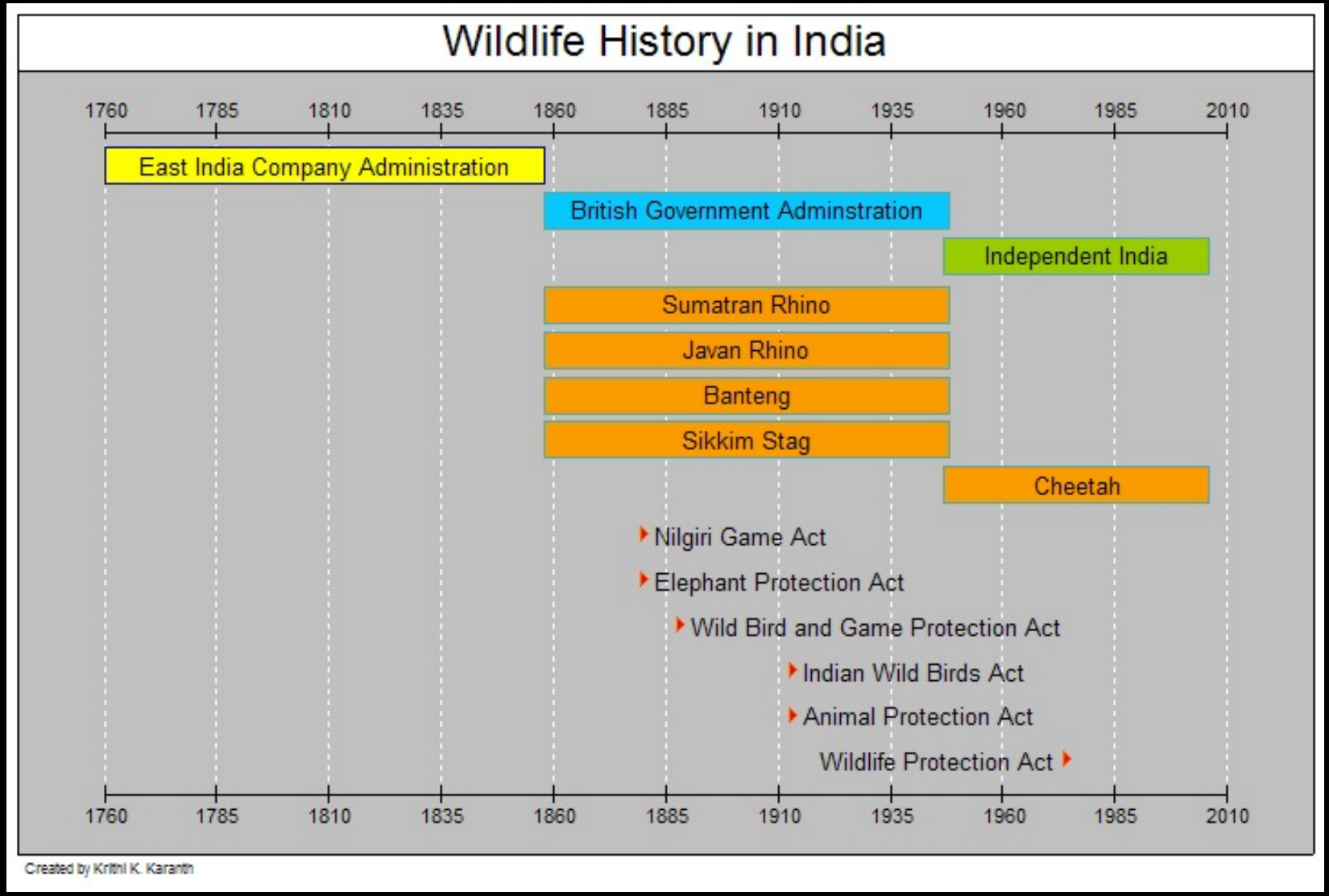
~ 1+ billion people

88 mammals on Red List

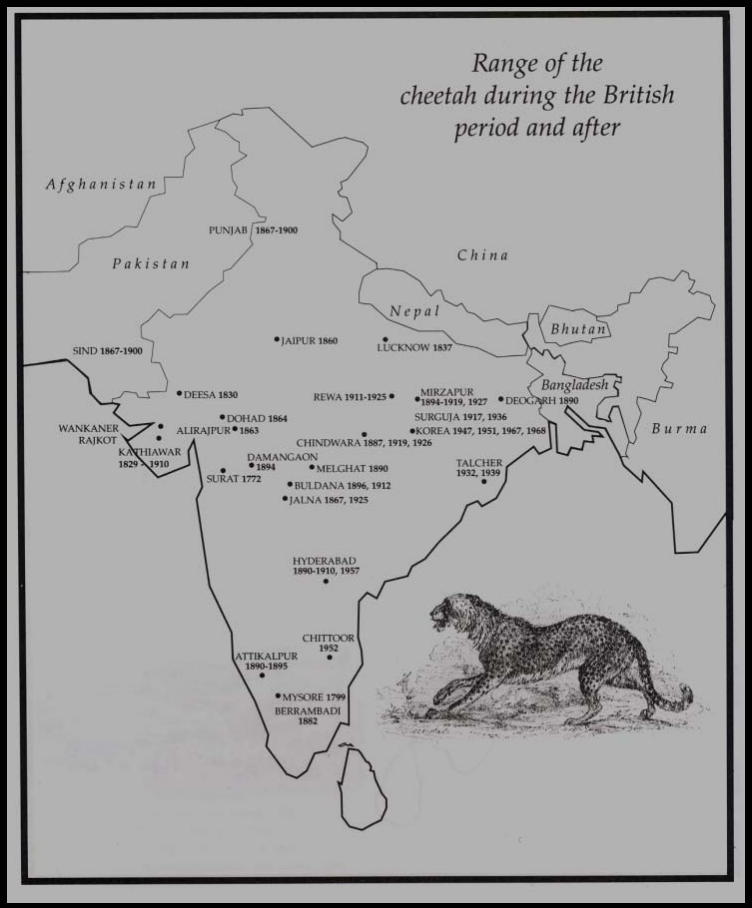
20% mammals extinct ?

90% of range contraction ?

Introduction



Introduction



Five Cheetahs at Rest with Two British Gentlemen
Hyderabad State, *c* 1900

1860 – 1920
Trophy Hunting & Capture

1920 – 1930
Population Crash

1947
Last verified record
1950 - 1960
Unverified Sightings

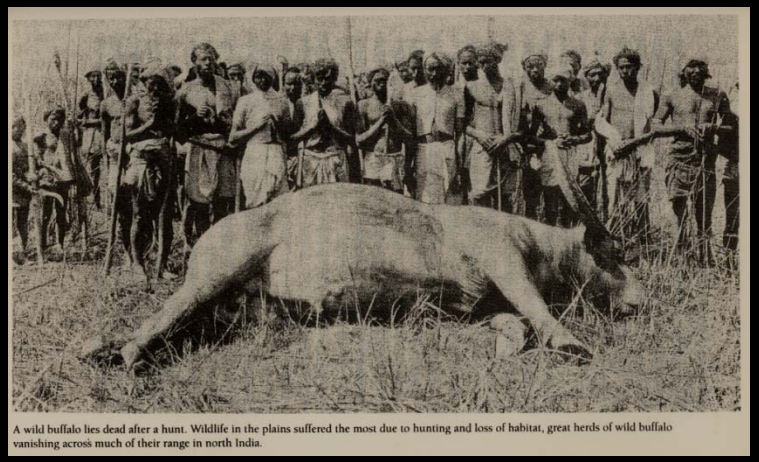
1960
Listed Extinct in India

Introduction

1860: Trophy and Vermin Killing Operations

Bounties to 'eliminate dangerous beasts & poisonous snakes'

Officers, Soldiers, Indian Royalty



A wild buffalo lies dead after a hunt. Wildlife in the plains suffered the most due to hunting and loss of habitat, great herds of wild buffalo vanishing across much of their range in north India.

British Army officers of the 93rd Highlanders with trophies from a fortnight's hunt in the Deccan early in the twentieth century.

1875-1925: Tigers ~ 80,000 Leopards ~ 150,000 Wolves ~ 200,000

1871: 31 Tigers, 50+ Leopards & Bears (2 days, Secunderabad)

1871-1907: 365 Tigers (Cooch Behar)

1936: 50,000 Animals + 46,000 Birds (Sadul Singh, Bikaner)

Rice 1857; Baldwin 1877; Baker 1891; Russell 1900; Afalo 1904; Dunbar Brander 1923; Field 1936; Rangarajan 2001

Introduction

- **Changing Landscapes**
  - Agriculture
  - Deforestation & Plantations
  - Railways

- **Changing Attitudes**

  "If the extermination of creatures which prey upon herbivores were taken up systematically in India as in England, there is no reason why very satisfactory results should not be soon obtained"

  - Major Tweedie 1874

- **Hunting Reserves**

- **Population**

- **Wars, Cars, Famines, Droughts**

Questions

Where and which mammals are threatened ?

How does time affect extinction ?

Which factors support persistence ?

Methods: Occupancy Surveys

- Proportion of sites occupied by a species

  Estimated as $\hat{\Psi} = x/s$

  where x = # of occupied sites , s = total # of sites

- Presence - Absence
- Large areas, Less effort & Unequal sampling
- Cost effective, Multiple taxa & Species

Hanski 1994; Karanth & Nichols 2002; Royle & Nichols 2003; Bailey et al. 2004; MacKenzie et al. 2002, 2003, 2004; Engler et al. 2004; MacKenzie & Royle 2005; Dorazio et al. 2006; Ferraz et al. 2007

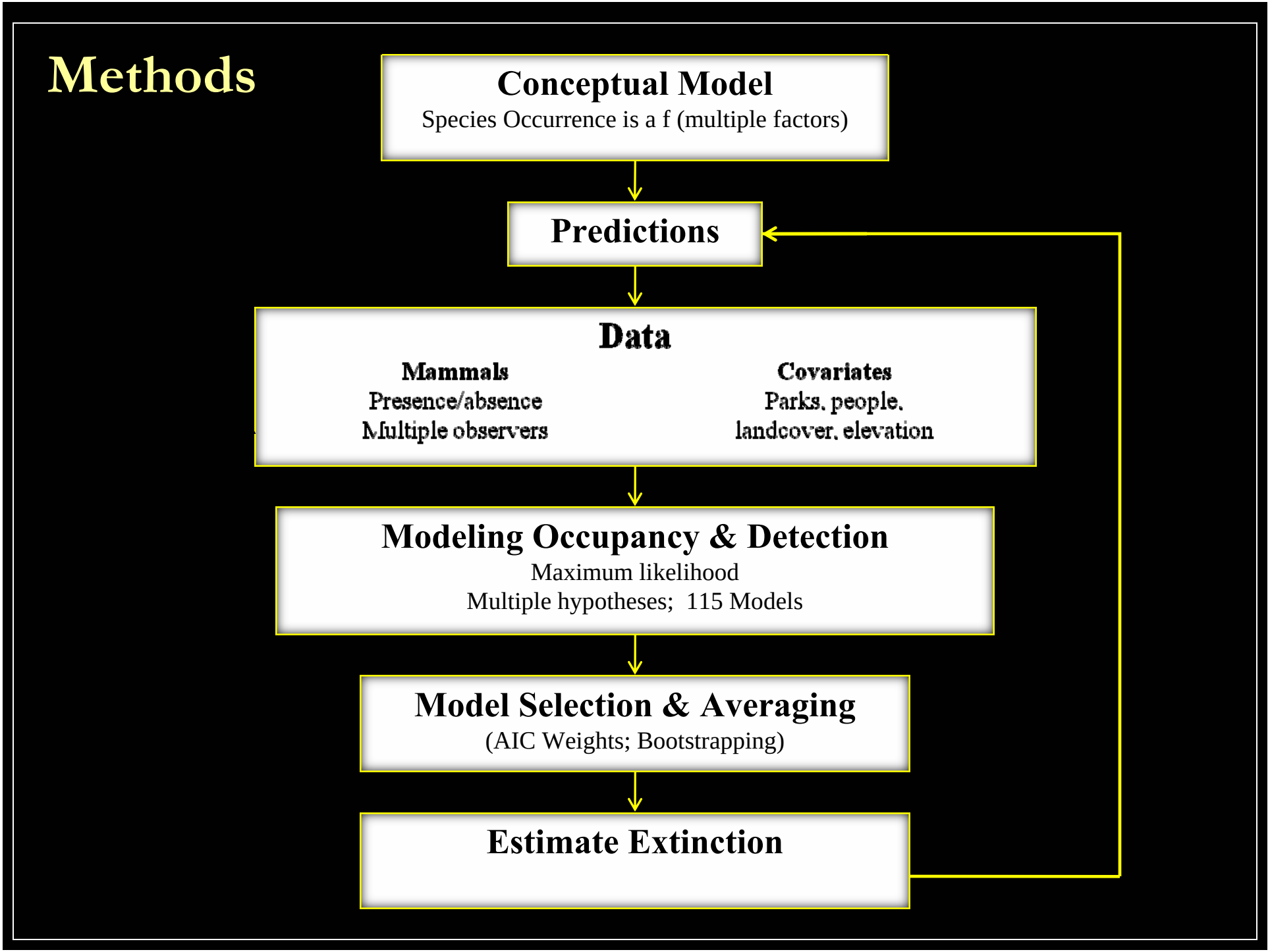
Methods: Occupancy Modeling

Site	Observer 1	Observer 2	Observer 3	Detection History
				
1	1	0	0	$Pr = \Psi\, p_1\, (1 - p_2)\, (1 - p_3)$
2	0	0	0	$Pr = \Psi \prod_{j=1}^{3} (1 - p_j) + (1 - \Psi)$

Detection
- # of individuals, Behavior, Activity, Size
- Habitat, Weather

Incorporating detection probability
- —Multiple observers
- —Repeat surveys
- —Covariates

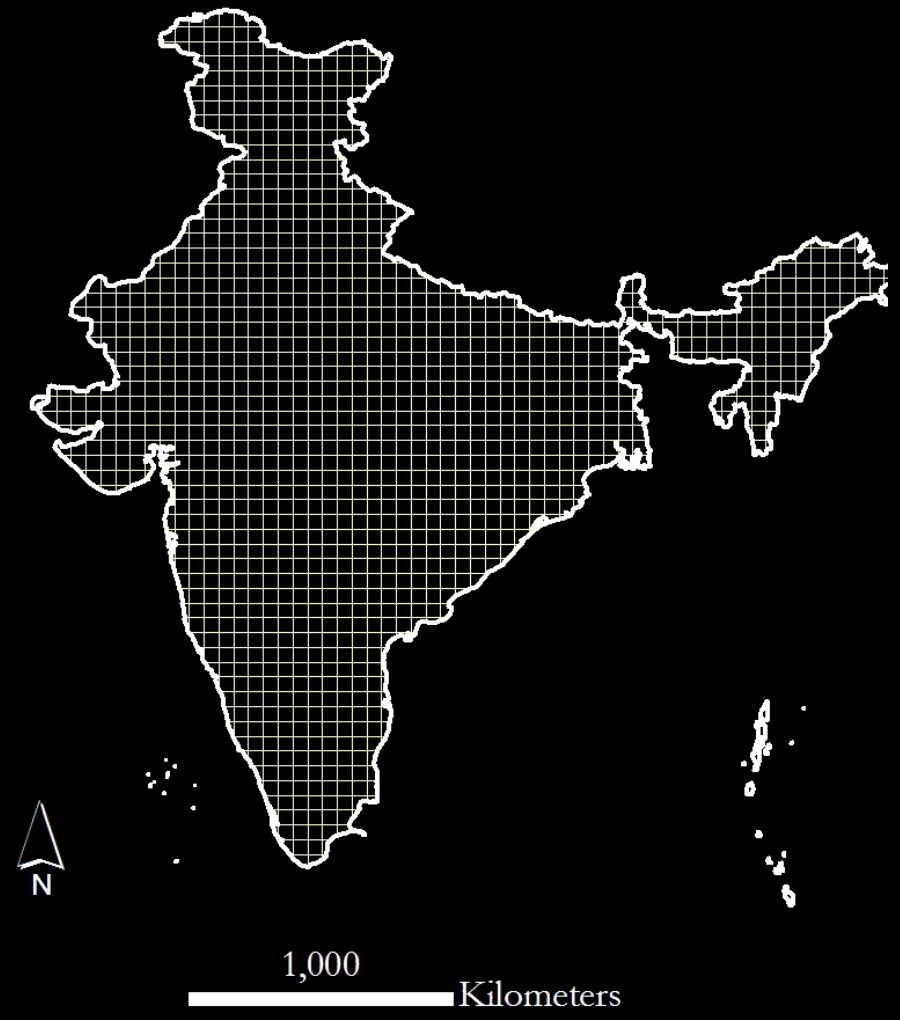
Methods


Conceptual Model
Species Occurrence is a f (multiple factors)
Predictions
Data
Mammals
Presence/absence
Multiple observers
Covariates
Parks, people,
landcover, elevation
Modeling Occupancy & Detection
Maximum likelihood
Multiple hypotheses; 115 Models
Model Selection & Averaging
(AIC Weights; Bootstrapping)
Estimate Extinction

Study Design

Current Distribution

- 1326 cells
- Presence – Absence data on 105 mammals
- > 100 Wildlife Experts

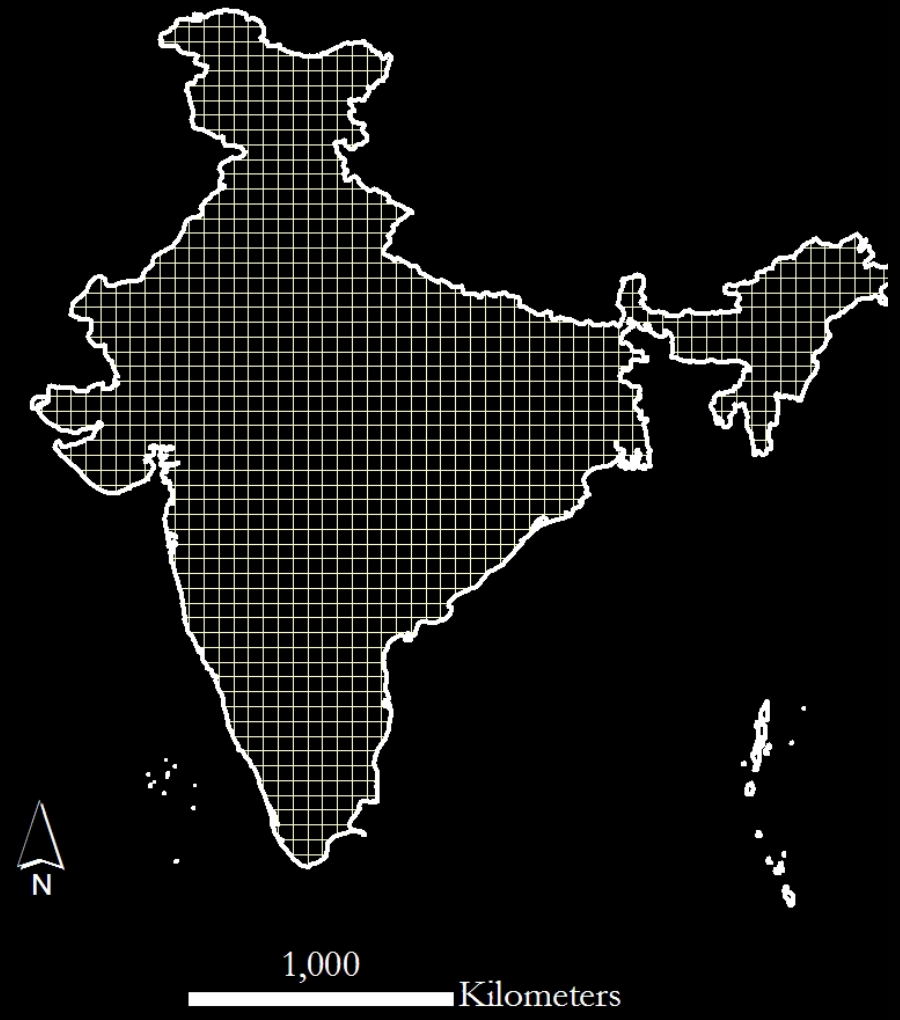


Study Design

Historic Distribution

- Museums (50+)
  Hunting Journals (150+)
- Journal of Bom Nat History
  Indian Forester
- Taxidermy Records *
- Land Tenure & Gazetteers

Total ~ 30,000 records



* Van Ingen & Van Ingen Firm

Methods

Tigers: 3600+ records, 572 cells

Methods

Data	Sources	Measures
Mammals	> 100 experts	Presence/Absence
Protected Areas	WDPA Topographic Maps Experts	a. Presence /Absence of PA b. Park Proportion
People	Landscan Population 2000	a. Population Density b. Cultural Tolerance
Forest Cover	USGS Joshi et al. 2006 Topographic Maps	a. Presence/Absence
Elevation	CGIAR-CSI SRTM	a. Average Elevation

Results

- **Extinction**

  E = 1 - Occupancy

- All 25 species E ≥ 0.20

- Higher over 100 years for 13 species

  100 years: 0.20 – 0.96

  50 years: 0.25 – 0.93

Results

- **Elapsed Time = (2006 – yr of historic record)**
  Scaled to 50 and 100 years

- Time included in top model of 24 species

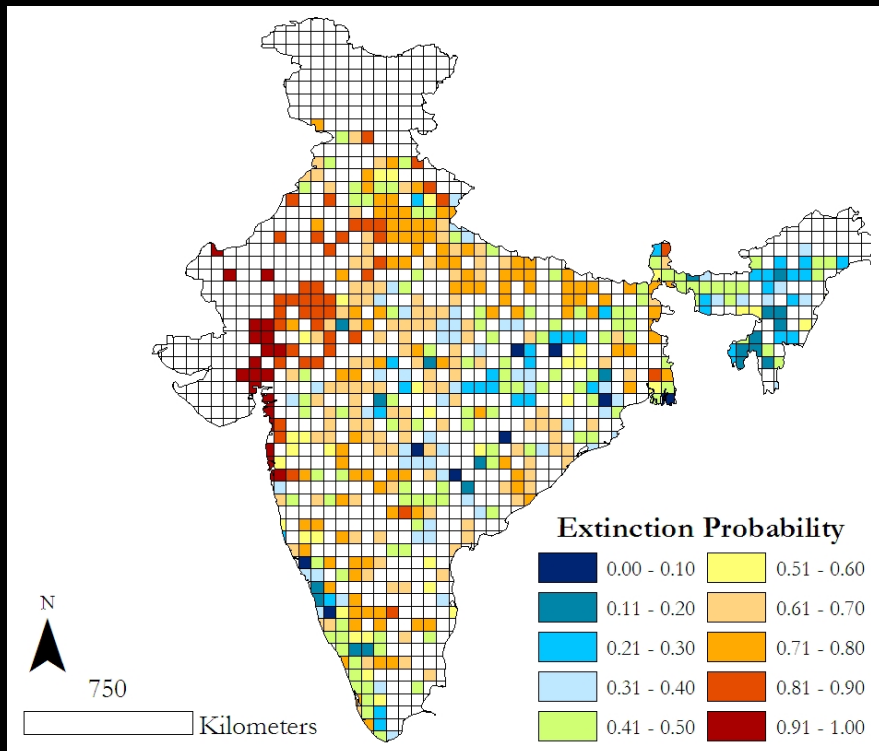
Positive	**13 species**
Negative	**11 species**

- Re-colonization (1920s, 1970s)

Results

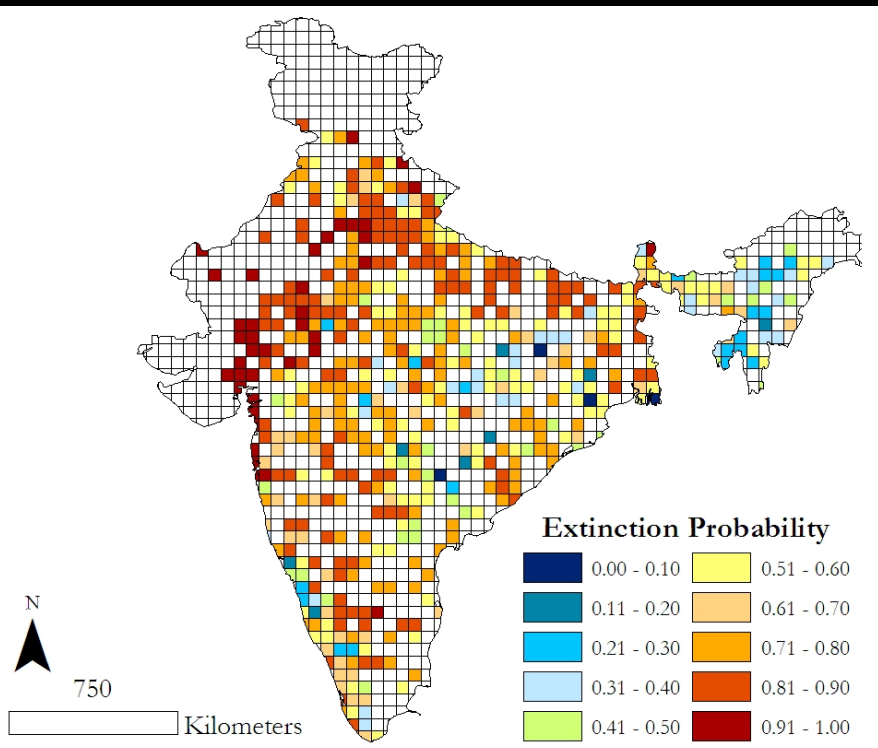
Extinction higher over 100 years

Tiger (E= 0.57)



50 years

Tiger (E = 0.68)



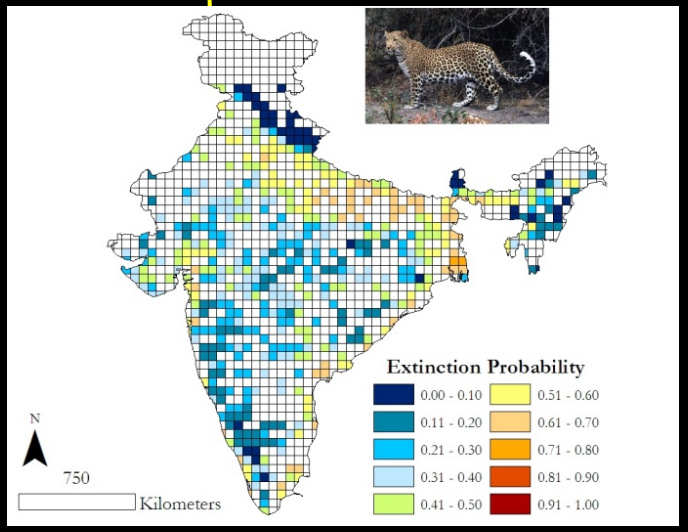
100 years

Extinction = (1 – Occupancy)

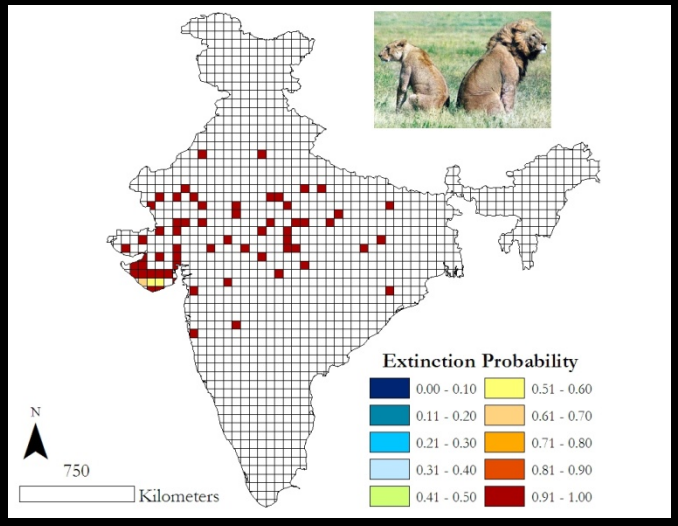
Results

Extinction higher over 100 years

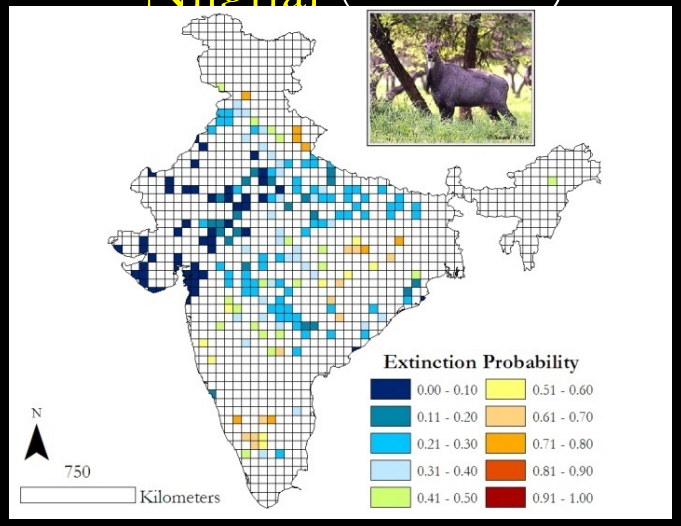
Leopard (E= 0.36)



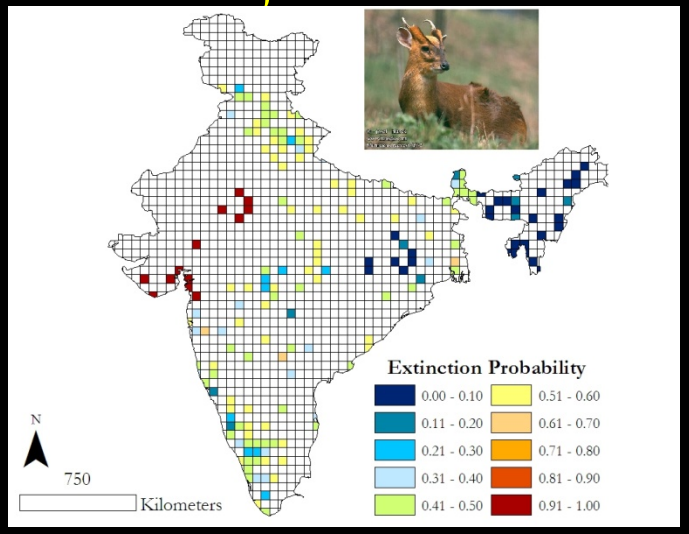
Lion (E= 0.98)



Nilghai (E = 0.29)



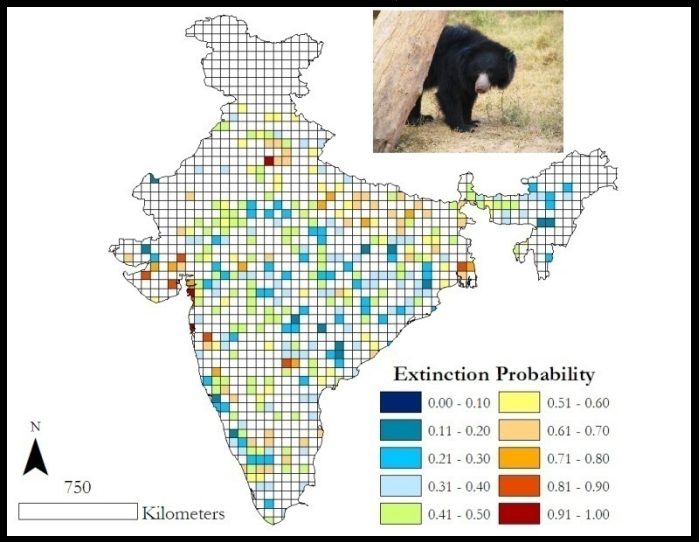
Muntjac (E=0.43)



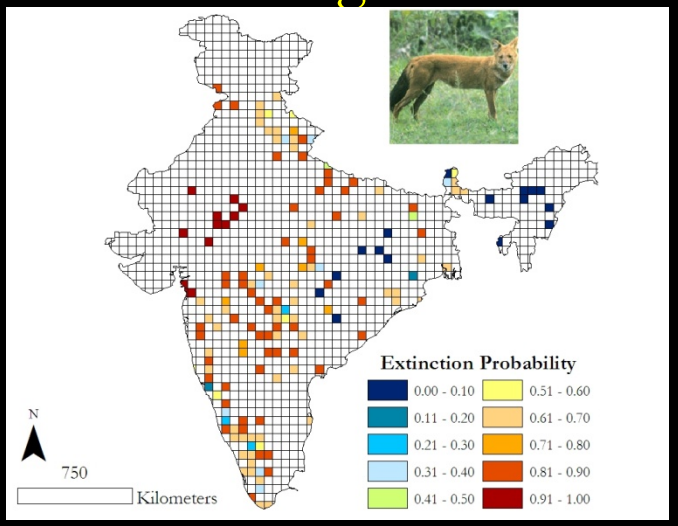
Results

Extinction higher over 50 years

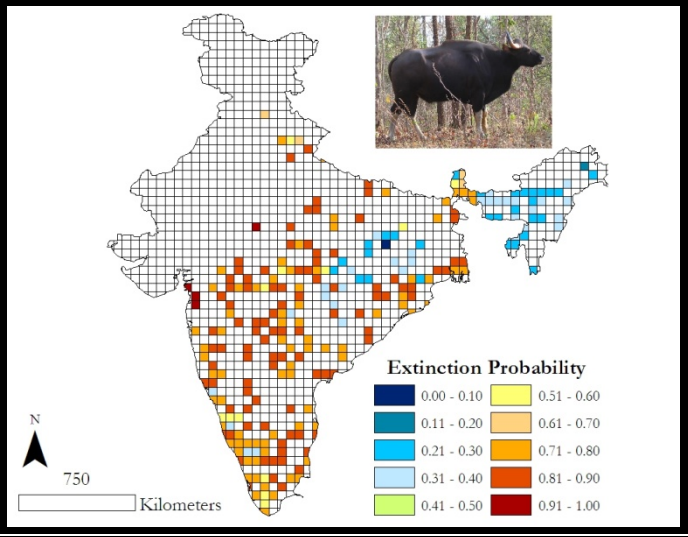
Sloth Bear (E =0.45)



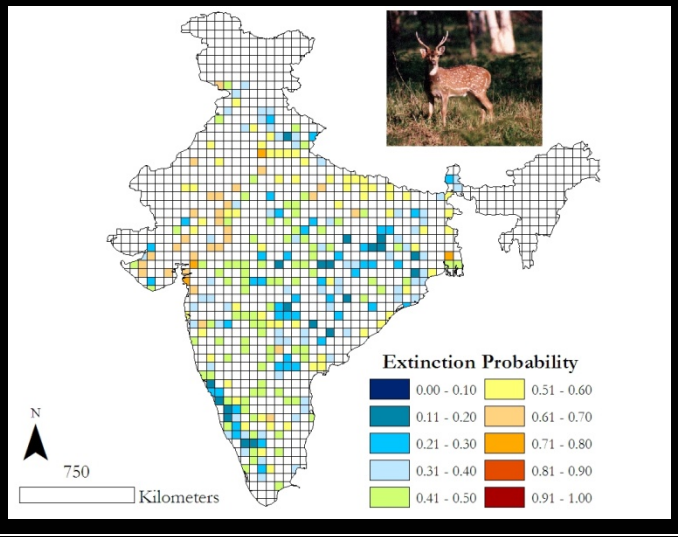
Wild Dog (E=0.29)



Gaur (E =0.65)



Chital (E =0.43)



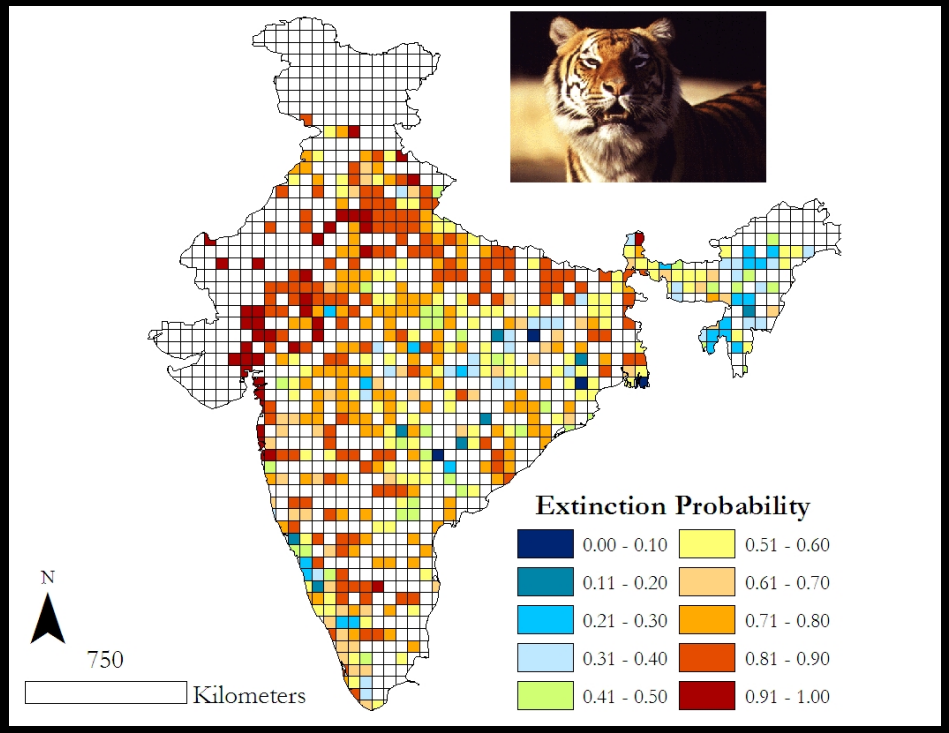
Results

Tiger top ranked models

Ψ (fc+tol+parkprop+elv+ppl+time+time^2) p (fc+tol+parkprop+elv+ppl+time+time^2)

Ψ (fc+tol+parkprop+elv+ppl+time) p (fc+tol+parkprop+elv+ppl+time)

Model 1 AIC weight = 0.66 Model 2 AIC weight = 0.29



Coefficients for Ψ Model 1

Constant	- 22.16
Park Prop	1.09
Forest Cover	25.78
Elevation	- 0.52
Pop Density	- 0.37
Intolerance	0.98
Time	- 0.23
Time-Squared	0.71

Results

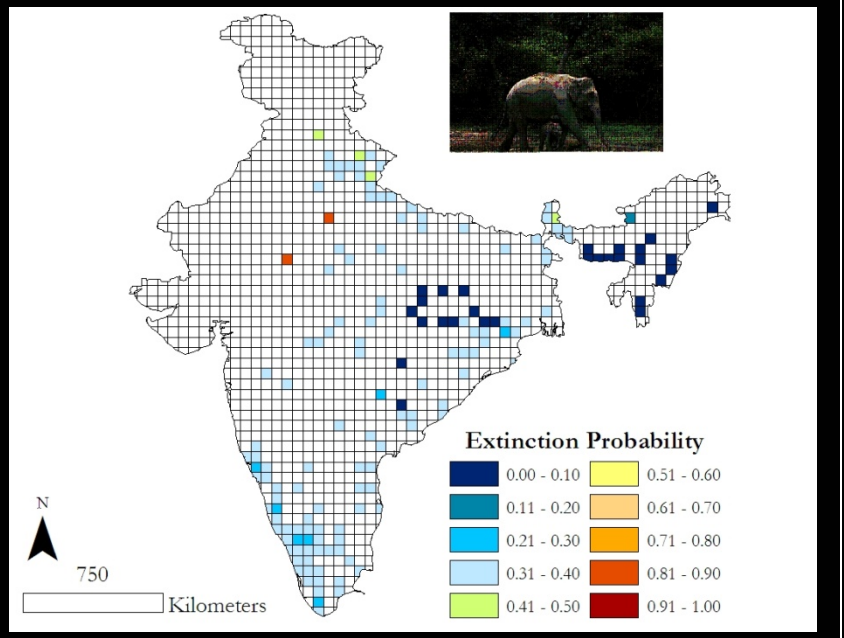
Protected area (presence / proportion of cell)

Top model: **17** species

Positive	14 species
Negative	3 species

Additional models: **5** species

Elephant (E= 0.35)



Results

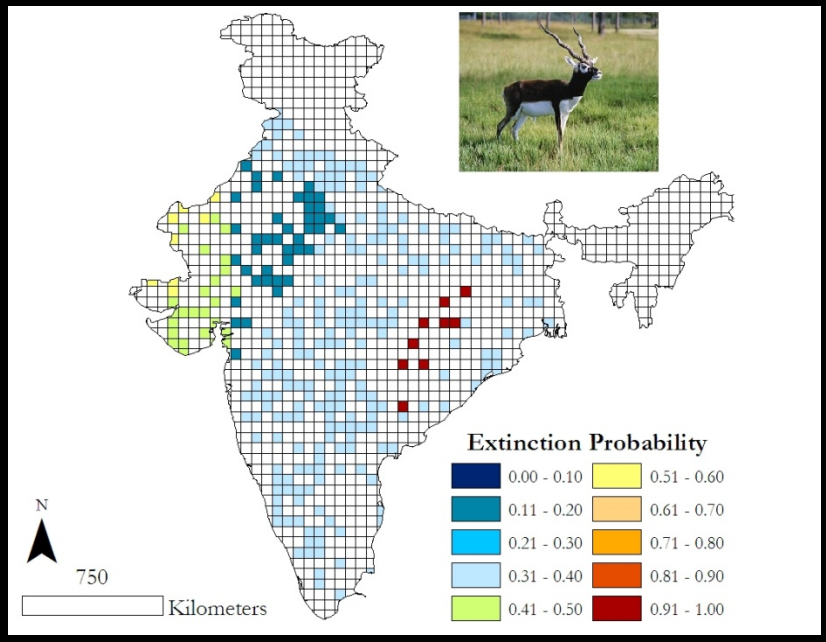
Forest cover (presence)

Top model: **9** species

Positive	3 species
Negative	6 species

Additional models: **7** species

Blackbuck (E= 0.37)



Results

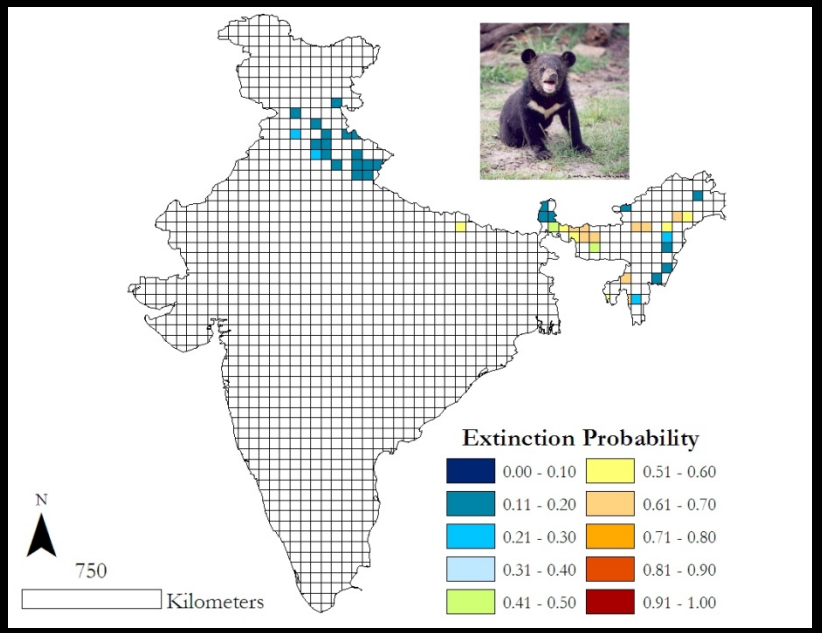
Elevation

Top model: **11** species

Positive	6 species
Negative	5 species

Additional models: **9** species

Black bear (E= 0.33)



Results

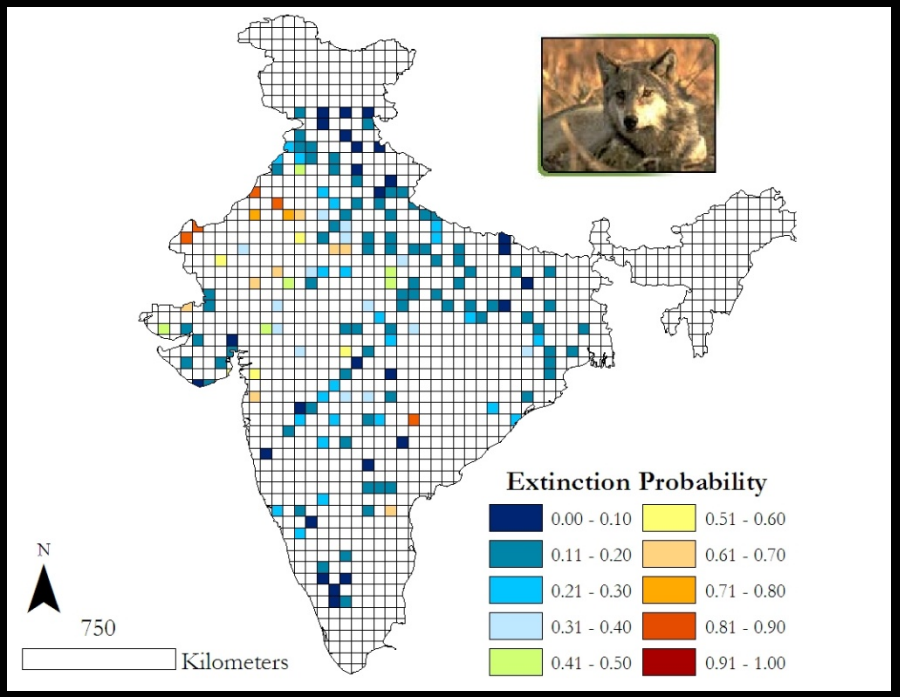
Human Population Density

Top model: **14** species

Positive	4 species
Negative	10 species

Additional models: **9** species

Wolf (E= 0.25)



Results

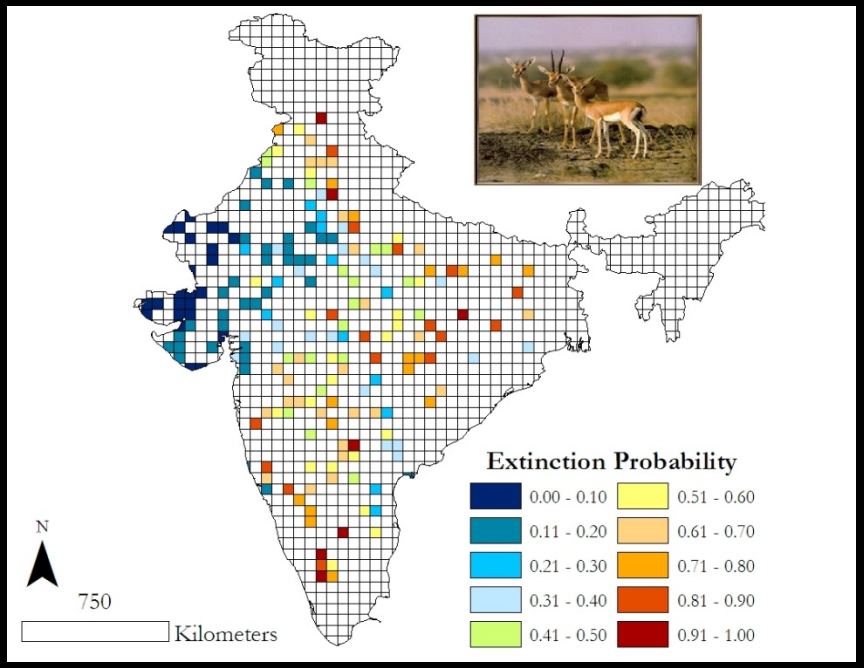
Human Cultural Tolerance

Top model: **12** species

Positive	7 species
Negative	5 species

Additional models: **9** species

Chinkara (E= 0.58)



Other Results

- Body size
  - ✓ Except elephant
  - ✓ Smaller and low density species
- Habitat generalists higher persistence
- Herbivores & carnivores equally vulnerable
- Endemics more vulnerable
- Culturally tolerated or forest dwelling herbivores & adaptable generalist carnivores less vulnerable

Summary

Factor	Species
Time	24 species
Protected Areas	22 species
	Forest dwellers & carnivores
	Many species habitat outside (new parks, connect)
Forest Cover	16 species
	Insufficient
Elevation	20 species
Human Density	23 species
	Adaptability & protection
Cultural Tolerance	21 species

- Occupancy surveys and detection
- Extinction: All 25 species $E \geq 0.20$ (Range: 0.20-0.96)

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Museums and Libraries

Bombay Natural History Society; Van Ingen & Van Ingen, Harvard Mus of Natural History; Am Mus of Natural History; Carnegie Mus; California Acad of Sciences; Field Mus of Natural History; Michigan State Mus; Univ of Kansas Biodiversity Center; Univ of Washington Burke Mus; Los Angles County Museum; Mus of Natural Sciences; Mus of Verte Zoology; Natural History Mus, D.C; Mus of Texas Tech Univ; Univ of Michigan Mus of Zoology; Univ of New Mexico Mus of Southwestern Biology; Mus of Natural History Berkeley; Yale Peabody Mus; Royal Ontario Museum; New Hancock Mus Duke Univ Library; Univ of Manchester Mus; Natural History Mus of Geneva; British Natural History Mus; Hungarian Natural History Mus; National Mus of Wales (Cardiff); New Castle Museum.

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