Amphibians of the Western Ghats
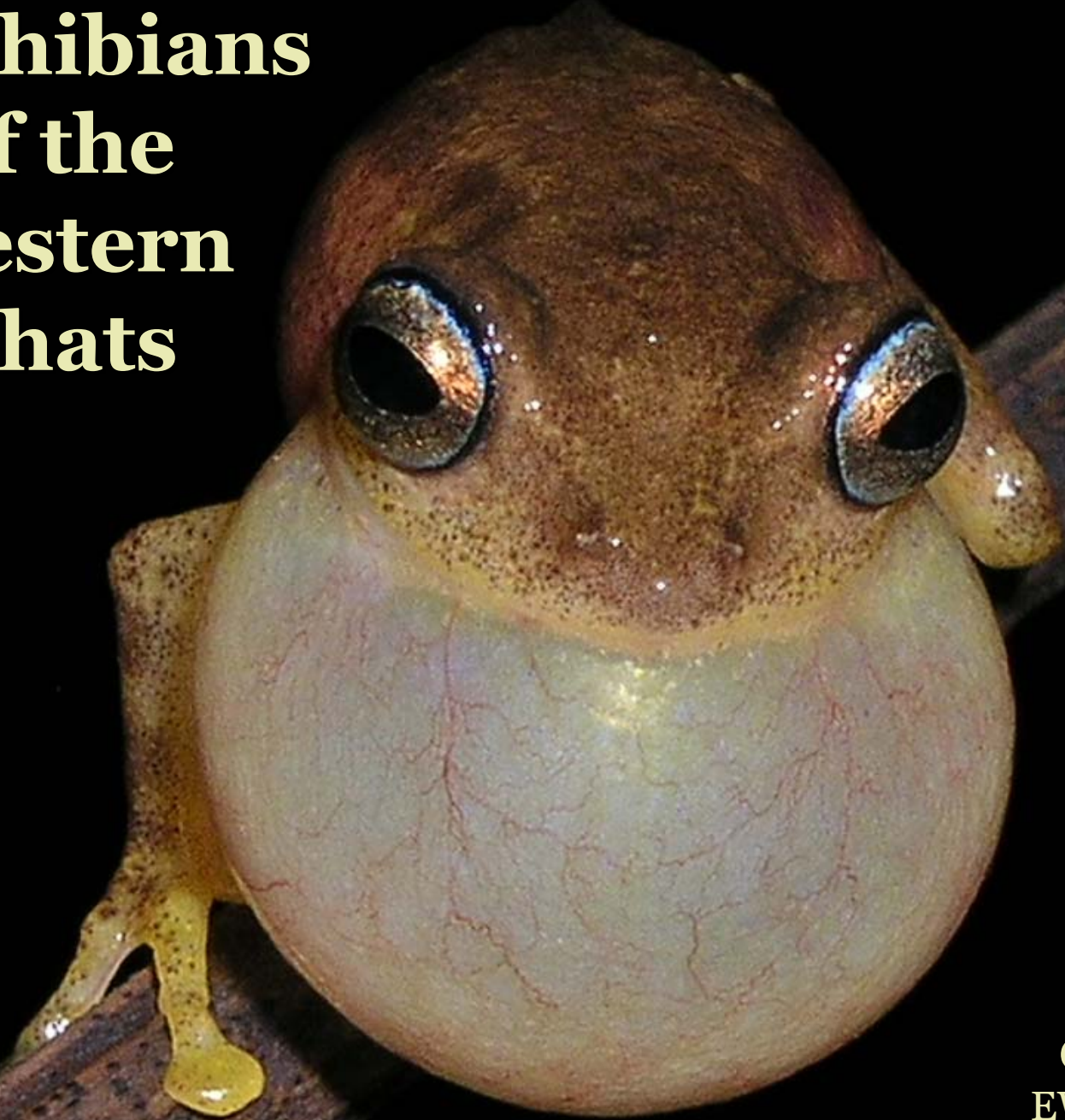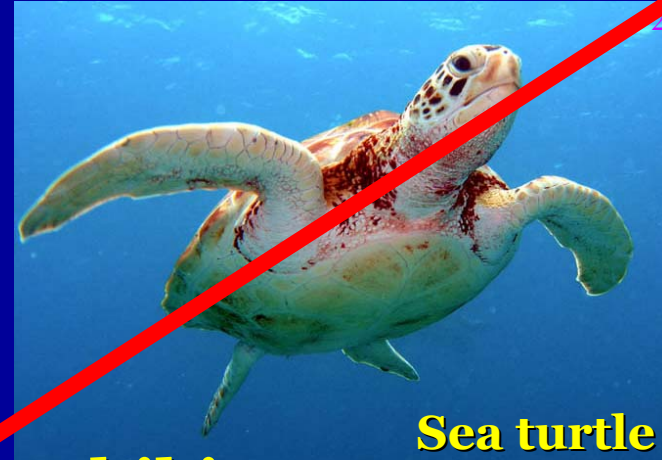
Gururaja KV
EWRG, CES, IISc,
gururaj@ces.iisc.ernet.in

Which are all Amphibians?

Crocodile

Sea turtle

They are not amphibians

Hippopotamus

Gharial

Corbis.co

1. http://images.google.co.in/images?q=tbn:2j-dAJg9Kl8J:www.cogsci.indiana.edu/farg/harry/bio/zoo/crocacu2.jpg

2. http://divebarbados.net/Current%20Photos/Pictures/Green%20Turtle%201.jpg

3. http://www.kidcyber.com.au/IMAGES/hippoaggro_s.jpg

4. http://homepage.mac.com/wildlifeweb/reptile/gharial/gharial03tfk.jpg
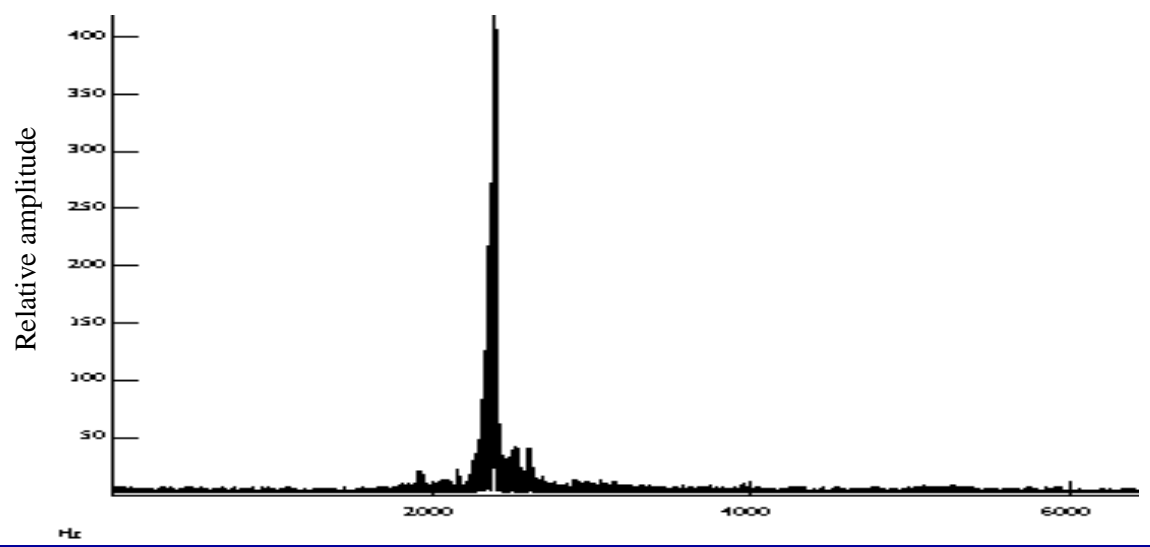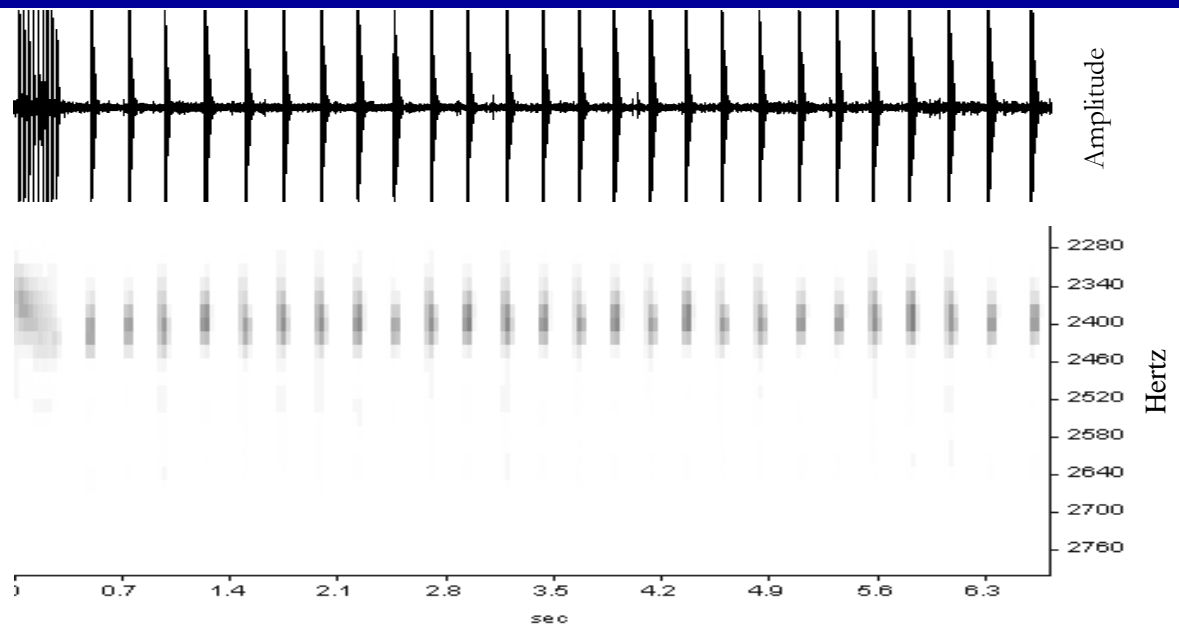
With a positive note …

A new species of shrub frog
Philautus neelanethrus sp. nov.
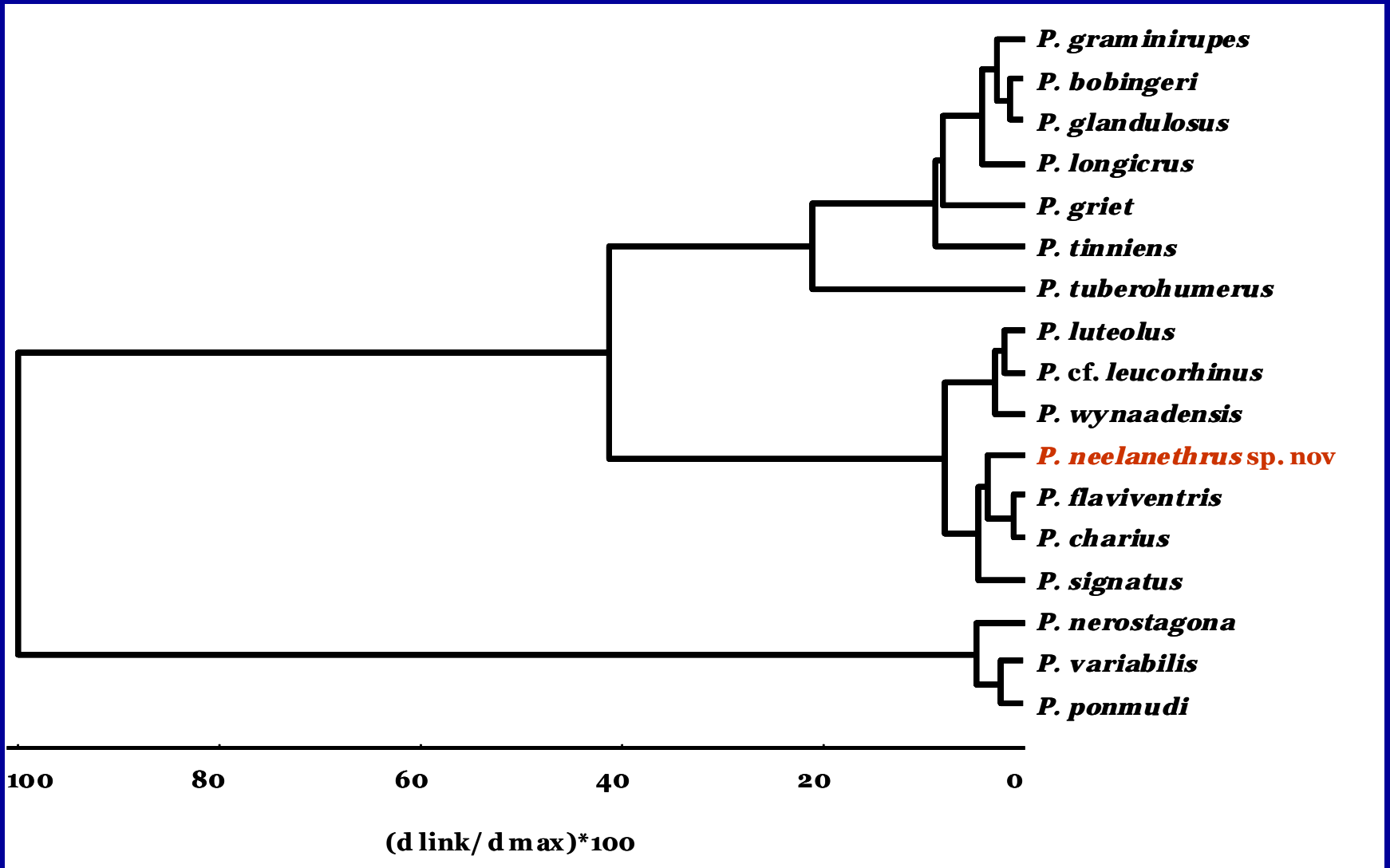from Western Ghats

A New Frog Species from the Central Western Ghats of India, and its phylogenetic status
Gururaja et al., 2006, *Zoological Science* (In Press)

A new species of *Philautus*

UPGMA cluster analysis of 15 *Philautus* species based on 22 variable morphometric characteristics
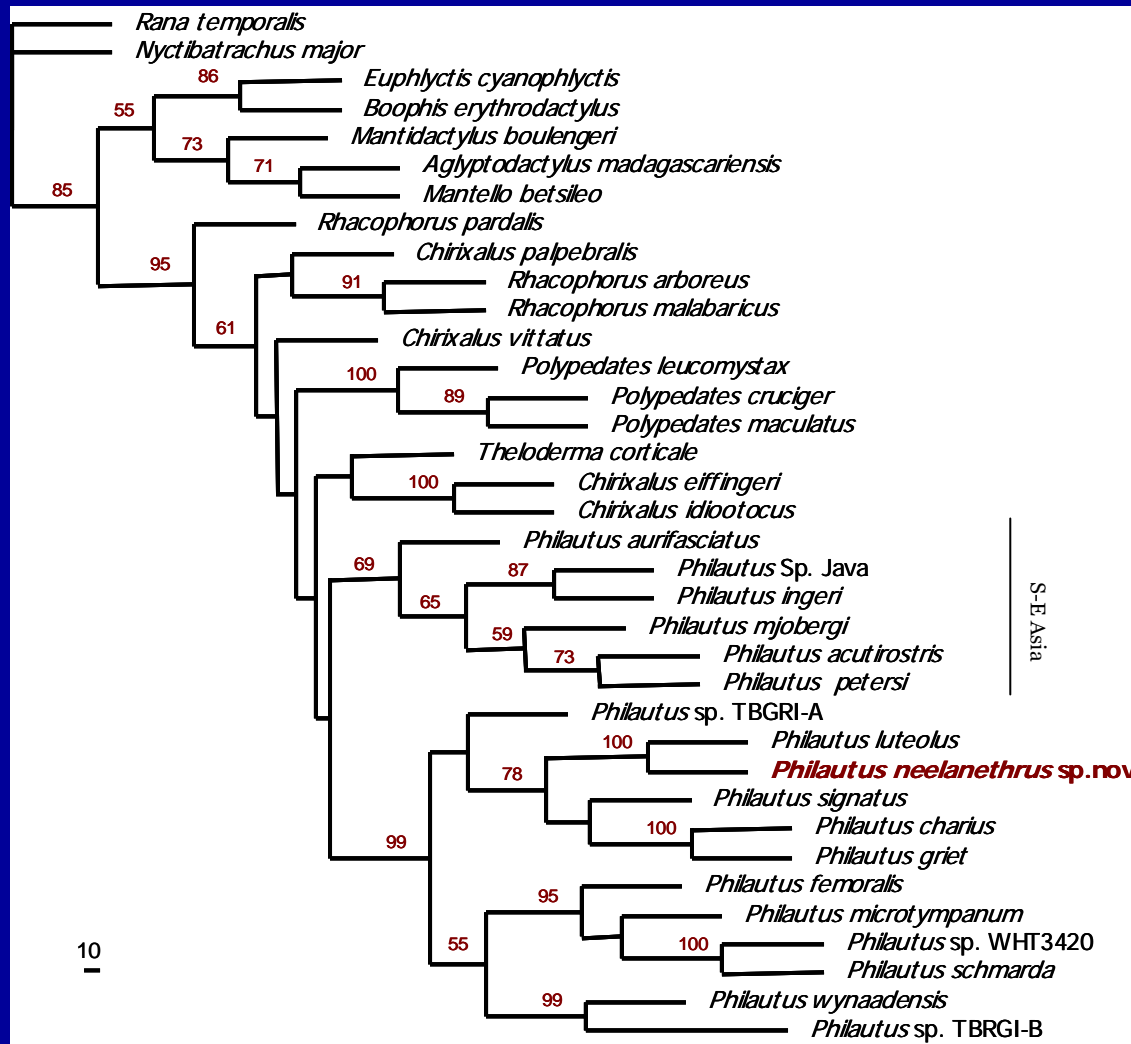
NJ phylogram [gamma corrected Kimura-2 parameter consensus tree with Tr/Tv: 4.0] based on combined 12S+16S rDNA polymorphism (788 nucleotide long alignment of which 575 were complete sites and 256 were phylogenetically informative) showing taxonomic status of the new frog taxon, *P. neelanethrus.* Values at the nodes are bootstrap values

How to identify amphibians

Mouth
Nostril
Eye
Tympanum
Arm
Leg
Finger
Toe
HEAD
BODY

Upper eyelid
Eye
Tympanic fold
Tympanum
Nostril
Upper lip
Lower lip
Throat
Mouth
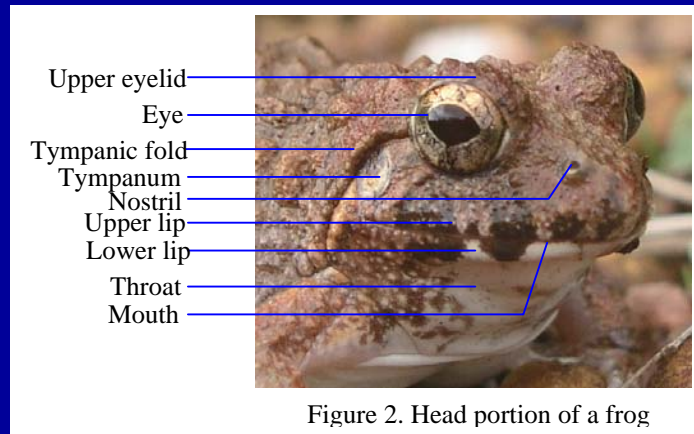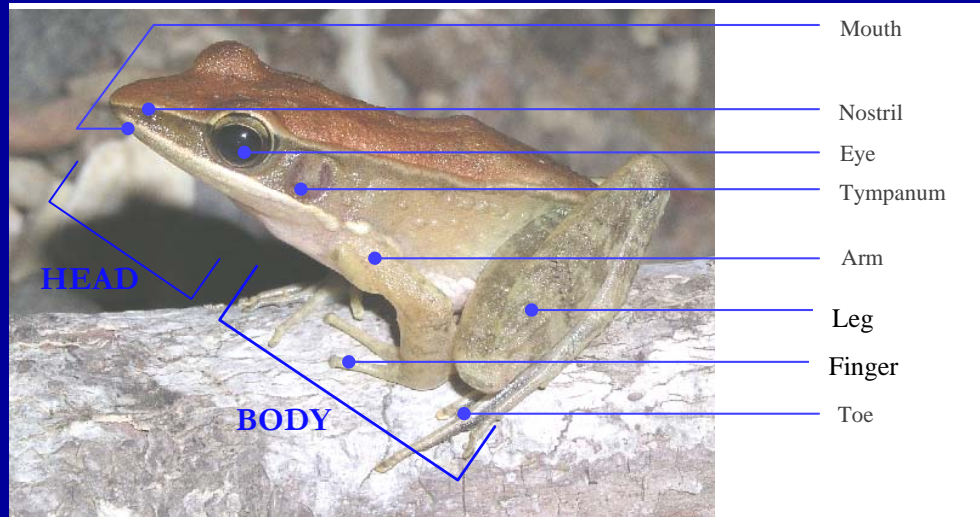
Figure 2. Head portion of a frog

What you have to note down in Field notes

Date:_____ Field No.:_____

Place:_____Longitude:_____°E

Altitude:_____m amsl   Latitude:_____°N

Time (start):_____ hr   Time (end):_____ hr

Prevailing conditions in that locality (habitat condition)

Species list

Individuals counted

Information on each individuals:

Climatic parameters: temperature, humidity, etc.

Sketches:

Other information:

Fejervarya limnocharis
Indian cricket frog

Hydrophylax malabaricus
Fungoid frog
Endemic

Hoplobatrachus tigerinus
Indian bull frog

Sylvirana temporals
Bronzed frog
Endemic

Clinotarsus curtipes
Bicoloured frog
Endemic

Sphearotheca breviceps
Indian Burrowing frog

Microhyla rubra
Red narrow mouthed frog

Microhyla ornata
Ornate narrow mouthed frog

Ramanella montana
Jerdon's narrow-mouthed frog
Endemic

Pedostibes tuberculosus
Malabar tree toad
Endemic

Bufo scaber
Ferguson's toad

Bufo melanostictus
Common toad

Philautus cf. *leucorhinus*
White nosed bush frog
Endemic

Philautus tuberohumerus
Knobbed hand bush frog
Endemic

Rhacophorus malabaricus
Malabar gliding frog
Endemic

An Ecosystem is a

- **functional unit of environment**

- **complex of interconnected living organisms - inhabiting particular area with their environment**

- **self-defined, self-sustained, dynamic natural system with well-maintained ecological processes and interactions**

Semi-evergreen forest patch

Ecosystem comprises of ...

- **Biotic components**
  - **Autotrophs**
    - Energy fix
    - Selfhelp group
  - **Heterotrophs**
    - Transfer energy
    - Dependent
  - **Detritivours**

- **Abiotic components**
  - **Physical**
    - solar radiation, temperature, rainfall
  - **Chemical**
    - soil, water, air

Abbe falls, Kodagu, Karnataka

Ecosystem Management is to

- restore and maintain ecosystem structure and function
- sustainability
- biological diversity of ecosystems
- supporting sustainable economies and communities

ECOLOGICAL
• Biotic
• Abiotic factors

Ecosystem approach

SOCIO-ECONOMIC
• Stake holders
• Values
• Issues

INSTITUTIONAL
• Laws and mandates
• Staffing and funding

Collection of Dalchini (*Syzygium* sp.)

Collection of dry litter

Biological indicators are ...

- Being part of ecosystem

- Eat and being eaten

- Dynamic and complex interactions – NOT static, i.e., feedback, process, feedback

- Increase our understanding/knowledge of the ecosystem/environment

Hanuman Langur
Presbytis entellus

Species diversity

Described

- Virus ~1,000
- Monera (Bacteria) ~4,800
- Algae ~26,900
- Protozoa ~30,800
- Fungi ~69,000
- Higher plants ~ 2,48,400
- Insects ~7,51,000
- Animals ~2,81,000
- Around 1.4 million

Estimate can be 2 to 100 million, best being 10 million

A vine snake eating *Uropeltis*

Mollusca

Wolf spider

•Indicator species –

- Indicative of changes in environment
- Either qualitatively or quantitatively
- Respond to mild and subtle changes
- Easy to handle, identify
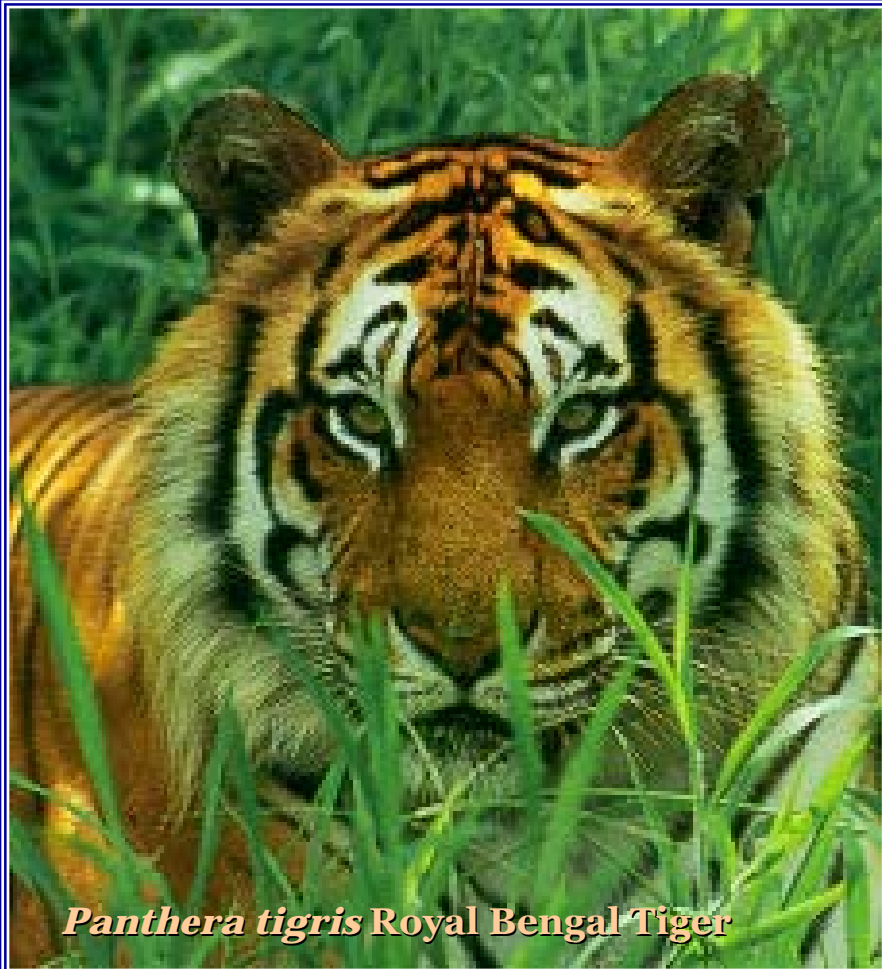- Wide distribution
- Model to human conditions

Myristica malabarica (Nutmeg tree)

Micrixalus saxicola (Torrent frog)

•Keystone species –

- Acts as keystones
- Controls many others

Panthera tigris Royal Bengal Tiger

© http://animals.timduru.org/dirlist/tiger/Bengal%20Tiger.JPG

Tyto alba Barn Owl

© Steven Jaremko
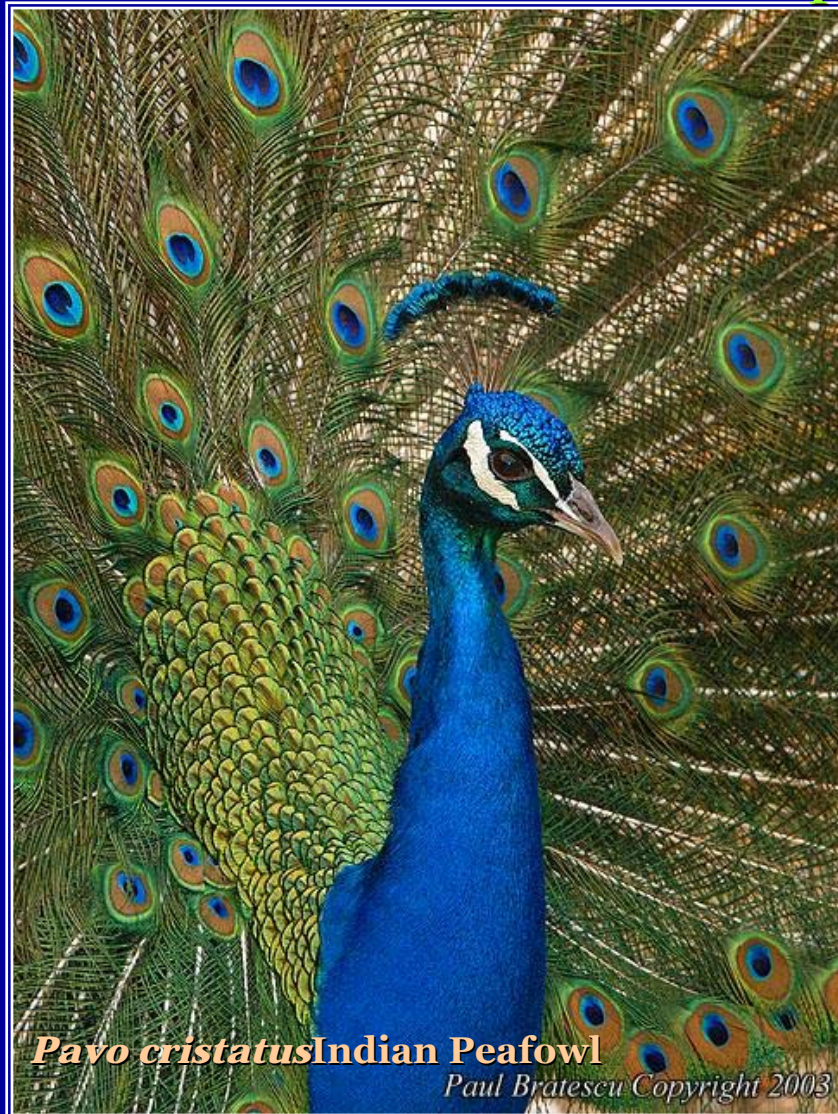
•Umbrella species –

- Require large areas
- Unaltered habitat for viable population

Elephas maximus Asian Elephant

•Flagship species –

- Possessing charisma
- Social-cultural importance

Pavo cristatus Indian Peafowl
Paul Bratescu Copyright 2003

© E.J. Peiker, 2005

Grus antigone Sarus crane

Antilope cervicapra
Blackbuck

© http://www.webindia123.com/wildlife/gallery/wild/goats/blckbuck.jpg

•Vulnerable species –

- - Reduced population
- - Poor dispersal
- - narrow niche – threat by fragmentation
- - vulnerable to human activities

Micrixalus saxicola Torrent frog

•Economically important species –

- harvested with reason
- economic importance

Amarphophalus

Honey comb
Photo by Ali, S

Myristica malabarica Nutmeg fruit

Garcinia morella

Amphibian Systematics

Ichthyophis malabaricus

Globally: Three orders –
Gymnophiona – limbless amphibians (Apoda)
6 families, 33 genera, 173 species

© 2001 William Flaxington

Caudata – Tailed amphibians – Salamanders
10 families, 62 genera, 548 species

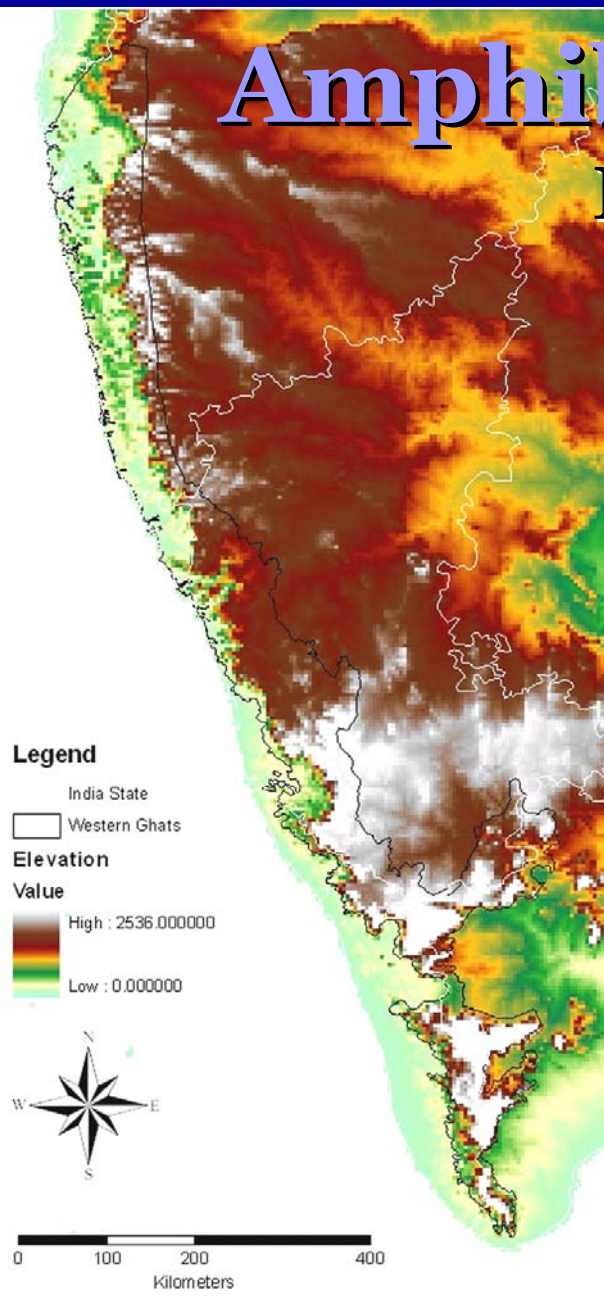Tiger salamander *Ambystoma californiense*

Anura – Tailless amphibians – Frogs and Toads
32 families, 372 genera, 5227 species

Brown Torrent frog *Micrixalus saxicola*

Amphibian Systematics ...
In Western Ghats

Order	Family	Subfamily	Genera	Species	Endemic to WG
Gymnophiona	Caeciliidae		*Gegeneophis*	8	8
			Indotyphlus	2	2
	Ichthyophiidae		*Ichthyophis*	7	7
			Uraeotyphlus	5	5
Anura	Sooglossidae		*Nasikabatrachus*	1	1
	Bufonidae		*Ansonia*	2	2
			Bufo	10	7
			Pedostibes	1	1
	Microhylidae		*Ramanella*	6	5
			Uperodon	2	0
		Melanobatrachinae	*Melanobatrachus*	1	1
		Microhylinae	*Kaloula*	1	0
			Microhyla	3	1
	Micrixalidae		*Micrixalus*	11	11
	Petrapedatidae		*Indirana*	10	10
	Dicroglossidae	Dicroglossinae	*Euphlyctis*	2	0
			Fejervarya	10	8
			Hoplobatrachus	2	0
			Minervarya	1	1
			Sphaerotheca	4	1
	Rhacophoridae	Rhacophorinae	*Philautus*	19	19
			Polypedates	4	2
			Rhacophorus	5	5
	Nycitbatrachidae		*Nyctibatrachus*	12	12
	Ranidae		*Clinotarsus*	1	1
			Sylvirana	2	2
			Hydrophylax	1	0
2	11	4	27	133	112

Legend

India State

Western Ghats

Elevation

Value

High : 2536.000000

Low : 0.000000

0 100 200 400
Kilometers

New descriptions since 2001 is 20 and still going on...

© Krishnamurthy et al., 2001

Nyctibatrachus hussaini

© Biju and Bossuyt, 2005

Philautus graminirupes

© Biju and Bossuyt, 2006

Philautus anili

© Biju and Bossuyt, 2005

Philautus nerostagona

© Das and Kunte, 2005

Nyctibatrachus petraeus

© Biju and Bossuyt, 2006

Philautus dubois

© Biju and Bossuyt, 2005

Philautus ponmudi

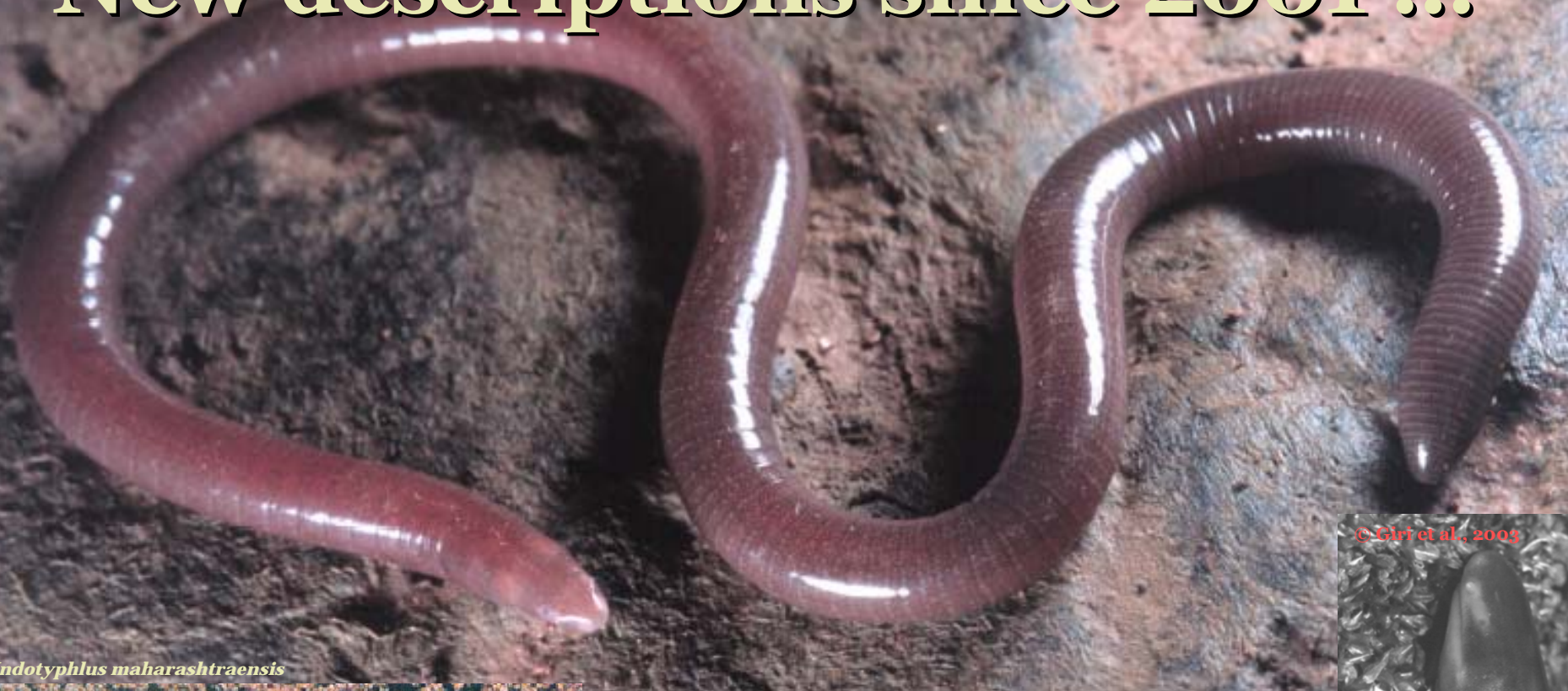© Biju and Bossuyt, 2005

Philautus bobingeri

© Bossuyt, 2005

Philautus griet

© Biju and Bossuyt, 2003

Nasikabatrachus sahyadrensis

© Das and Dutta, 2006
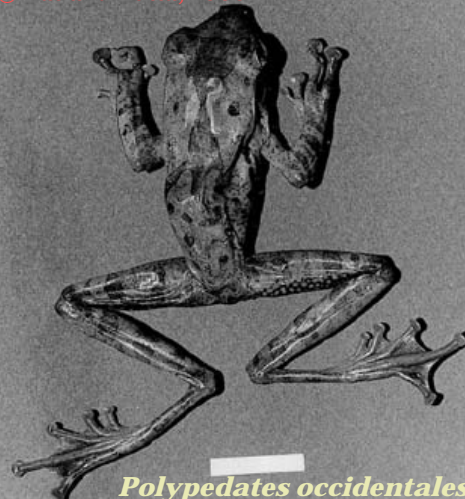
Polypedates occidentales

Philautus neelanethrus

New descriptions since 2001 ...

Indotyphlus maharashtraensis

Gegeneophis nadakarnii

Gegeneophis madhavorum
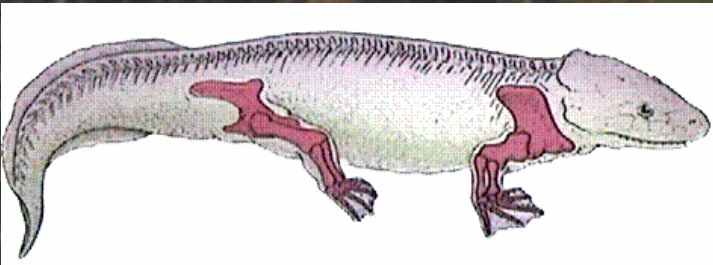
Gegeneophis danieli

Amphibians are ...

• **Dual life** (Gk: *Amphibios* means two life styles)

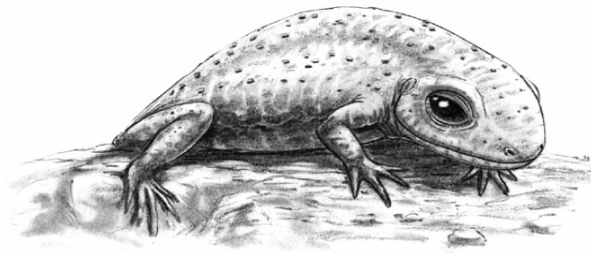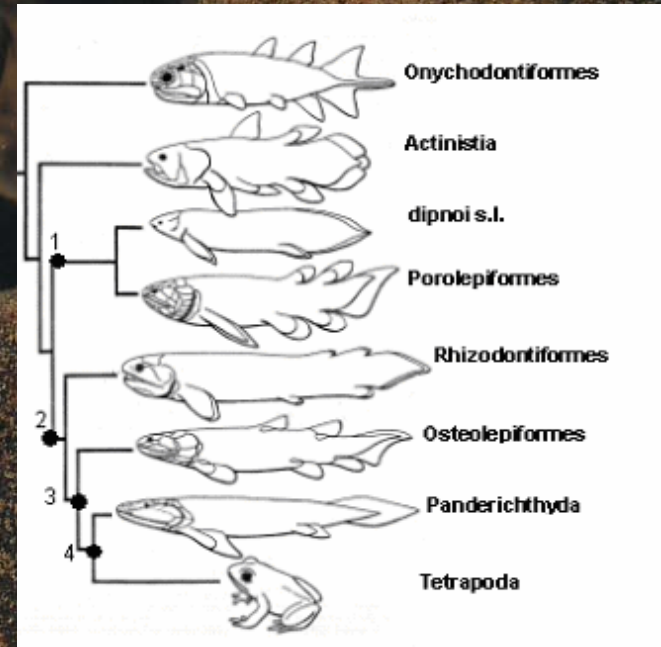Tadpoles of *Nyctibatrachus* sp.

Adult of *Sylvirana temporalis*

Evolution of Amphibians

About 360 million years ago, late Devonian period

Early amphibian!!!

Triadobatrachus

Metamorphosis
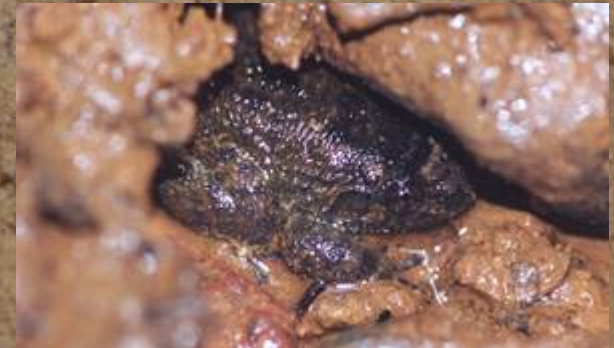
Direct Development

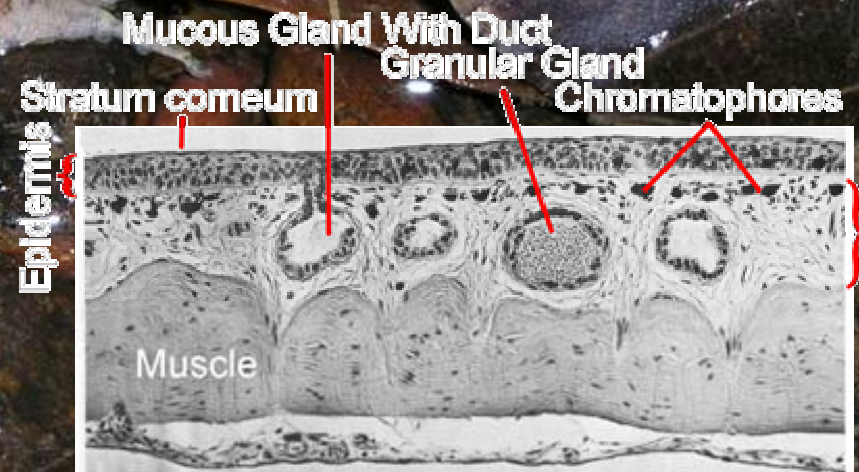# Ectotherms –

Body temperature externally maintained

Basking in sun

Hiding away from sun

Skin respiration –

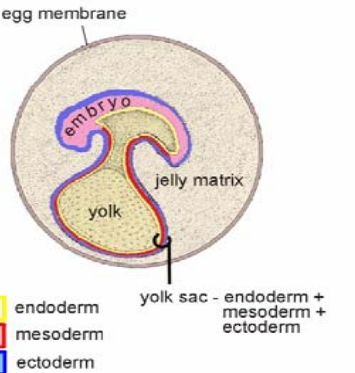Exchange of gases from the surroundings through skin

Mucous Gland With Duct
Granular Gland
Chromatophores
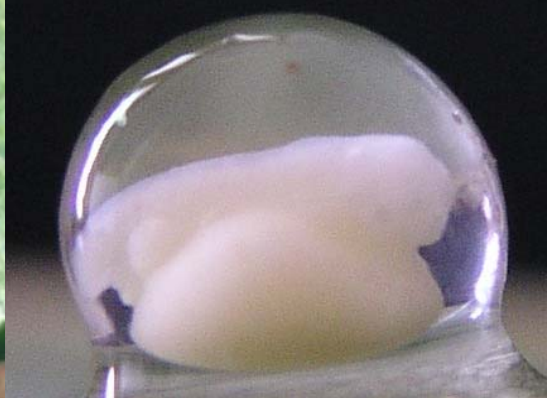Stratum corneum
Epidermis
Dermis
Muscle

AMPHIBIAN SKIN
(Patt & Patt. 1968. Comparative Vertebrate Histology: Harper & Row Publ, New York.)

Anamniotes –

No protective layer in their eggs

egg membrane

embryo

jelly matrix

yolk

yolk sac - endoderm +
mesoderm +
ectoderm

- □ endoderm
- □ mesoderm
- □ ectoderm

Ecosystem function –

Prey and predator

Human welfare –

- **best bio-pest controller,**
- **Bufotonin, epibatidine – pain killers**
- **delicacy, media for microbial culture, cryosurgery…**
- **Acoustic Analysis in Rig Veda, verse 7!!!**

Factors	Process(es)
Climate change	Temperature and precipitation patterns are altered so as to cause disruptions in micro or macro-climatic conditions
Habitat modification	Deforestation and agriculture; drained and filled wetlands, land filling
Habitat fragmentation	Roads, introduced species, and low pH dissect habitats, creating barriers to dispersal.
Introduced species	Introduced predators, prey on/or compete with native amphibians.
UV-B radiation	UV-B damages and/or kills cells, causing egg mortality, lesions, malformations and increased susceptibility to disease and low pH.
Chemical contamination	Toxins cause direct mortality of eggs and adults, mimic endocrine harmones, reduce the prey base, pesticidal effect; fluoranthene.
Acid precipitation and soil	Toxins create barriers to dispersal and cause high egg and larval mortality.
Disease	Disease often causes death in amphibians (*Chytridiomycosis*)

…… So one among the BEST Biological indicators!!!

Peak Frequency (kHz)
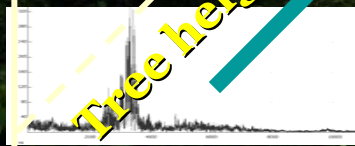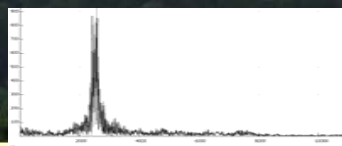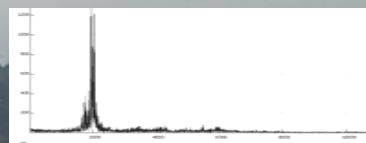
Tree height (m)

Snout vent length (mm)
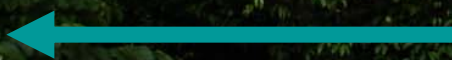
Weight (g)
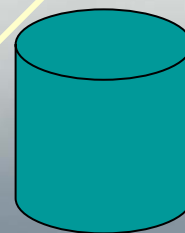
INFLUENCE OF LAND-USE CHANGES IN RIVER BASINS ON DIVERSITY AND DISTRIBUTION OF AMPHIBIANS

Gururaja KV, Sameer Ali and Ramachandra TV
EWRG, CES, IISc, Bangalore-12
gururaj@ces.iisc.ernet.in

Study Area

Uttara Kannada district, Central Western Ghats (12-16°N) ~78% forest cover, four west flowing rivers, Kali, Bedti, Aghanashini and Sharavathi. Development projects pumped into these river basins. 4 hydel projects in Sharavathi, 5 in Kali and proposals for Bedti, Aghanashini
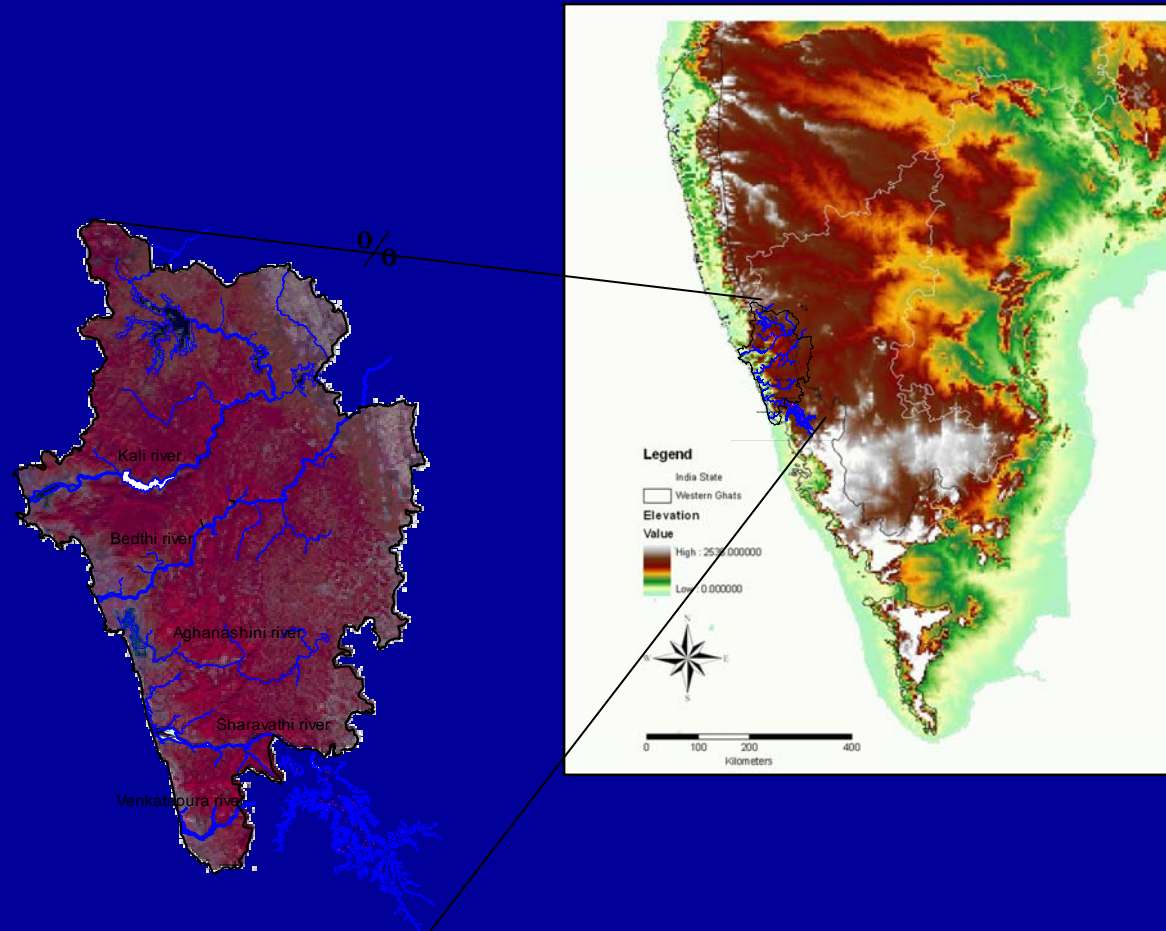
Methods

For Amphibians Survey

- **Systematic stratified random sampling**
- **night survey with torch lights (17:30-20:30 hr) 42 sites, from 2003 – still going on, seasonal, search for all (including calls, tadpoles), in all micro habitats**
- **Identify and record species, number etc.**
- **Opportunistic observations also included for overall diversity in the region**

For Habitat variables

- **20 years rainfall data from nearest rain gauge station**
- **Densiometers for canopy estimation**
- **Transect and quadrat methods for vegetation parameters**
- **Stream persistence based on year long observation**

Methods …

For land-use classification

- **Indian Remote Sensing satellite 1C multispectral image of 2000**
- **Supervised classification with maximum likelihood classifier**

Analysis

Amphibian diversity

- **Shannon's ($H' = -\Sigma\, p_i\, ln\, p_i$),**
- **Simpson's ($D = 1/ \Sigma\, p_i^2$) and Probability of Interspecific Encounters (PIE $= = \Sigma(ni/N)\, ((N - ni)/(N - 1))$) were calculated.**

Analysis …

Landscape and Fragmentation metrics
- **Percentage land-use classification in sub-catchments**
- **Forest fragmentation index**
- **Landscape metrics**

Amphibian relationship with environmental descriptors
- **Correlation coefficients (r) were calculated between endemic species richness, abundance with environmental descriptors**
- **Correlation among the environmental descriptors**
- **Principal Component Analysis to determine influence of environmental descriptors in reduced space**
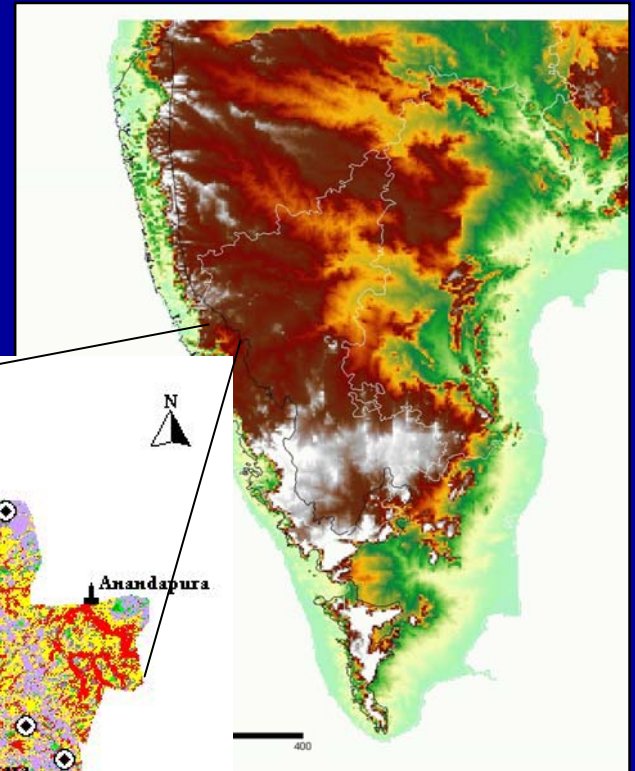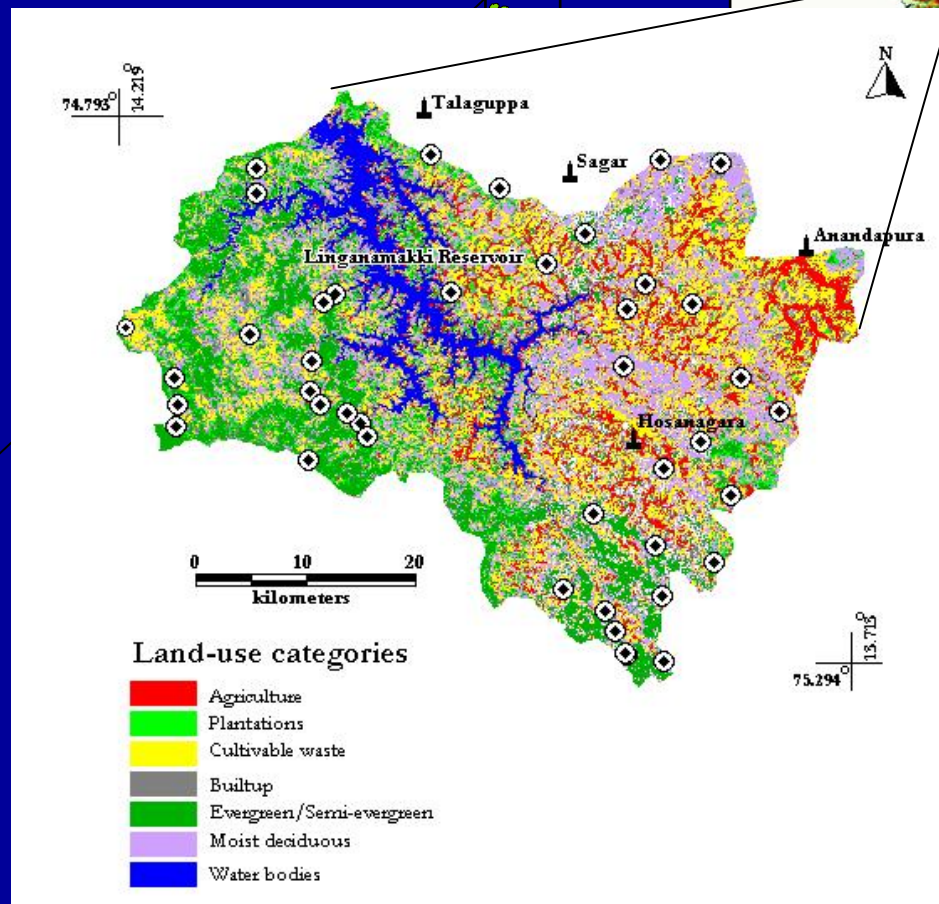
Results

Amphibian diversity

	Aghanashin	Sharavathi	Bedti	Endemic	GAA
Family: Bufonidae					
Bufo melanostictus	+	+	+		LC
Bufo scaber	+	+	+		LC
Bufo sp.	+				
Pedostibes tuberculosus	+	+	+	+	EN
Family: Microhylidae					
Ramanella montana		+		+	NT
Sub-family: Microhylinae					
Kaloula pulchra		+			LC
Microhyla ornata	+		+		LC
Microhyla rubra	+		+		LC
Family: Micrixalidae					
Micrixalus fuscus		+		+	NT
Micrixalus gadgili		+		+	EN
Micrixalus saxicola		+	+	+	VU
Family: Petrapedatidae					
Indirana beddomii	+	+	+	+	LC
Indirana semipalmatus	+	+	+	+	LC
Family: Dicroglossidae					
Sub-family: Dicroglossinae					
Euphlyctis cyanophlyctis	+	+	+		LC
Euphlyctis hexadactylus		+			LC
Fejervarya brevipalmatus	+		+	+	DD
Fejervarya keralensis	+	+	+	+	LC
Fejervarya limnocharis	+	+	+		LC
Fejervarya syhadrensis	+	+	+		LC
Fejervarya sp.			+		
Hoplobatrachus crassus	+				LC
Hoplobatrachus tigerinus		+	+		LC
Minervarya syhadris	+		+	+	EN
Minervarya sp.			+		
Sphaerotheca breviceps	+	+	+		LC
Sphaerotheca rufescens	+	+	+	+	LC
Sphaeroteca dobsonii		+			LC

Results ...

Amphibian diversity...

	Aghanashin	Sharavathi	Bedti	Endemism	GAA
Family: Rhacophoridae					
Sub-family: Rhacophorinae					
Philautus cf.leucorhinus	+	+	+	+	EX
Philautus cf.luteolus	+	+	+	+	VU
Philautus cf.nasutus	+	+		+	EX
Philautus cf.ponmudi	+	+		+	VU
Philautus tuberohumerus	+	+	+	+	VU
Polypedates leucomystax		+			LC
Polypedates maculatus		+	+		LC
Polypedates pseudocruciger		+	+	+	LC
Rhacophorus malabaricus		+	+	+	LC
Family: Nyctibatrachidae					
Nyctibatrachus cf. aliciae	+	+	+	+	EN
Nyctibatrachus major	+	+	+	+	VU
Nyctibatrachus cf. petraeus		+	+	+	EN
Family: Ranidae					
Clinotarsus curtipes	+	+	+		NT
Hydrophylax malabaricus		+	+		LC
Sylvirana aurantiaca		+	+	+	VU
Sylvirana sp.	+				
Slyvirana temporalis	+	+	+		NT
Family: Ichthyophiidae					
Ichthyophis beddomi		+		+	LC
Ichthyophis malabaricus			+	+	LC
Species richness	**27**	**36**	**33**	**24**	

Sharavathi river basin

Land-use categories
- Agriculture
- Plantations
- Cultivable waste
- Builtup
- Evergreen/Semi-evergreen
- Moist deciduous
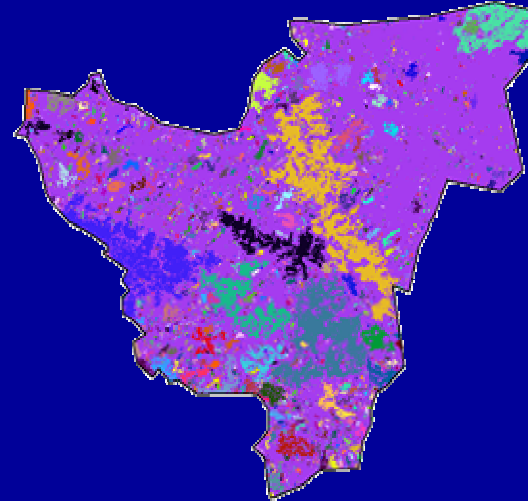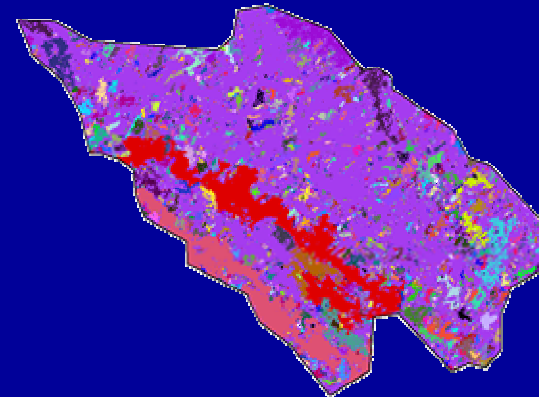- Water bodies

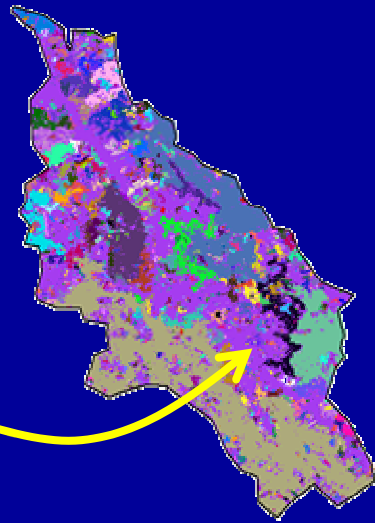# Fragmentation maps
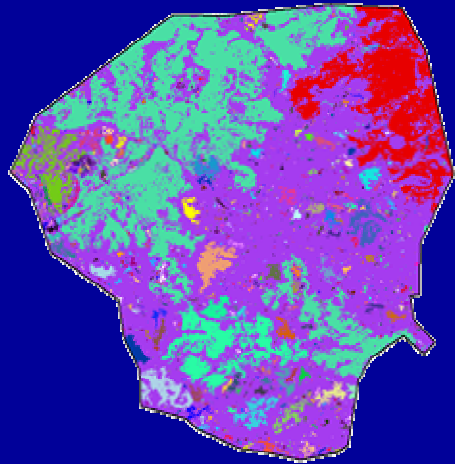
Nandi

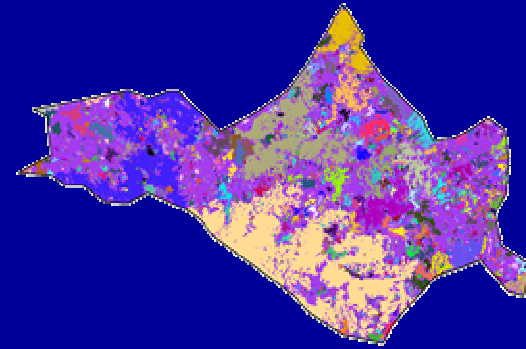Haridravathi

Background
colour

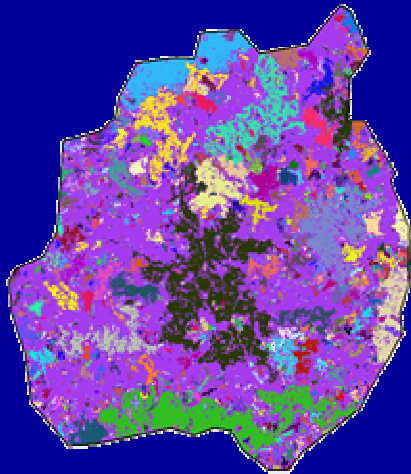Mavinhole

Sharavathi

Fragmentation maps ...

Background colour

Hilkunji

Nagodi

Hurli
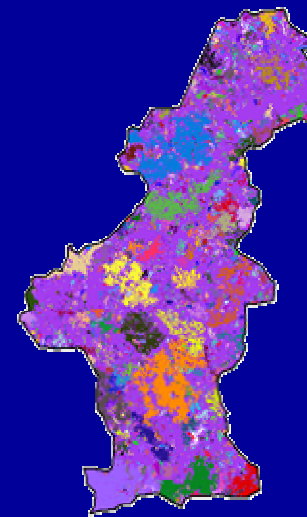
Yenne

Results …

Amphibian diversity in Sharavathi river basin

- 833 individuals, 36 species, 8 families
- 21 species endemic to Western Ghats
- 4 endangered, 6 vulnerable species

Sub-basin	Richness	Abund.	Simpson	Shannon	PIE
Nandi	10	36	5.456	1.963	0.840
Haridravathi	14	49	8.747	2.356	0.904
Mavinhole	14	48	7.629	2.298	0.888
Sharavathi	14	33	7.316	2.298	0.890
Hilkunji	20	48	10.128	2.653	0.921
Nagodi	18	59	7.548	2.436	0.883
Hurli	15	38	11.100	2.544	0.935
Yenne	22	66	13.299	2.807	0.938

Results ...

Endemics

Sub-basin	Richness	Abund.	Simpson	Shannon	PIE
Nandi	4	12	3.429	1.309	0.773
Haridravathi	6	28	4.000	1.522	0.778
Mavinhole	8	28	3.853	1.668	0.768
Sharavathi	9	27	5.184	1.884	0.838
Hilkunji	11	31	5.459	2.034	0.844
Nagodi	11	45	4.773	1.903	0.808
Hurli	9	26	7.123	2.071	0.894
Yenne	13	35	8.708	2.361	0.911

Results …

Correlation coefficient (r) at significance level (P<0.05) between endemic species richness and abundance with habitat, land-use, fragmentation and landscape metrics.

	Richness	Abundance
Habitat variables		
Tree endemism (%)	0.513	
Evergreenness (%)	0.544	
Stream flow (%)	0.817	0.607
Canopy (%)	0.643	0.58
Rainfall (mm)	0.892	0.7
Land-use		
Evergreen–semievergreen (%)	0.853	0.617
Moist deciduous (%)	-0.737	-0.735
Agriculture (%)	-0.734	-0.585
Open land (%)	-0.783	-0.659
Forest fragmentation index		
Interior (%)	0.635	
Patch (%)	-0.709	-0.577
Landscape pattern metrics		
Shape index	0.791	
Contiguous patch (m^2)	-0.809	
Shannon's index	0.842	0.618
Total edge (m)	0.832	0.551
Edge density (#/area)	0.715	

Results …

Correlation coefficient (r) at significance level (P<0.05) among the environmental descriptors.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	0.985															
3	0.812	0.855														
4	0.675	0.704	0.628													
5	0.791	0.824	0.973	0.749												
6	0.858	0.878	0.965	0.771	0.992											
7	-0.6	-0.7	-0.8	-0.81	-0.83	-0.8										
8	-0.67	-0.7	-0.92		-0.89	-0.86	0.689									
9	-0.7	-0.73	-0.87	-0.78	-0.93	-0.92	0.755	0.845								
10	0.701	0.695	0.806	0.596	0.841	0.847	-0.54	-0.87	-0.94							
11	0.736	0.706	0.799	0.526	0.828	0.849		-0.8	-0.89	0.962						
12	-0.67	-0.69	-0.86	-0.64	-0.9	-0.88	0.652	0.891	0.976	-0.98	-0.93					
13	0.873	0.9	0.907	0.762	0.925	0.952	-0.76	-0.7	-0.82	0.711	0.765	-0.75				
14	-0.87	-0.89	-0.91	-0.76	-0.92	-0.94	0.782	0.69	0.761	-0.63	-0.68	0.687	-0.98			
15	0.831	0.864	0.923	0.754	0.934	0.944	-0.82	-0.72	-0.77	0.63	0.665	-0.7	0.965	-0.99		
16	0.812	0.858	0.896	0.722	0.907	0.921	-0.8	-0.68	-0.75	0.614	0.661	-0.67	0.977	-0.97	0.969	
17	0.935	0.943	0.906	0.77	0.917	0.956	-0.71	-0.72	-0.84	0.77	0.814	-0.79	0.978	-0.96	0.941	0.921

1. Tree endemism; 2. Evergreenness; 3. Stream flow; 4. Canopy; 5. Rainfall; 6. Evergreen-semievergreen; 7. Moistdeciduous; 8. Agriculture; 9. Open land; 10. Interior; 11. Perforated; 12. Patch; 13. Shape index; 14. Contiguous patch; 15. Shannon's index; 16. Total edge; 17. Edge density
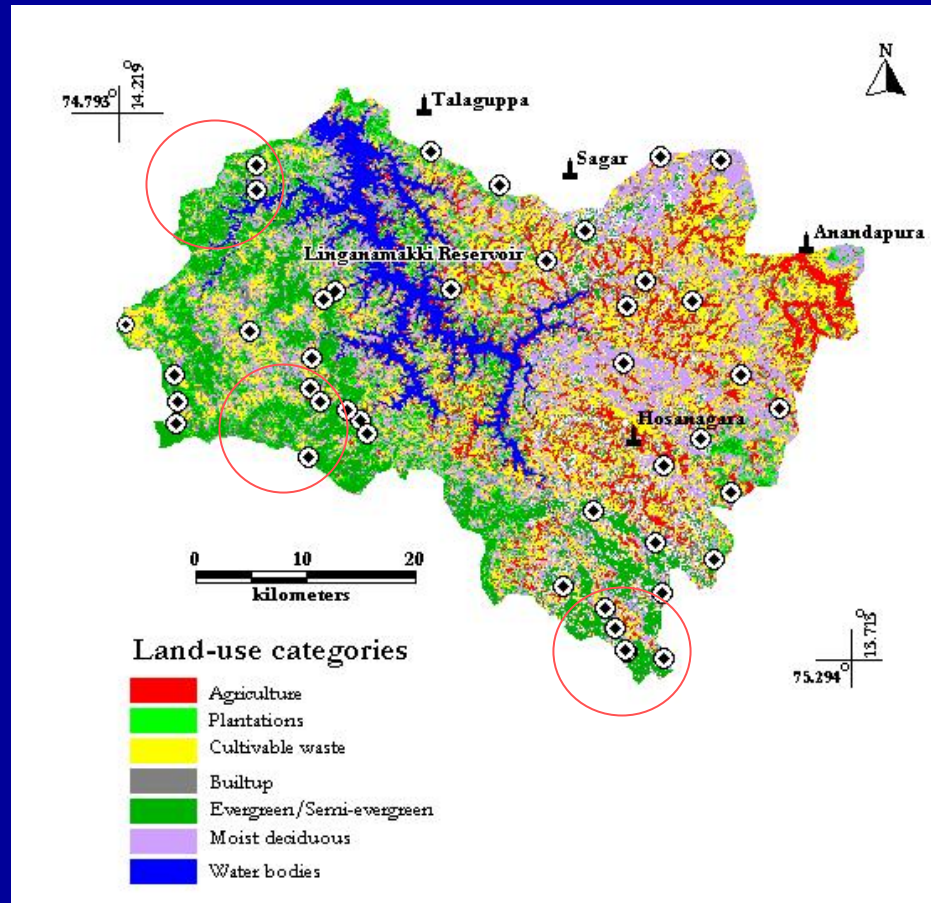
Results …

Biplot of Principal Component Analysis 1. Nandihole, 2. Haridravathi, 3. Mavinhole, 4. Sharavathi, 5. Hilkunji, 6. Hurli, 7. Nagodi and 8. Yennehole.
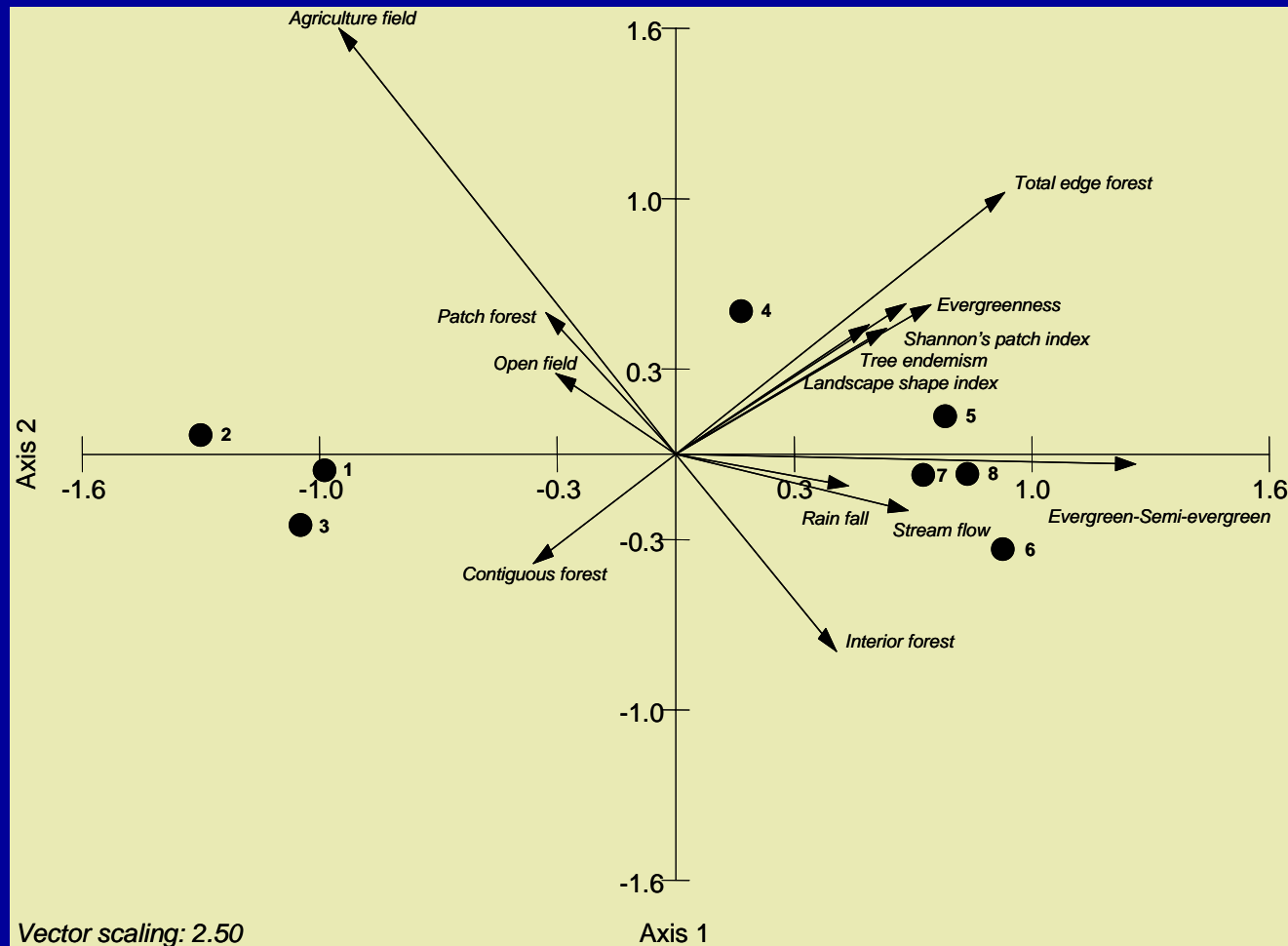
Results …

Conservation priority regions in Sharavathi river basin

Acknowledgements

Thank You