Assessing Long Term Ecological Changes Through Bioindicators in Western Himalayan Protected Areas, India

.....

Prof. V.P. Uniyal, Ph.D

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

universität innsbruck
IMC Innsbruck 2019
International Mountain Conference

Invertebrates-Why?

" the little things that run the world"- Wilson,1987

Invertebrates play a central role in all terrestrial ecosystems as herbivores, pollinators, for nutrient cycling, and as food and host organisms

There are probably 4-6million insect species globally (Novotny et. al. 2002) of which we know about 23-35% (Hammond,1992)

How do we conserve species when we have limited knowledge of which species are endangered or even how many species there are?

Aim of the Study

- To assess the ecological diversity and distribution patterns of Indicators (Invertebrates) in Western Himalayas.
- To determine the impact of anthropogenic pressures on indicators.
- To develop and suggest long-term management strategies for ecological changes in the landscape.

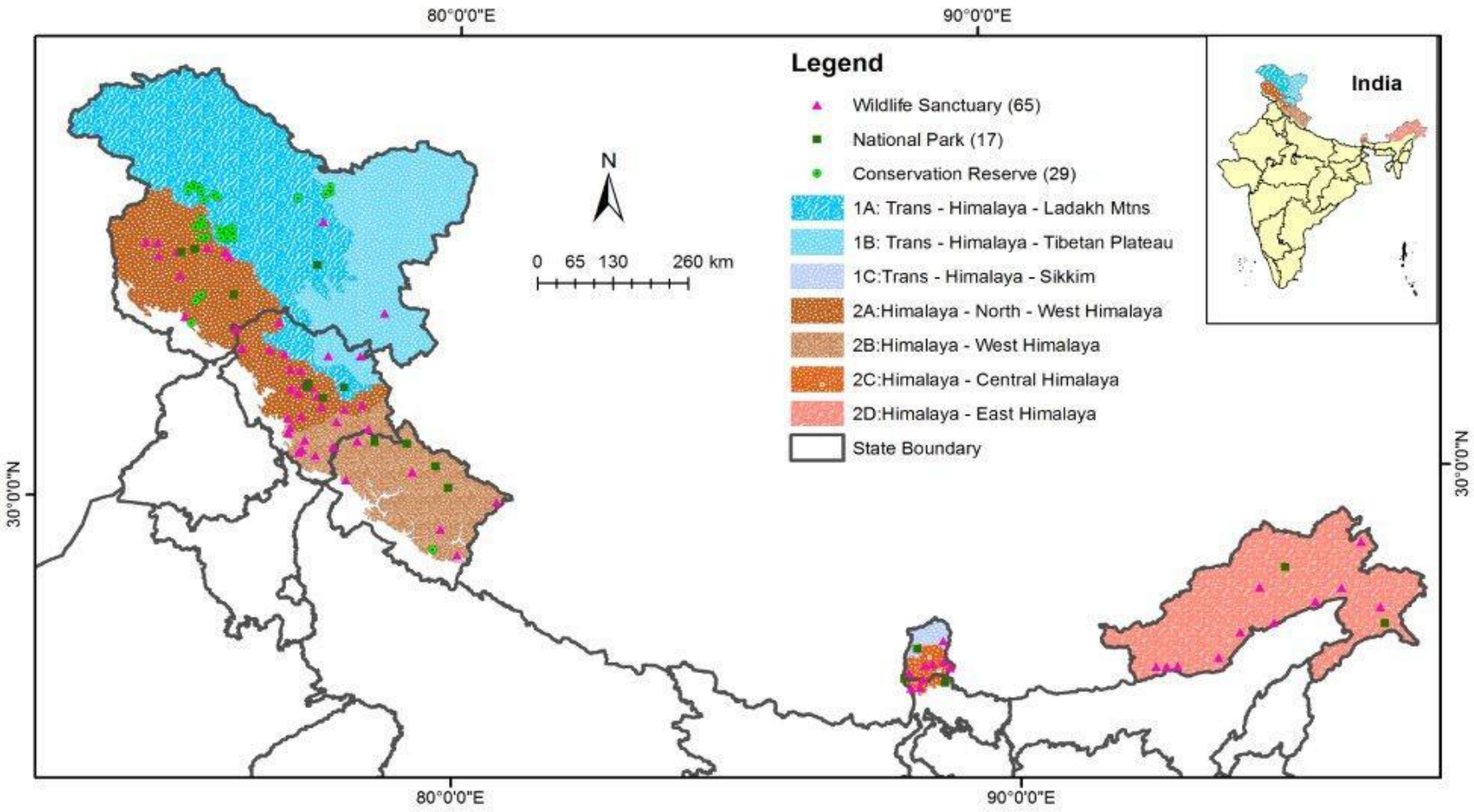
Need and Scope of Insects Study

- Monitoring of biodiversity through use of insects as bioindicators (umbrella group for biodiversity conservation).
- Developing area specific management guidelines for conservation of biodiversity.

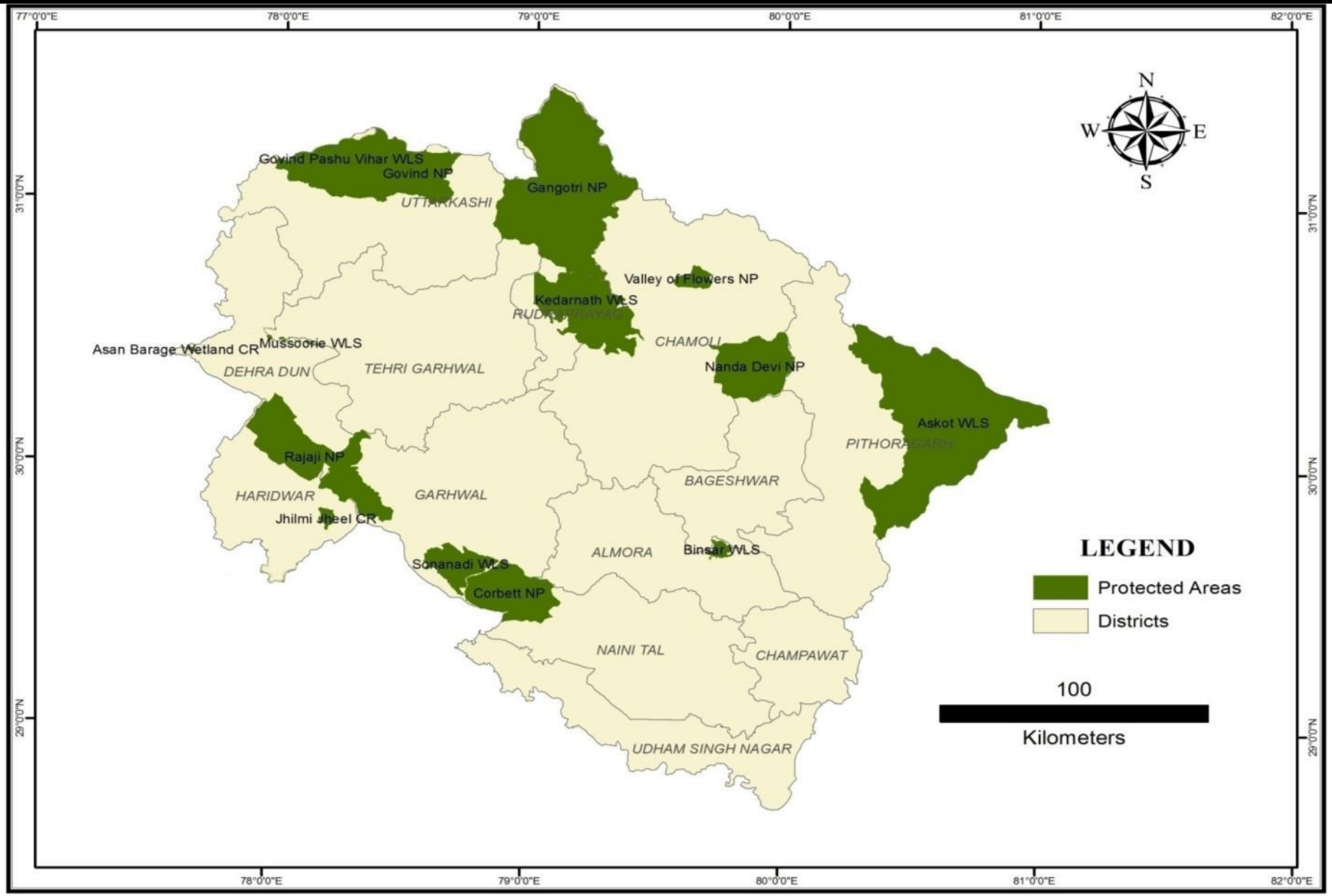
Status of Invertebrates in Indian PAs

- Research on Invertebrates (entomofauna) is little explored.
- Endemicity and Wildlife (Protection) Act 1972, status of many groups is not clearly known and not included.
- Lepidoptera (Butterflies & Moths) and some small groups have been documented in few PAs.
- Other insects groups almost neglected No status survey has been conducted.

Protected Areas in Indian Himalaya



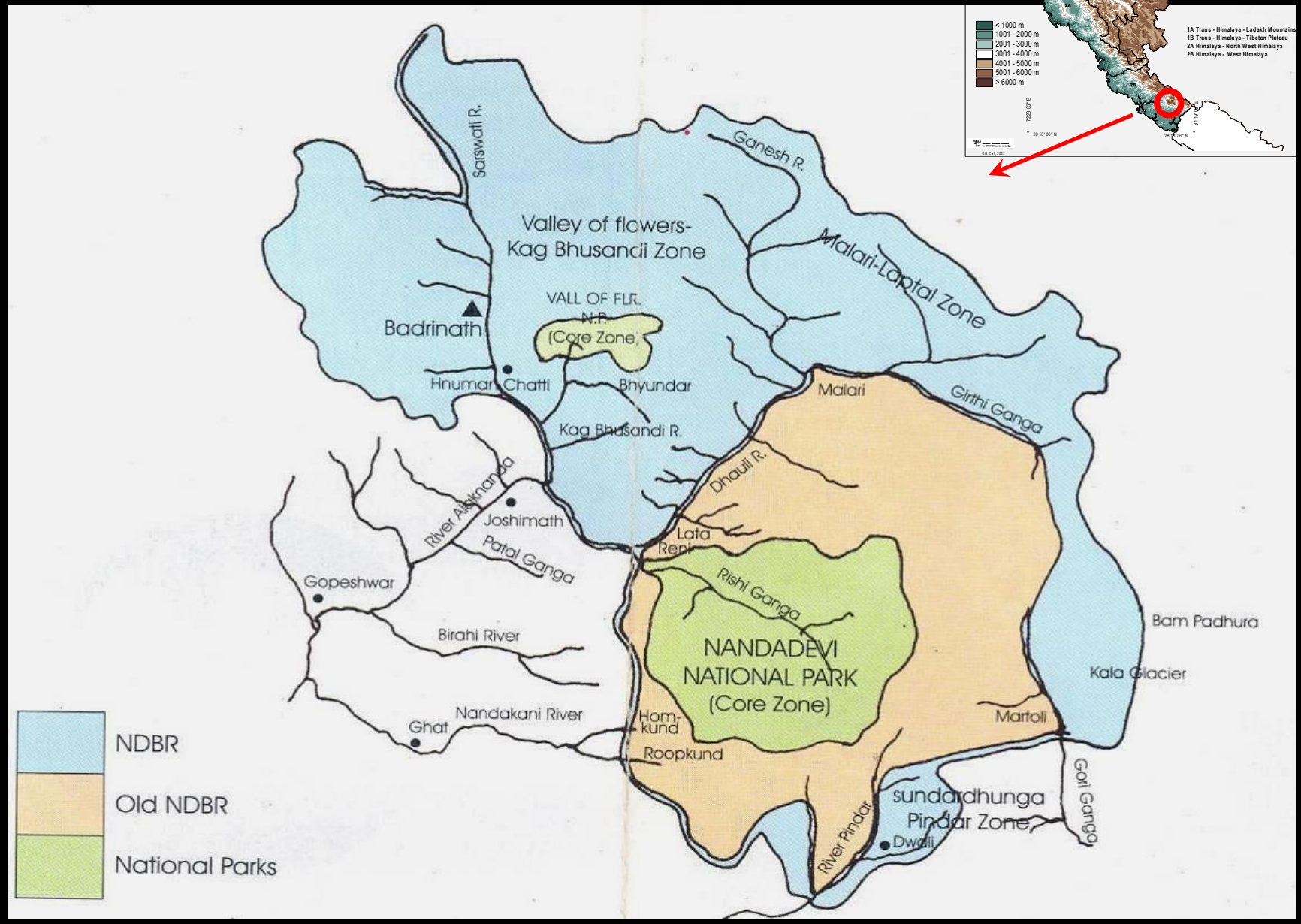
Protected Areas in Uttarakhand



Nanda Devi – Goddess in the Himalaya

The Nanda Devi is the second highest peak (7, 817m) in India and the mountain basin falls within the jurisdiction of Chamoli, Bageshwar and Pithoragarh districts of Uttaranchal. First Bioshphere Reserve of Himalayas : World Heritage Site.

- **Area: 5860.69 sq km with 721.12 sq km core area comprising of two National Parks – Valley of Flowers & Nanda Devi National Park**


< 1000 m
1001 - 2000 m
2001 - 3000 m
3001 - 4000 m
4001 - 5000 m
5001 - 6000 m
> 6000 m
1A Trans - Himalaya - Ladakh Mountains
1B Trans - Himalaya - Tibetan Plateau
2A Himalaya - North West Himalaya
2B Himalaya - West Himalaya
Sarswati R.
Ganesh R.
Valley of flowers-
Kag Bhusandi Zone
Malari-Lapital Zone
VALL OF FLR.
N.P.
(Core Zone)
Badrinath
Hnuman Chatti
Bhyundar
Kag Bhusandi R.
Malari
Girthi Ganga
Dhauli R.
River Alaknanda
Joshimath
Lata
Reni
Patal Ganga
Gopeshwar
Rishi Ganga
Bam Padhura
Birahi River
NANDADEVI
NATIONAL PARK
(Core Zone)
Kala Glacier
Nandakani River
Ghat
Hom-
kund
Martoli
Roopkund
Gori Ganga
sundardhunga
Pindar Zone
River Pindar
Dwali
NDBR
Old NDBR
National Parks

Valley of Flowers National Park

Nanda Devi National Park

Faunal Diversity of NDBR

520 Faunal Species

Mammals

Birds

Reptiles

Amphibians

Fishes, Insects

Molluscs

Annelids

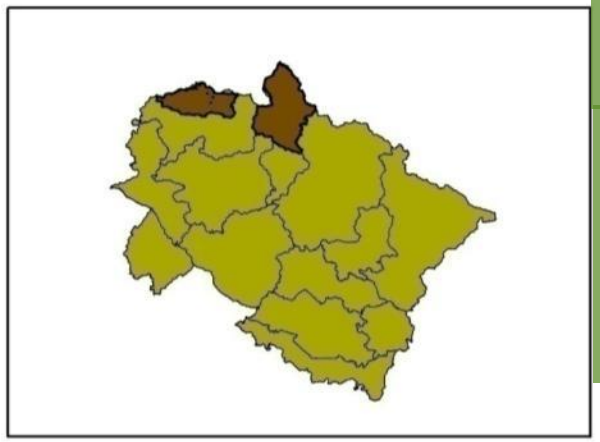
(Samant, 2001)

Floral Diversity of NDBR

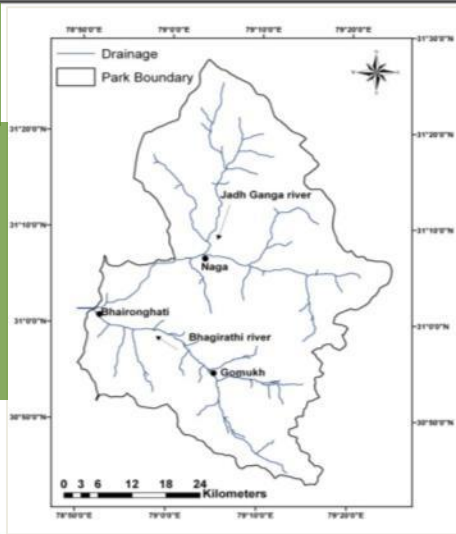
1000 Floral Species

(Samant, 2001)

Gangotri Landscape

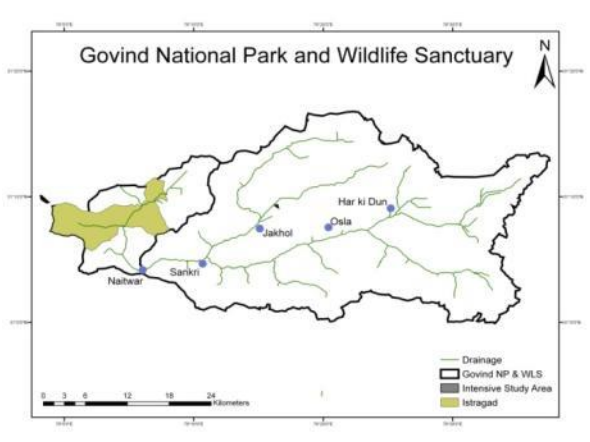


District: Uttarkashi
Altitude Range: 1300m-7000m
Total Area: 3343 sq. k.
Himalayan Moist Temperate
Average Annual Rainfall: 1500mm



Govind WLS & NP

Gangotri NP



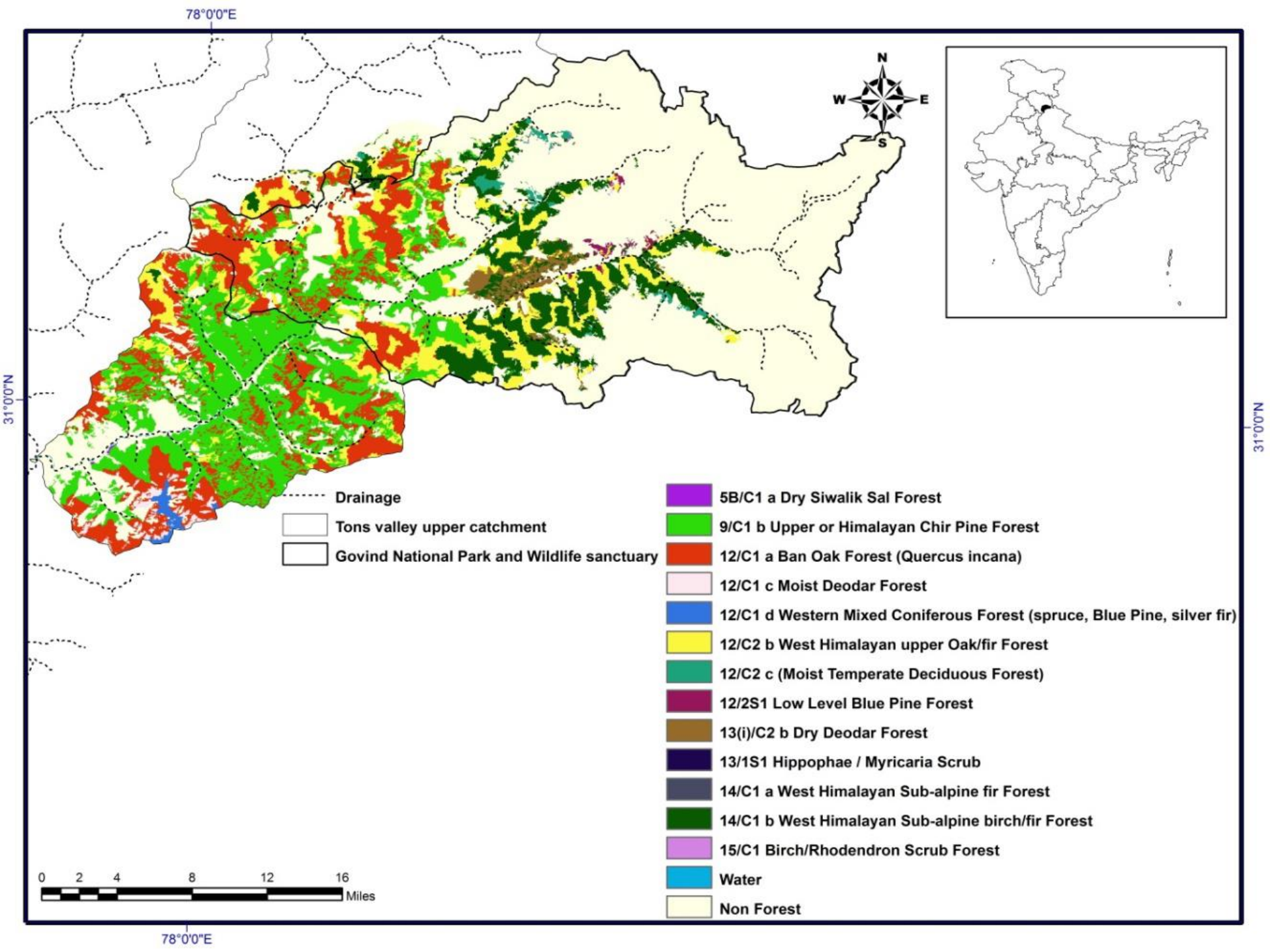
LEGEND

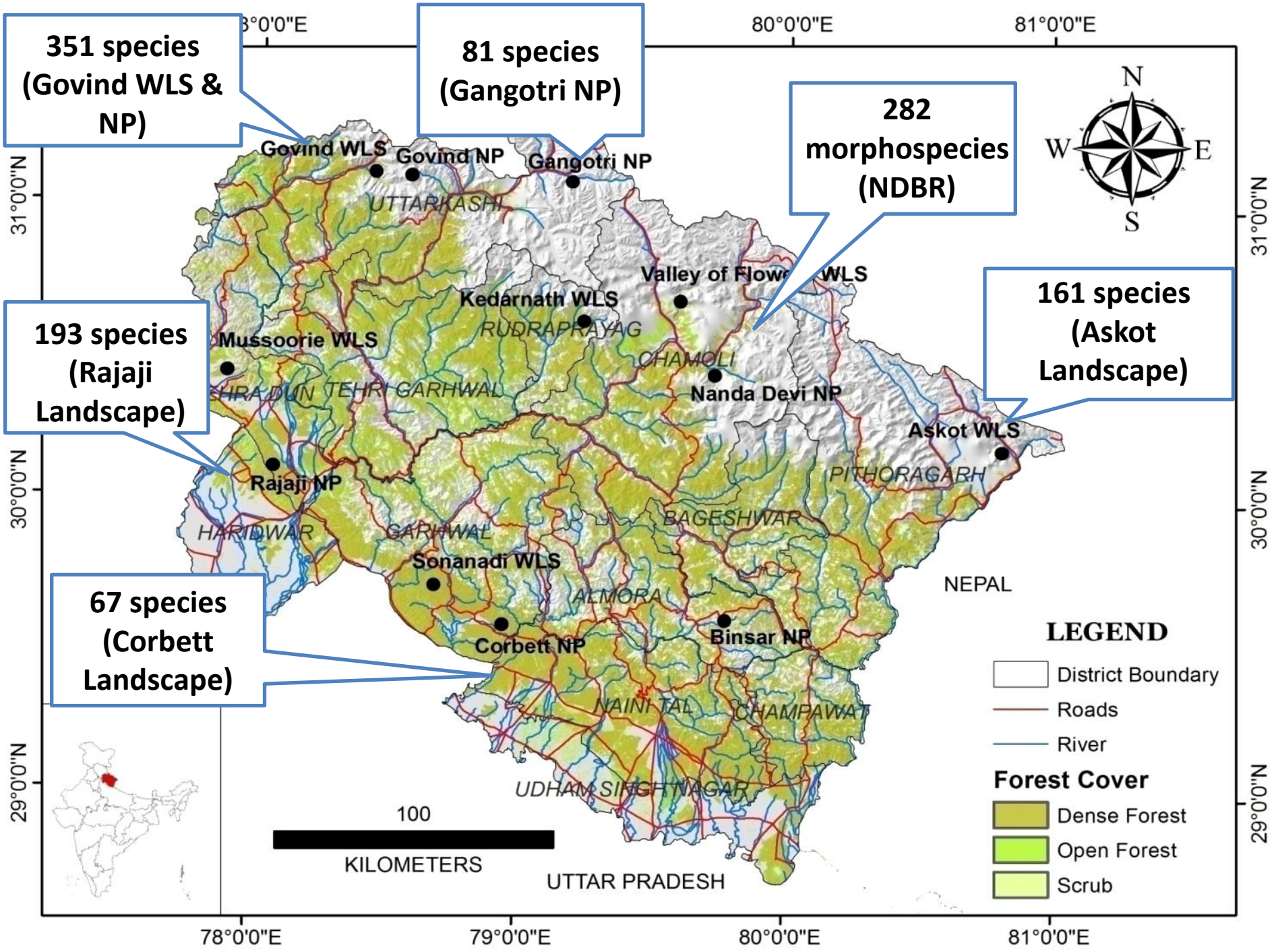
High : 7076

Low : 1295

0 5 10 20 30 40

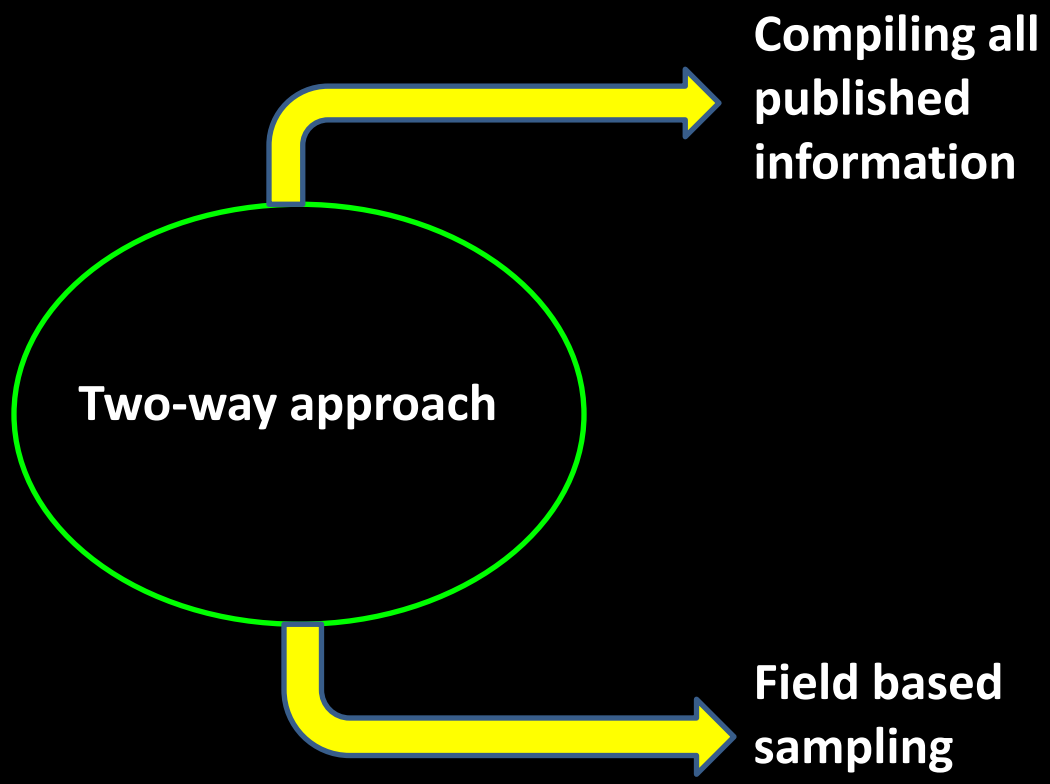
KILOMETERS


78°0'0"E
31°0'0"N
N
W
E
S
Drainage
Tons valley upper catchment
Govind National Park and Wildlife sanctuary
5B/C1 a Dry Siwalik Sal Forest
9/C1 b Upper or Himalayan Chir Pine Forest
12/C1 a Ban Oak Forest (Quercus incana)
12/C1 c Moist Deodar Forest
12/C1 d Western Mixed Coniferous Forest (spruce, Blue Pine, silver fir)
12/C2 b West Himalayan upper Oak/fir Forest
12/C2 c (Moist Temperate Deciduous Forest)
12/2S1 Low Level Blue Pine Forest
13(i)/C2 b Dry Deodar Forest
13/1S1 Hippophae / Myricaria Scrub
14/C1 a West Himalayan Sub-alpine fir Forest
14/C1 b West Himalayan Sub-alpine birch/fir Forest
15/C1 Birch/Rhodendron Scrub Forest
Water
Non Forest
0 2 4 8 12 16
Miles

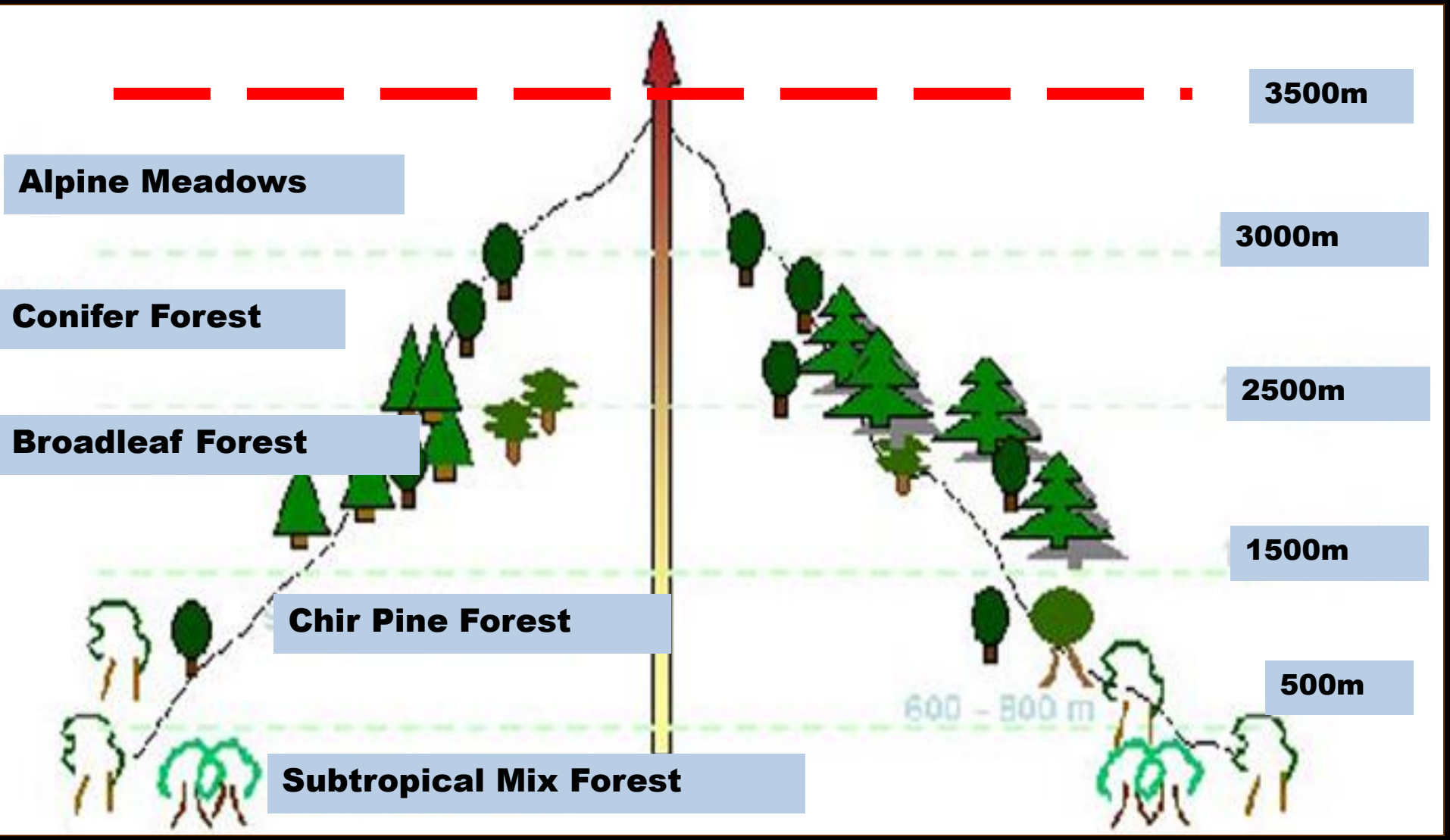

351 species (Govind WLS & NP)
81 species (Gangotri NP)
282 morphospecies (NDBR)
161 species (Askot Landscape)
193 species (Rajaji Landscape)
67 species (Corbett Landscape)
Govind WLS
Govind NP
Gangotri NP
UTTARKASHI
Valley of Flowers WLS
Kedarnath WLS
RUDRAPRAYAG
Mussoorie WLS
CHAMOLI
Nanda Devi NP
DEHRADUN
TEHRI GARHWAL
Askot WLS
PITHORAGARH
Rajaji NP
HARIDWAR
GARHWAL
BAGESHWAR
Sonanadi WLS
ALMORA
NEPAL
Corbett NP
Binsar NP
NAINI TAL
CHAMPAWAT
UDHAM SINGH NAGAR
UTTAR PRADESH
100
KILOMETERS
N
S
E
W
LEGEND
District Boundary
Roads
River
Forest Cover
Dense Forest
Open Forest
Scrub
78°0'0"E
79°0'0"E
80°0'0"E
81°0'0"E
31°0'0"N
30°0'0"N
29°0'0"N

Major Habitats Sampled

Methodology

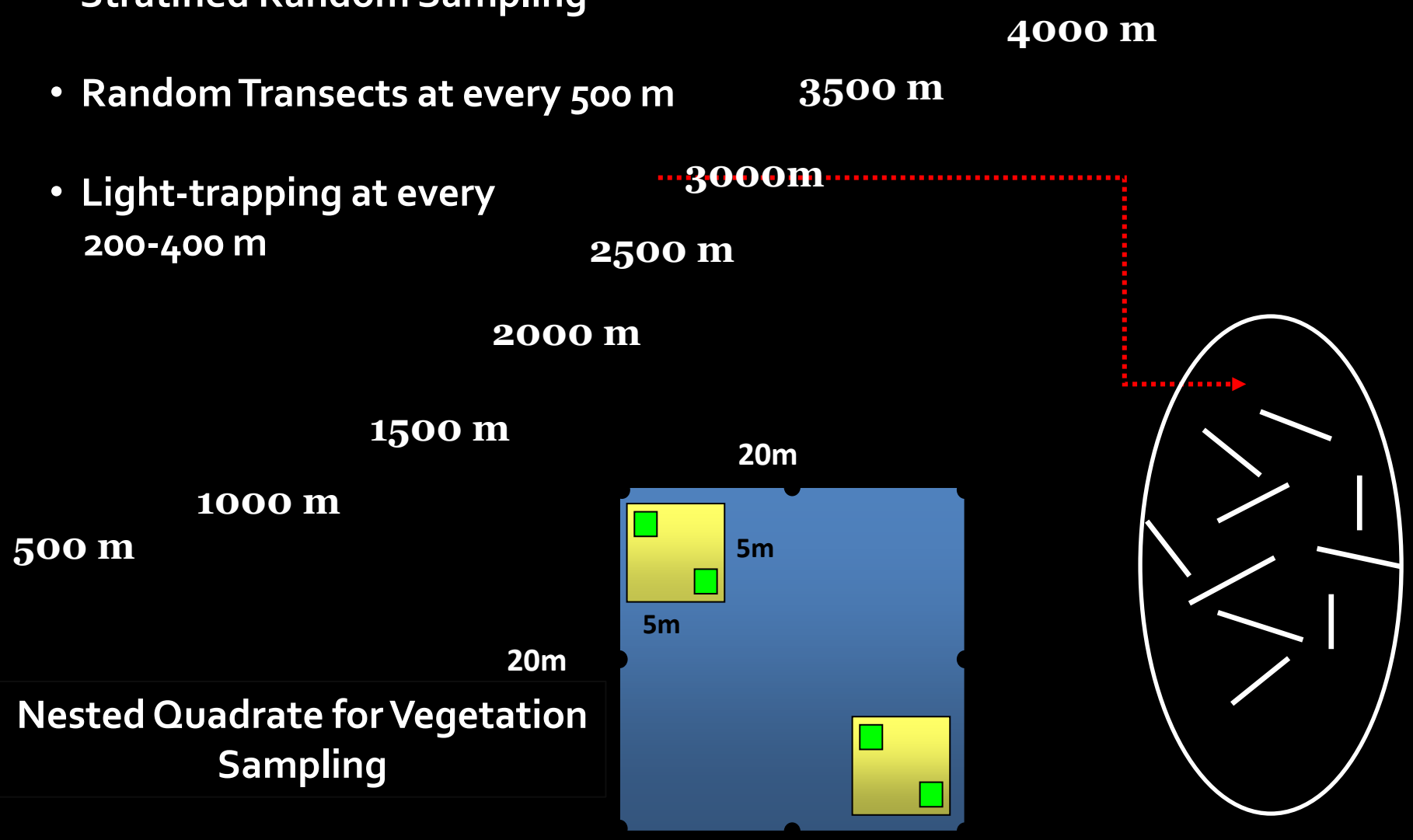


Altitudinally Specialist Species Assemblage



Sampling Design

- Stratified Random Sampling
- Random Transects at every 500 m
- Light-trapping at every 200-400 m



Nested Quadrate for Vegetation Sampling

Plot level characteristics quantified:

Habitat Variables

1. Canopy cover (%)
2. Tree density
3. Shrub density
4. Herb species richness
5. Litter cover at ground (%)
6. Soil at ground (%)
7. Grass cover at ground (%)
8. Wind speed
9. Ambient humidity
10. Ambient temperature
11. Average no of dead trees
12. Dominant flowering plants shrubs, herbs and grasses (in 5m plot), Trees (in 10 m plot).

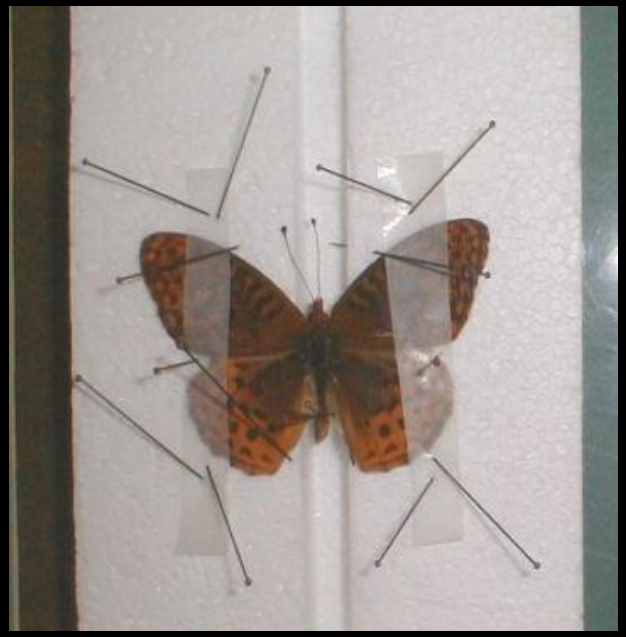
Disturbance Variables

1. Presence of logging sign
2. Presence of felled tree
3. Presence of indirect sign (livestock and dog)
4. Presence of direct sighting of grazing - livestock
5. Presence of fire sign.

Sampling Techniques

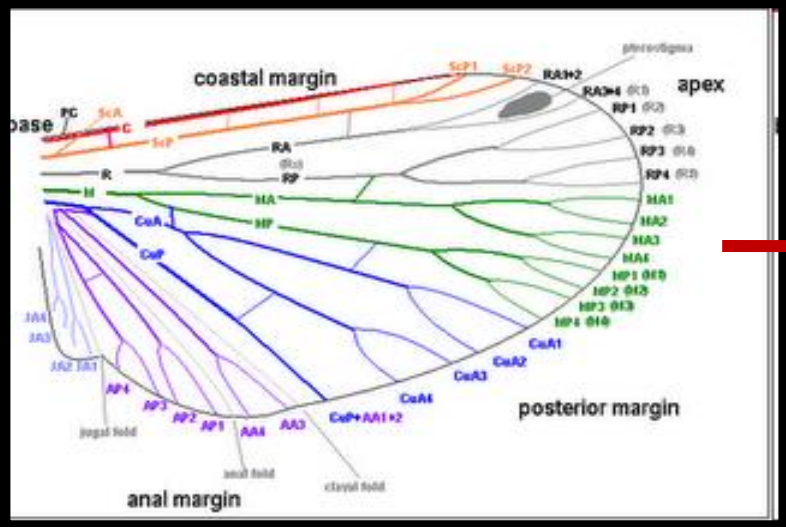
- Direct Search & Transect
- Sweep netting & Bait Trapping
- Opportunistic sampling mud puddles, nectar sources, and other resource rich sites to increase species inventory of the area

Spreading, Mounting & Preservation

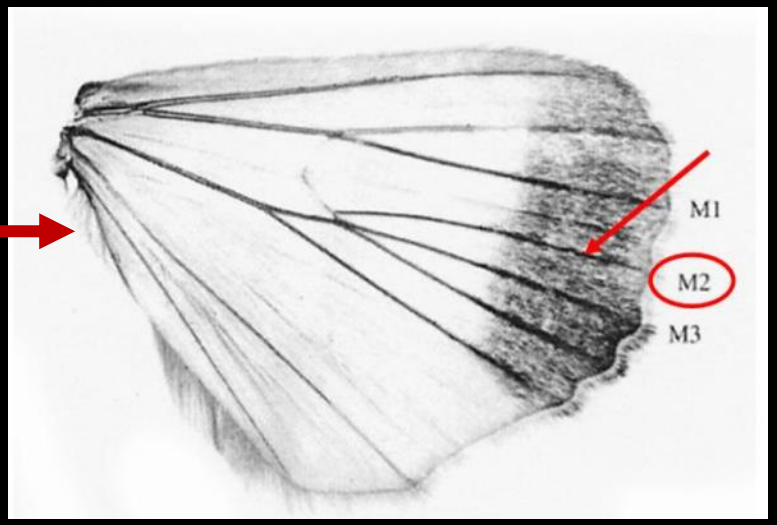


Identification .....

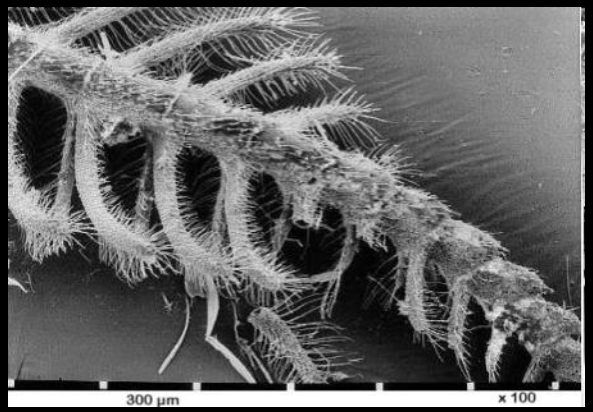
FAMILY & GENUS LEVEL IDENTIFICATION



General Lepidopteran Wing Venation

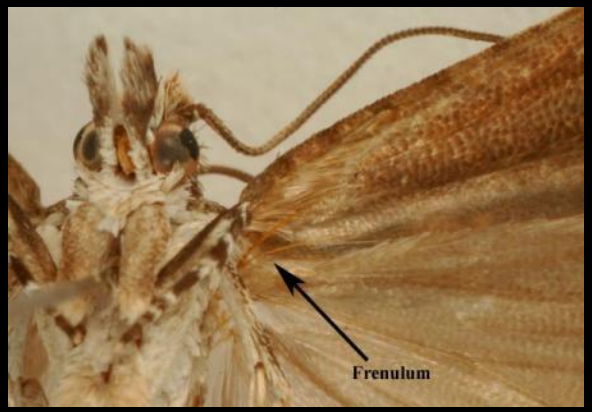


Wing Venation of Family Noctuidae



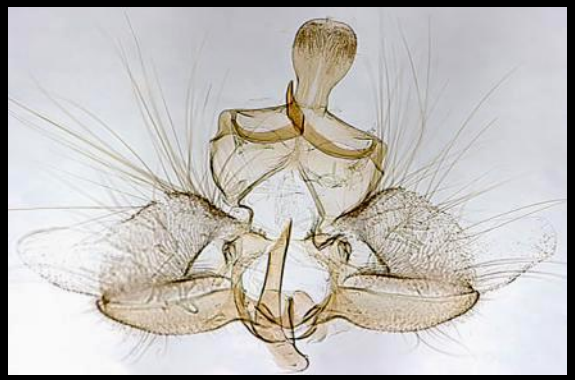
Antenna Structure

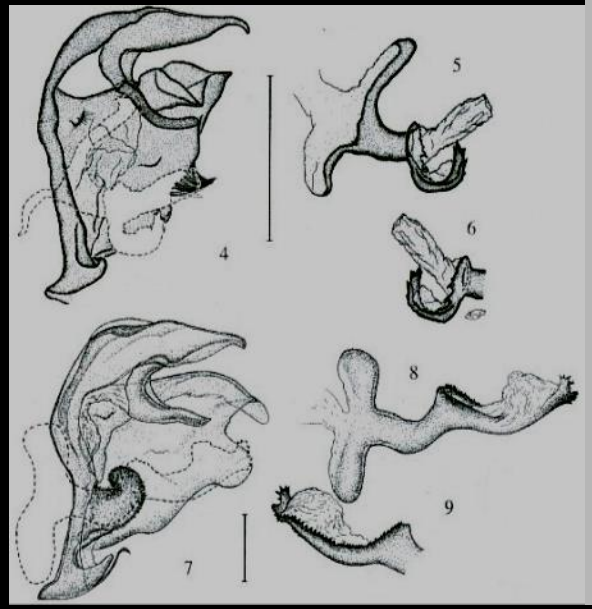
Leg Structure



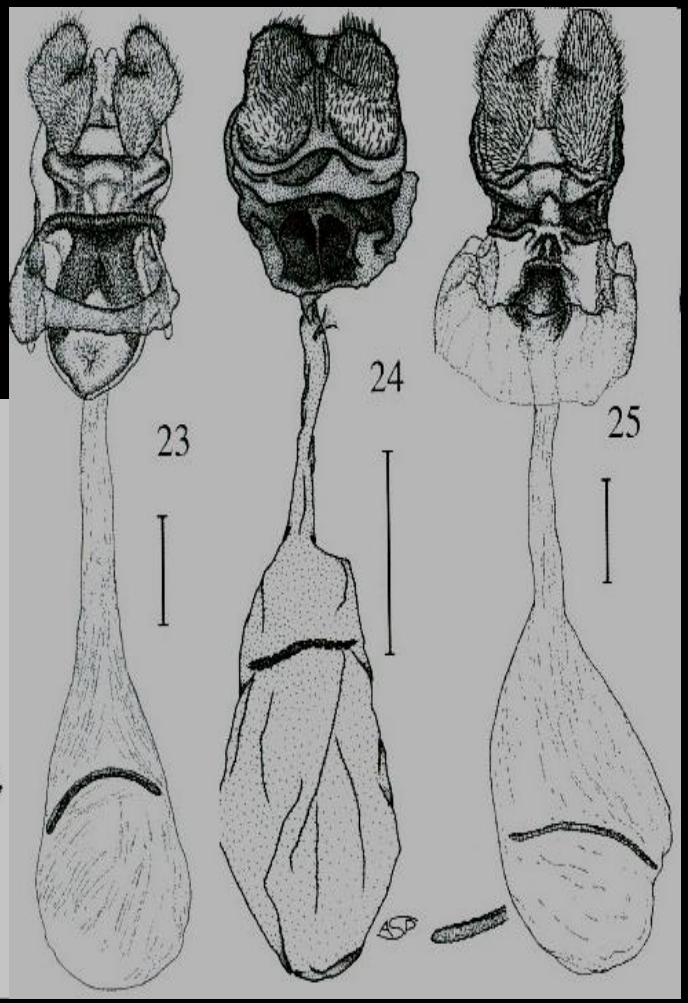
Frenulum

Species level identification





Male Genitalia



Female Genitalia

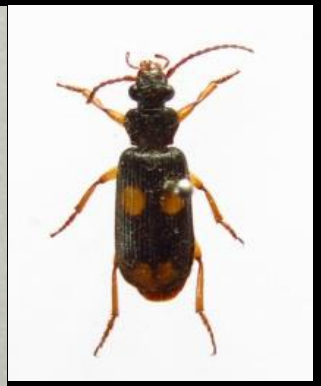
Wing Pattern

Results

***Mantispa sp.* (Order: Neuroptera, Subfamily: Mantispidae): First time record of this Subfamily from Uttarakhand. Recorded from Mix Riverine Forest patch at 2200m in Govind National Park.**

Number of species Recorded from the Study Areas

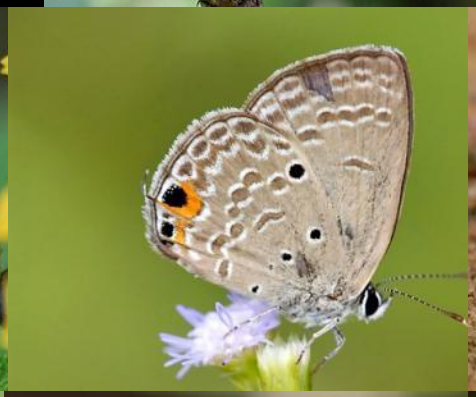
1535 Morphospecies were documented
(Moths , Butterflies and beetles)



Butterfly Families
Papilionidae (Swallowtails and Apollos)

Butterfly Families
Pieridae (Whites and Yellows)

Butterfly Families
Lycaenidae (Blues, Coppers and Hairstreaks)



Butterfly Families
Nymphalidae (Brush-footed Butterflies)

Butterfly Families
Hesperiidae (Skippers)

Moth Families
Pyralidae & Crambidae (Grass & Tussock Moths)

Moth Families
Pterophoridae, Cossidae & Limacodidae

Moth Families
Geometridae (Looper Moths)

Superfamily Bombycoidea (Bombycidae, Eupterotidae, Brahmaeidae, Lasiocampidae ,Saturniidae)

Arctiidae (Tiger Moths)

Noctuidae (Owl Moths)

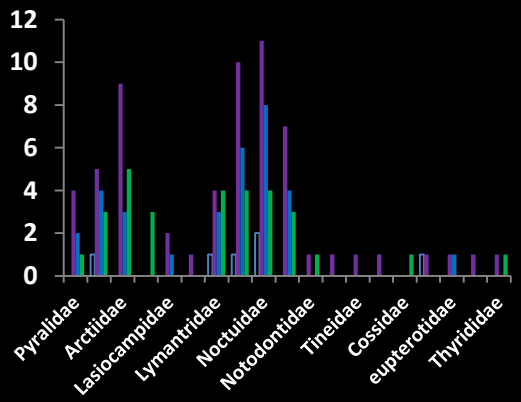
Family Drepanidae & Notodontidae

Beetles Species Recorded from Gangotri Landscape Area

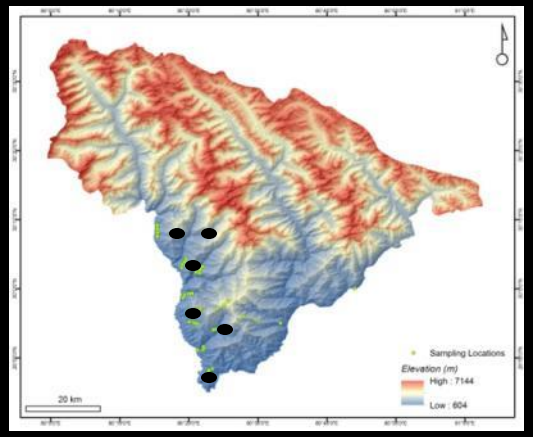
Findings on Moths study as Indicators

Subtropical Mix Forest, Askot (600m-1000m)

- Species Catch per trap night: Avg 84.5+-5.6
- Noctuidae major family
- Highest % of Sphingid moths (26%)



Representation of major Families



Major Sampling Locations in Askot Landscape

Agathodes ostentalis

Loepa katinka

Amplypterus panopus

Antherea assmensis

Rhyncholaba acteus

Aegocera bimacula

Actias maenas

Eudocima phalonia

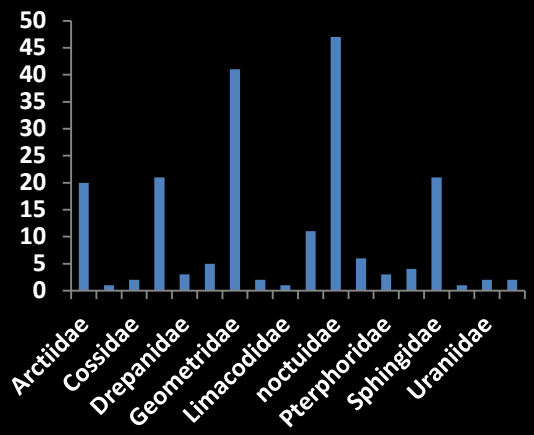
Phocoderma velutina

Nannoarctia obliquifascia

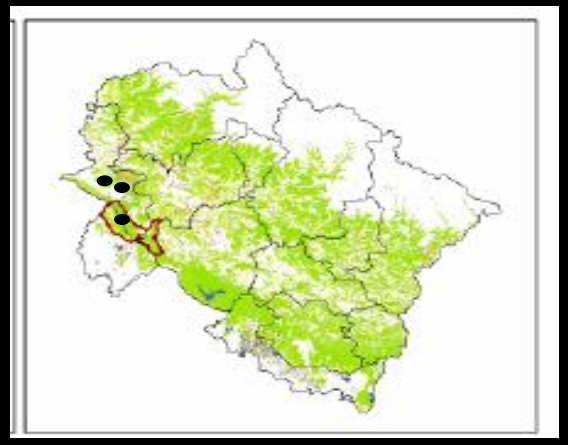
Asota ficus

Moist Sal Forest, Doon & Rajaji (600m-800m)

- Species Catch per trap night: Avg. 63.6+-6.7
- Noctuidae major family
- Highest Family Richness



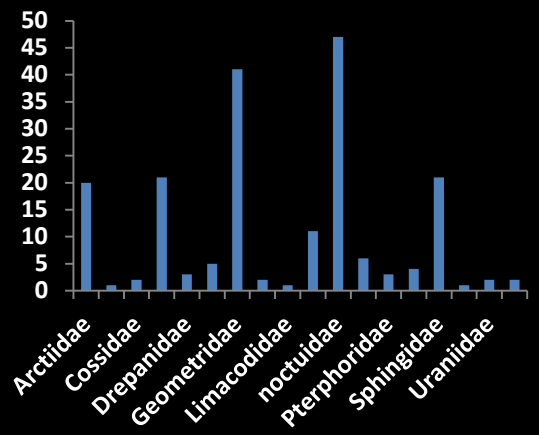
Representation of major Families



Sampling Locations

Tropical Deciduous Forest, Corbett (600m-1000m)

- Species Catch per trap night: Avg. 49.2+-3.1
- Noctuidae major family
- Highest Family Richness



Representation of major Families

Sampling Locations

Botyodes flavibasalis

Satoblephara parvularia

Antityrgodes sp.

Satoblephara parvularia

Zamarada symmetra

Psilalcis subfasciata

Neostauropus sp.

Anambulyx elwesi

Xyleutes mineus

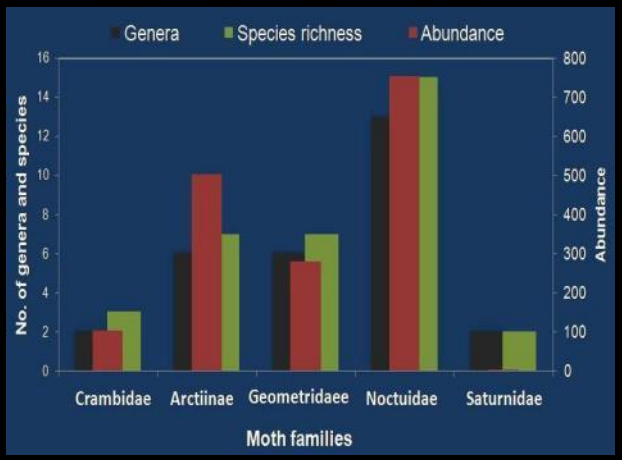
Attacus atlas

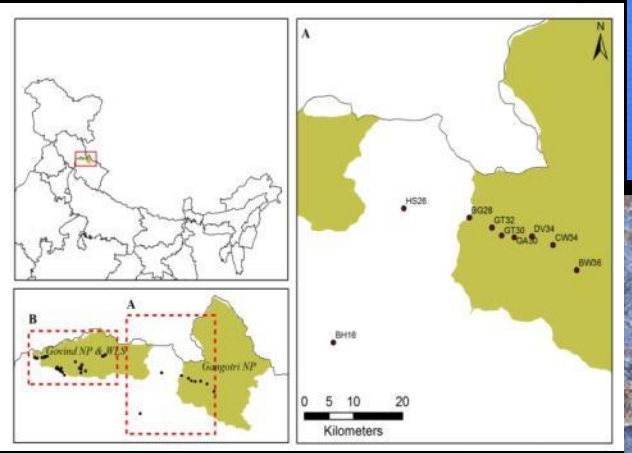
Catocala patala

Sarcinodes reductatus

Trans Himalayan Pasture, Gangotri NP (3500m-4500m)

- Species Catch per trap night: Avg. 16.2+-4.1
- Palaearctic faunal dominance
- Highest no. of species first record from Uttarakhand





Sampling Locations in Gangotri NP

Docirava aquiliniata

Ttrichopterygia rufinotata

Nordtromia duplicata

Calligula thibeta

Rhopalopsyche nycteris

Amphipyra cupriepennis

Erebitidia haderenoides

Chersotis harutai

Diarsia albipennis

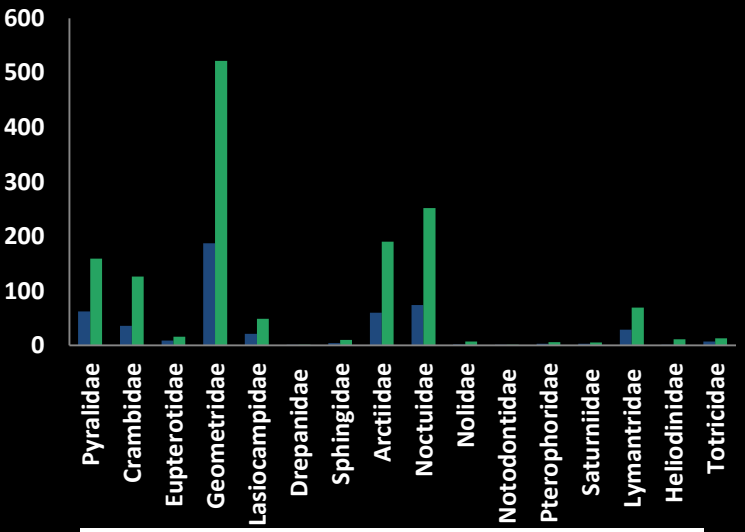
Diarsia nigrosigna

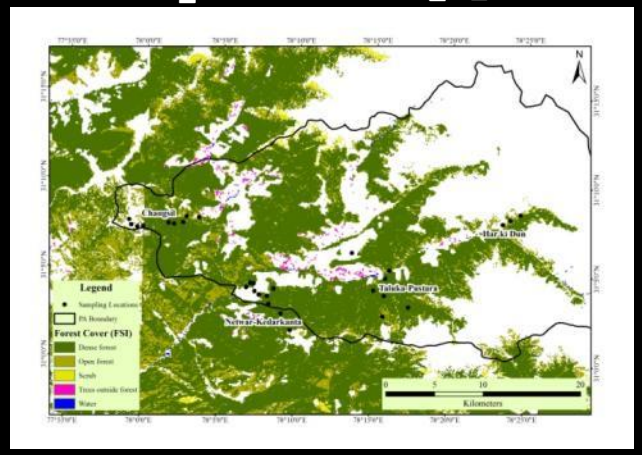
Polygrammodes sabelialis

Omeodes noctescens

Subalpine Forest, Govind NP (3000m-3500m)

- Species Catch per trap night: Avg. 98.4+-13.7
- Highest % of Indicator score
- Individual abundance recorded highest, in monsoon

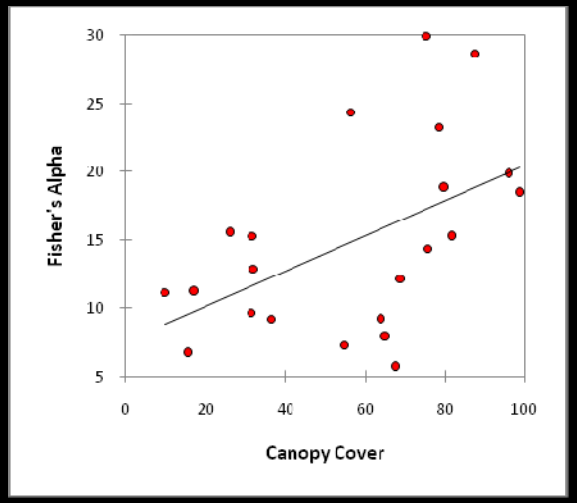




Sampling Locations in Govind NP

Western Mix Coniferous & Oak Forest, Govind WLS, (2200m-3000m)

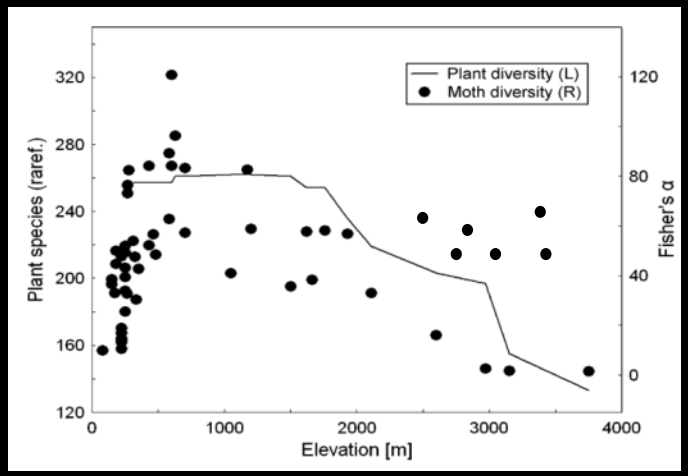
- Species Catch per trap night: Avg. 102.1+-14.7
- Highest Species Richness among all the major habitat types sampled, irrespective of all the indices
- Highest number of unique species recorded
- Geometridae most diverse family



Canopy Cover good predictor of Species Richness

Subtropical Broadleaf & Pine Forest (1200m-2000m)

- Species Catch per trap night: Avg. 94.1+-10.3
- Most incompletely sampled habitat with high numbers of singletons and doubletons
- Highest number of unique species recorded
- Maximum incidence of Fire-related disturbances



Plant species richness not a good predictor of moth diversity. Structural vegetation parameters are more important.

Odontopera Kametaria

Oresia emerginata

Callopistria albolineola

Menophra subplagiata

Scopula pulchellata

Tamindra ruptilinea

Euchera substigmaria

Auzata superba

Estigena pardalis

Chrysorhabdia bivittata

Leucophlebia lineata

Arcte corulae

New Species Record From India

Euphyia coangulata

Venusia classisigna

Venusia roseicosta

Gaurena dierli

Habrosyne conscripta

Homocentridia concentrica

Euplexia tibetensis

Heliophobus texturata

Haderonia culta

New Species Record From India

Phlogophora subpurpurea

Ebertidia haderonides

Xestia bdelygma

Euxoa hypochlora

Anaplectoides perviridis

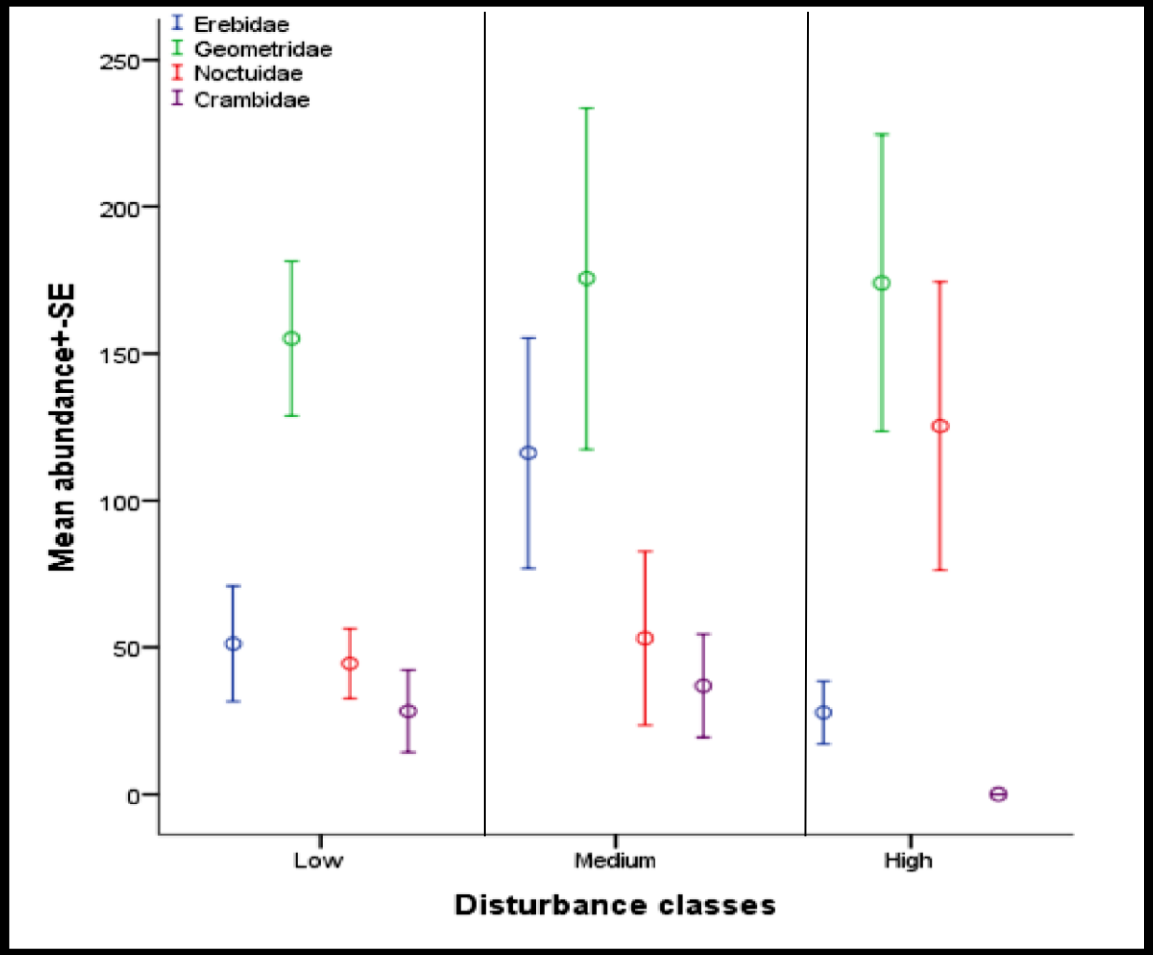
Estimata clavata

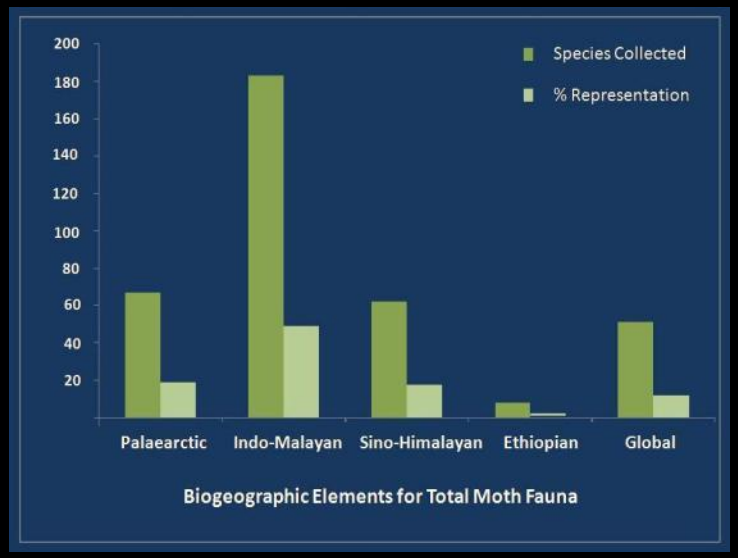
Nacna malachitis

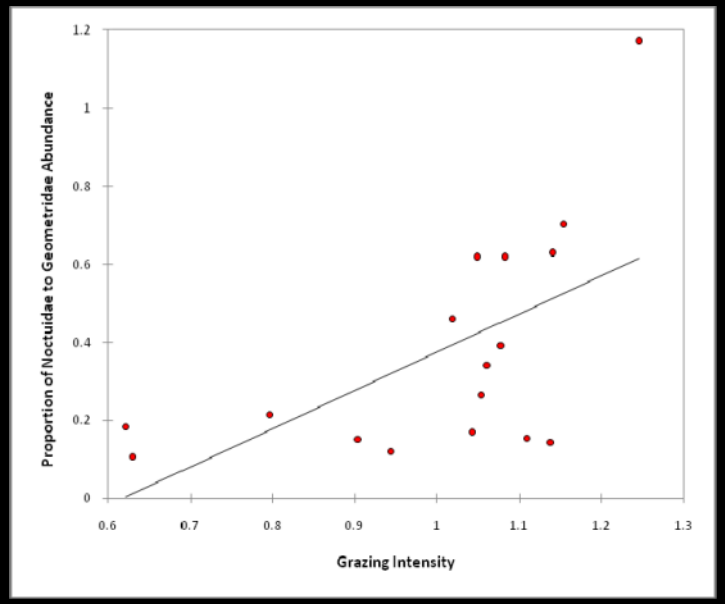
Pseudeustrotia dimera

Semidonta biloba

Significant Ecological Trends Valuable for Conservation output





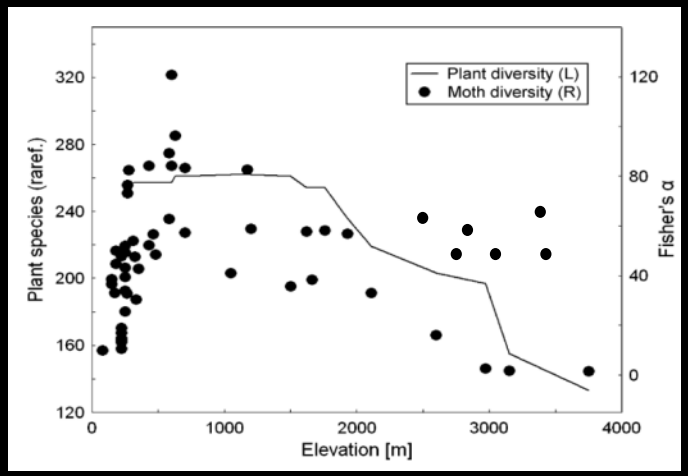


Noctuidae most sensitive family for assessing human disturbance

Proportion of Noctuidae to Geometridae good index for assessing Intensity of livestock grazing in forest habitat

Warm Temperate Forest (1200m-2000m)

- Species Catch per trap night: Avg. 94.1+-10.3
- Most incompletely sampled habitat with high numbers of singletons and doubletons
- Highest number of unique species recorded
- Maximum incidence of Fire-related disturbances



Plant species richness not a good predictor of moth diversity. Structural vegetation parameters are more important.

Odontopera Kametaria

Oresia emerginata

Callopistria albolineola

Menophra subplagiata

Scopula pulchellata

Tamindra ruptilinea

Euchera substigmaria

Auzata superba

Estigena pardalis

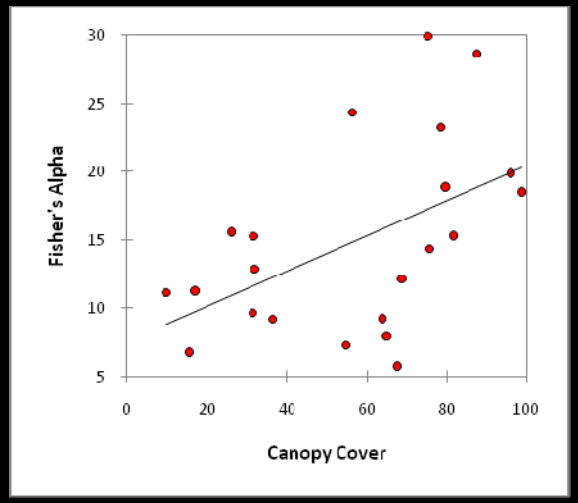
Chrysorhabdia bivittata

Leucophlebia lineata

Arcte corulae

Cool Temperate Forest (2200m-3000m)

- Species Catch per trap night: Avg. 102.1+-14.7
- Highest Species Richness among all the major habitat types sampled, irrespective of all the indices
- Highest number of unique species recorded
- Geometridae most diverse family



Canopy Cover good predictor of Species Richness

Pseudopanthera himalayica

Odontopera lentiginosaria

Spilosoma leopardina

Diptherocome fasciata

Mustilia sphiniformes

Stenorumia sp.

Cotachena histricalis

Hyaloplaga pulchralis

Perizoma seriata

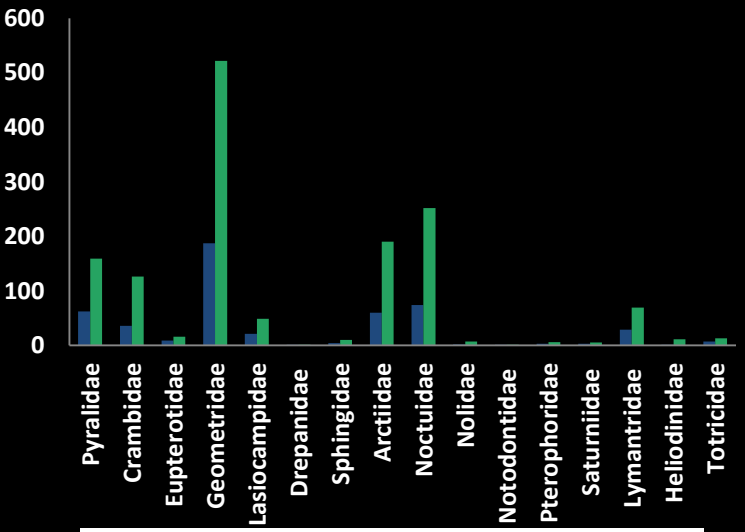
Xanthorhoe aurata

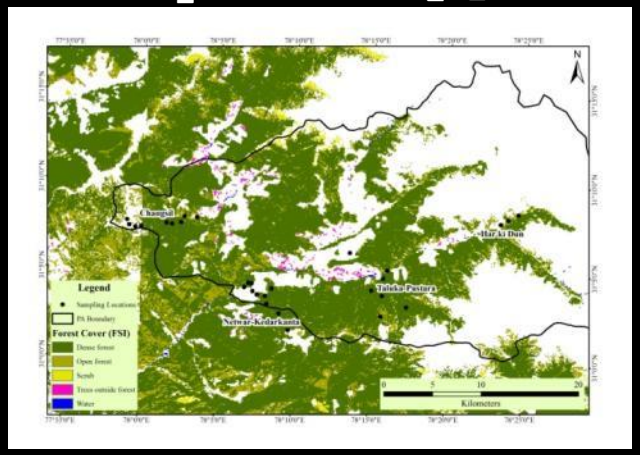
Oreta pavaca

Habrosyne conscripta

Sub - alpine Forest, (3000m-3500m)

- Species Catch per trap night: Avg. 98.4+-13.7
- Highest % of Indicator score
- Individual abundance recorded highest, in monsoon





Euphyia stellata

Hermonassa consignata

Diphtherocome pallida

Photoscotosia amplicata

Opisthograptis tridentifera

Hermonasa incisa

Haderonia culta

Euplexia thibetensis

Venusia classisigna

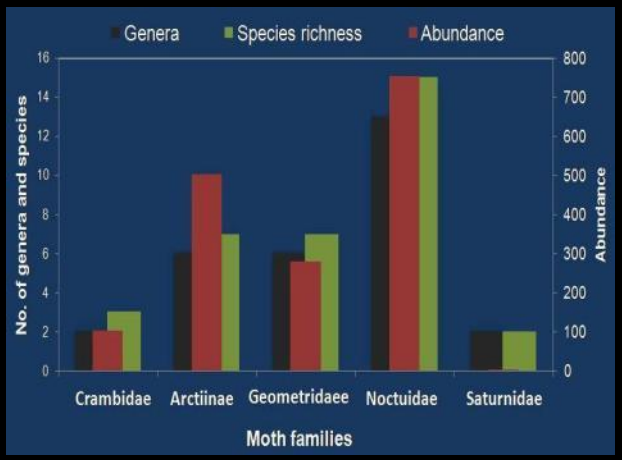
Eustroma chalcoptera

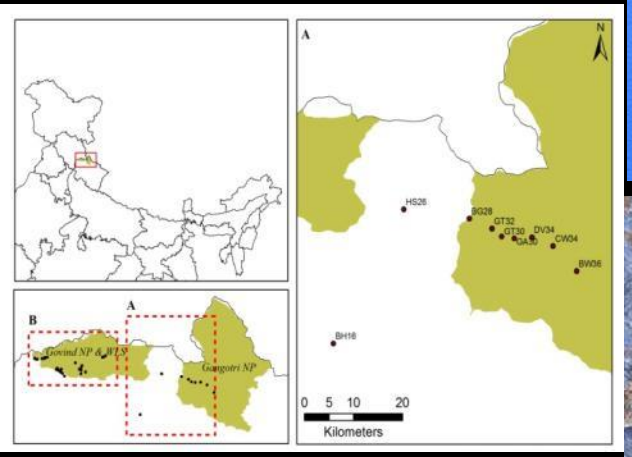
Opisthograptis sulpheura

Triphosa rubrodotata

Trans Himalayan Alpine Pasture, (3500m-4500m)

- Species Catch per trap night: Avg. 16.2+-4.1
- Palaearctic faunal dominance
- Highest no. of species first record from Uttarakhand





Docirava aquiliniata

Ttrichopterygia rufinotata

Nordtromia duplicata

Calligula thibeta

Rhopalopsyche nycteris

Amphipyra cupriepennis

Erebitidia haderenoides

Chersotis harutai

Diarsia albipennis

Diarsia nigrosigna

Polygrammodes sabelialis

Omeodes noctescens

Species Recorded First Time from the Region

Euphyia coangulata

Venusia classisigna

Venusia roseicosta

Gaurena dierli

Habrosyne conscripta

Homocentridia concentrica

Euplexia tibetensis

Heliophobus texturata

Haderonia culta

Species Recorded First Time from the Region

Phlogophora subpurpurea

Ebertidia haderonides

Xestia bdelygma

Euxoa hypochlora

Anaplectoides perviridis

Estimata clavata

Nacna malachitis

Pseudeustrotia dimera

Semidonta biloba

Indicator Species

- Species collected at lower altitudes are relatively more widespread than those collected at higher altitudes
- High incidence of locally restricted species in higher altitude areas
- Provides arguments why effective conservation of these threatened ecosystems is important

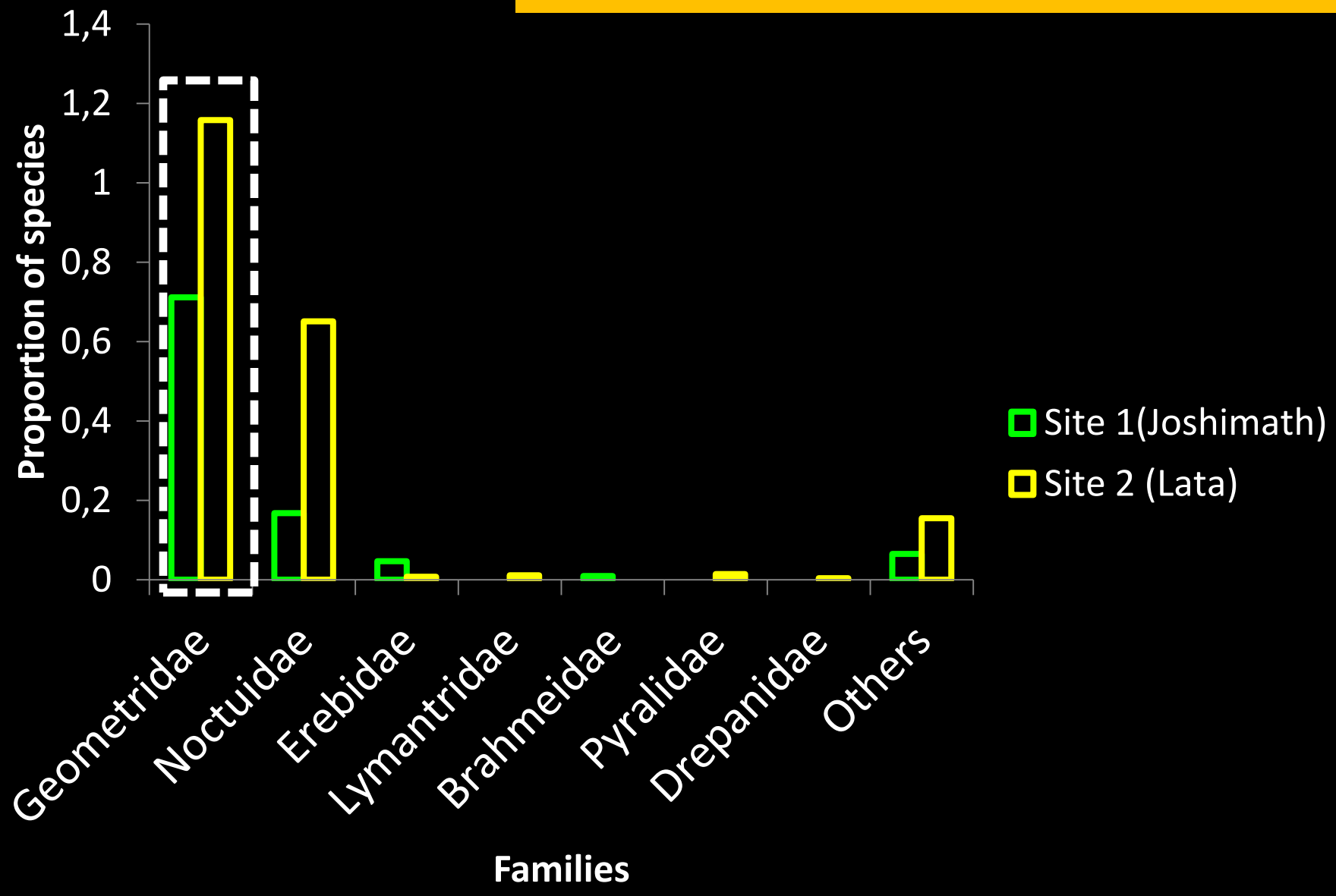
Low

Medium

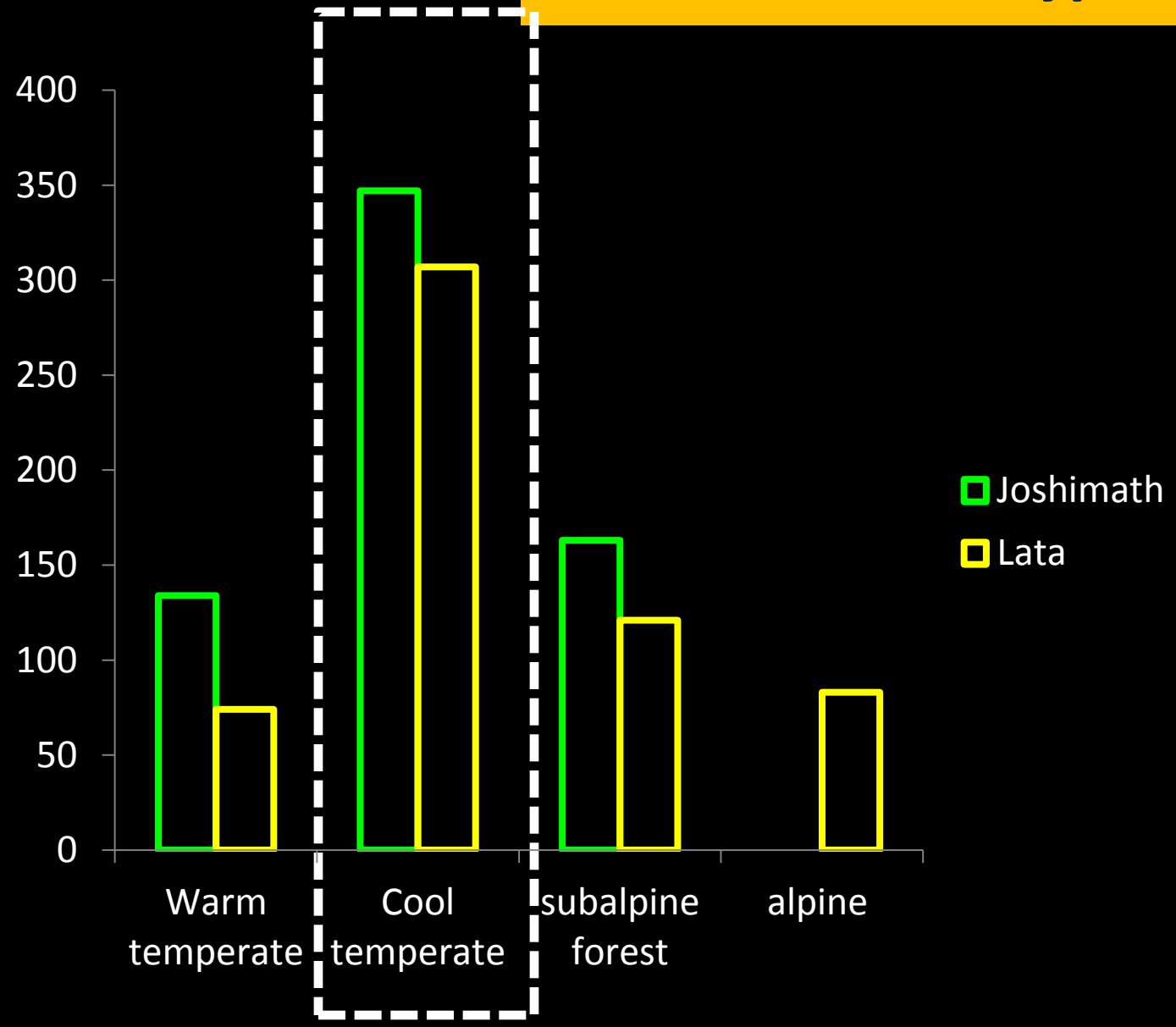
High

Suitable Disturbance Indicators, e.g. Grazing & Logging

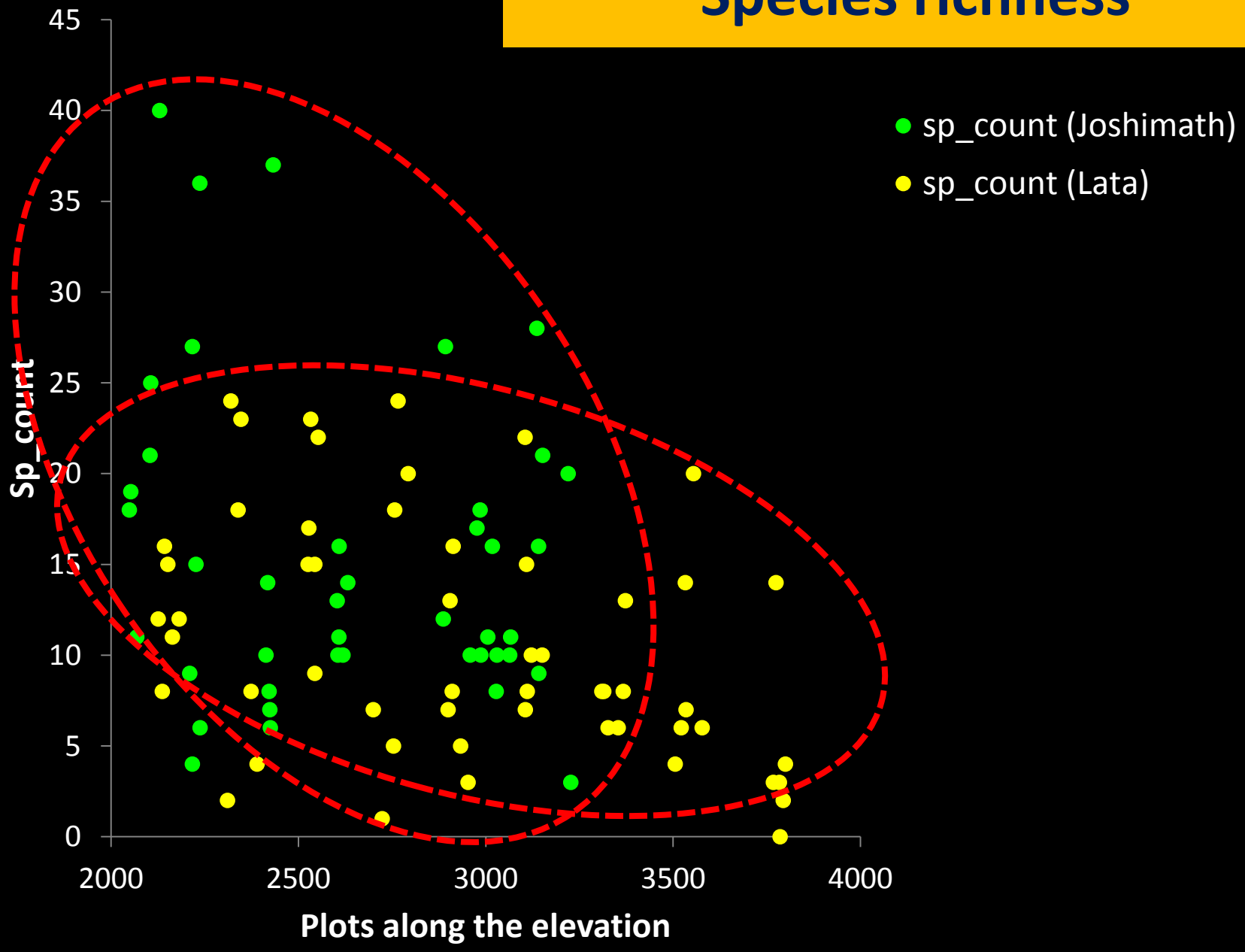
Family Abundance



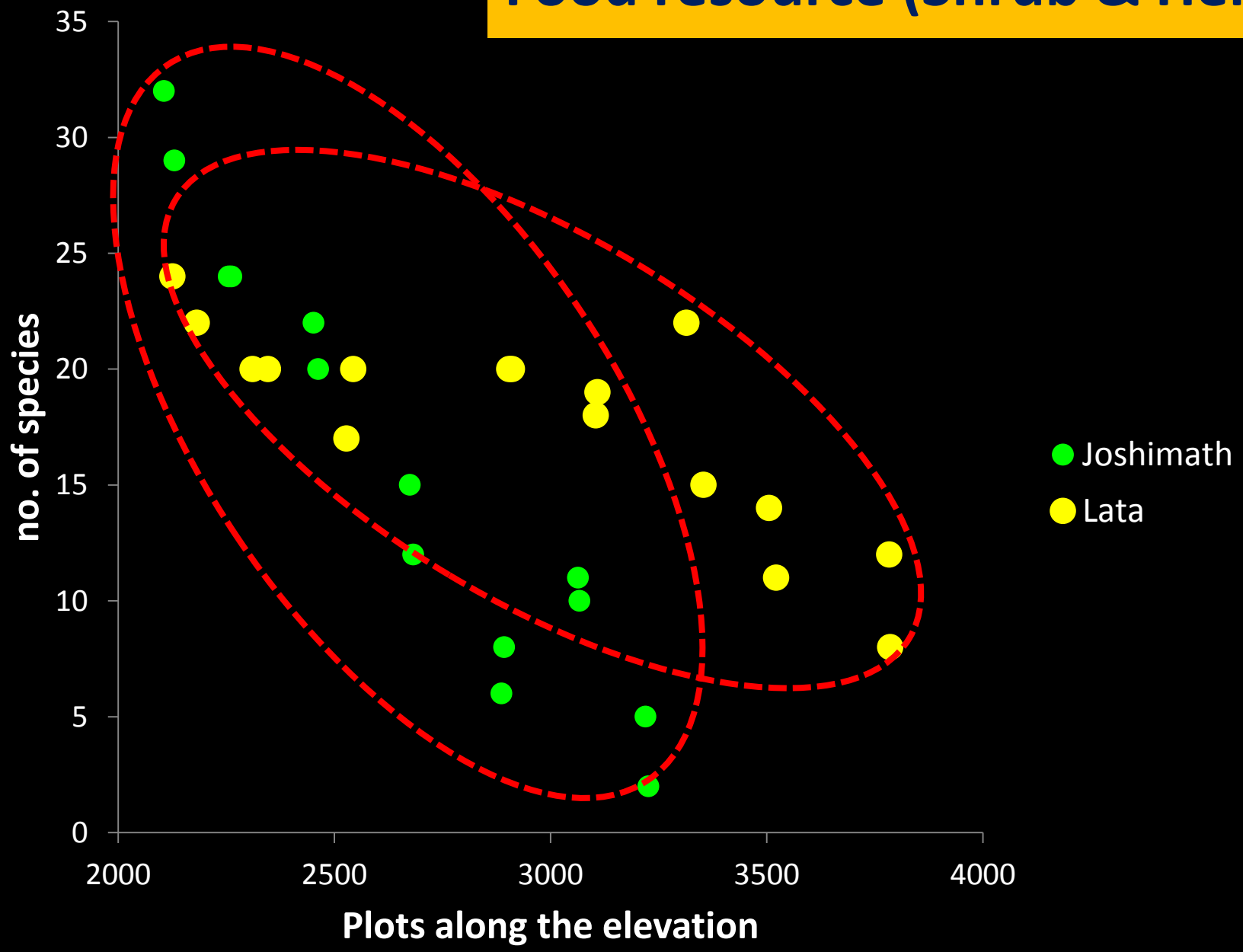
Forest Types



Species richness



Food resource (Shrub & Herb)



31 High Altitude Restricted Species Recorded

Biston falcata
(3000-3200m)

Euplexia tibetensis
(3000-3200m)

Anonychia lativitta
(3000m)

Photoscotosia metachryseis
(3000m)

Amsacta lactinea (3200m)

Venusia crassisigna
(3200-3600m)

Indicator Species for Different Disturbance Categories

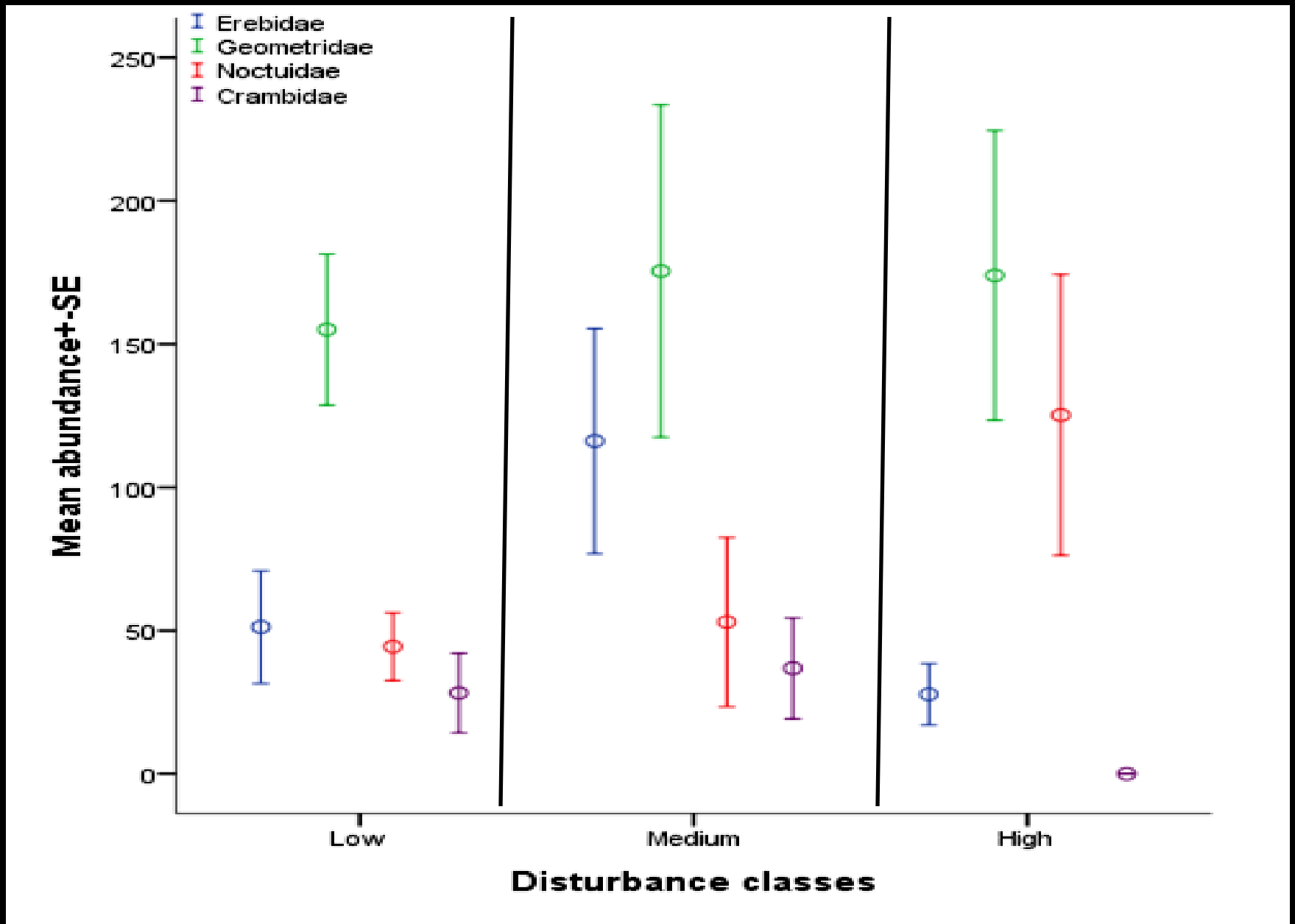
Disturbance Level	Species	Family	Indicator Val	Significance
Low	*Medasina albidaria*	Geometridae	76.8	0.0335
Low	*Heterolocha phaenicotaeniata*	Geometridae	76.1	0.1899
Low	*Percnia belluaria*	Geometridae	66.1	0.1432
Medium	*Panaxia similis*	Erebidae	80.4	0.0155
Medium	*Spilosoma obliqua*	Erebidae	80.2	0.0069
Medium	*Cymoriza ustalis*	Crambidae	65	0.0467
High	*Sirinopteryx longipennis*	Geometridae	84.1	0.0113
High	*Diphtherocome pallida*	Noctuidae	80	0.0417
High	*Anonychia violaceae*	Geometridae	76.3	0.0515
High	*Triphosa sp.*	Geometridae	76.1	0.015
High	*Colostygia albigirata*	Geometridae	71.5	0.131

Low

Medium

High

Mean abundance of four major families in three disturbance classes, viz. low, medium and high



Major Conservation Implications for Ecological change

- Conservation managers must be supported with quick and cost effective monitoring techniques and protocols for difficult taxa like insects.

- Integrated approach by sampling across multiple habitats and land use types using multiple data collection techniques can provide adequate assessment of indicator species in the Western Himalayan Landscape.

- The results presented and discussed here will help conservation planners and managers by aiding them in the selection of biodiversity rich areas and by giving attention to remaining fragmented habitats facing human alterations, which will increase biodiversity conservation efforts in the area.

Thank You……