

# Hilly Ecosystem of Pine Forest in Koraput- An Overview for Higher Faunal Diversity and their Conservation in Eastern – Ghats of Southern Odisha, India

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**Abstract:** The hilly regions of Koraput district in Odisha, India, form a vital component of the Eastern Ghats, characterized by diverse topography, rich biodiversity, and ecologically significant forest systems. Among these, the pine forests predominantly composed of *Pinus kesiya*—hold exceptional ecological, hydrological, and socio-economic importance. This study investigates the composition, functions, and challenges associated with the pine forest ecosystem in Koraput, focusing on their role in soil conservation, water regulation, carbon sequestration, and biodiversity preservation. The local flora fauna is conserved through participatory management of the local VSS and SHG women committee through ecotourism income generation and helping in conservation of wildlife species. The maximum tree girth of pine trees found in sample plot is 4 ft 10 inches and tree height is between 76-85 feet tall the forest shelters to maximum 15 reptilian and 56 avifauna species in relation to 15 wild mammals. The important critically endangered amphibians like Sacreed grove frogs and Jeypore gecko which are Critically endangered by IUCN. The sloth bear and leopard are the scheduled –I species under WPA1972 present in the pine forests of Koraput region.

## 1. Introduction

A pine forest is a type of coniferous forest dominated by pine trees (*Pinus* species). These forests are found in temperate and subtropical regions across the world, including North America, Europe, Asia, and parts of the Himalayas. The faunal diversity (animal life) in pine forests varies depending on the region, elevation, and climate, but in general, these ecosystems support a wide range of species.



**Photo -1** Landscape of the Pine forest foot hill at Eco-tourism site , Pine Resorts, koraput Forest division at outskirts of koraput town.

### Scope and Significance of this study

The research focuses on the ecological characteristics, biodiversity, and environmental dynamics of pine forests in the hilly regions of Koraput district, Odisha. Koraput is known for its undulating terrain and tribal communities, presents a unique ecosystem where pine forests play a crucial role in maintaining environmental balance. This study aims to explore the ecological significance of these forests; their interaction with local flora, fauna, and human populations. The scope also includes the impact of climate change, deforestation, and human activities on this fragile ecosystem, and explores sustainable forest management practices suited for the region.

There are research that examined how dispersal limitations and climate change influence pine invasions in treeless ecosystems, such as grasslands and shrub land. The study found that certain pine species can overcome dispersal barriers and establish in new areas, with climate change potentially facilitating these invasions. The authors recommend monitoring and managing pine invasions to protect native ecosystems ( Pauchard et, al. 2016).

This research holds considerable significance in the field of zoology and biodiversity conservation, particularly within the context of Eastern India's lesser-studied ecosystems. The pine forests in the hilly terrains of Koraput district form a unique ecological niche that supports a range of faunal species, some of which may be endemic, threatened, or poorly documented.

### Characteristics of Pine Forests

- **Dominant Vegetation:** Pine trees such as *Pinus sylvestris* (Scots pine), *Pinus ponderosa*, *Pinus strobus* (Eastern white pine), etc. other vegetation, simul, acasia, eucalyptus, mango, jackfruit, are also present in the pine forest.
- **Soil:** Often acidic and nutrient-poor due to needle litter.
- **Climate:** Can range from cold temperate to subtropical.

- Adaptations: Pines are adapted to fire-prone areas and often have thick bark or serotinous cones that open after fire.

#### Scope of the study

Through field observations, biodiversity assessments, and ecological analysis, this study aims to assess the current status and sustainability of these forests. The findings emphasize the urgent need for conservation strategies that integrate ecological preservation with local community welfare. This research contributes to the broader understanding of hilly forest ecosystems and serves as a valuable resource for environmental planning, policy formulation, and sustainable development initiatives in similar ecological contexts.

[https://pubmed.ncbi.nlm.nih.gov/?term=Serrao-Neumann+S&cauthor\\_id=36717471](https://pubmed.ncbi.nlm.nih.gov/?term=Serrao-Neumann+S&cauthor_id=36717471) There is study for study utilized remote sensing techniques to monitor the spread of invasive *Pinus caribaea* in Sri Lanka's Belihuloya region over two decades. The research demonstrated the effectiveness of satellite imagery in tracking invasive species and highlighted the ecological impacts of pine invasions on native biodiversity and water resources (Nandasena WDKV, Lars Brabyn, Salvia Serrao and Neumann, 2023).

There were analysis of forest fire frequency and impact in pine-dominated hill areas. It showed how dry pine needles and resin increase flammability, leading to recurrent fires that hinder regeneration and reduce faunal diversity (Singh, S.P. & Rawat, Y.S. 2000).

#### Overview of Pine forests in India:

In India the pine forests naturally are high altitude mountain forest in Himalayas, basically they grow in altitudes nearly 2200 to 5000 metre of altitudes in Himalayas. After reaching the peaks of above alpine meadows occur, then the fluctuating snow covers the peaks. The Pine forest is one of the important forest as the foliage is evergreen and leaf stays at the branches throughout the year. But maximum leaf fall is occurring during summer. However, the forest has the aesthetic values that no other forest gives in India. The soil is well protected due to spreading of leaf needles all along the forest floors. It keeps the soil moist and works as sponges for percolation of rain water to soil, increases soil fertility, regeneration of pine and other herbs, shrubs of various economic and ecological importance. The water recharge capacity of the pine forest is high and it avoids flooding by absorbing rain water precipitation and keeps longer time to release as ground water or as surface flowing rain water. So it controls heavily land erosion and prevents landslides like calamity in hilly and sloppy regions of the pine forest sites.

The major pine species found in India include Chir Pine (*Pinus roxburghii*), Blue Pine (*Pinus wallichiana*), and Khasi Pine (*Pinus kesiya*), each dominating different altitude and geographical zones across the Western Himalayas, Eastern Himalayas, and Northeast India.



**Photo-2** Landscape of hilly pine forests near Deoghati Bus stop in between Koraput and Jeypore town. Pine forests covered by scrub vegetation at foot hill.

While pine forests are often considered monoculture-dominated ecosystems, especially when compared to rich tropical rainforests, they are by no means barren or lifeless. In fact, these forests sustain a distinct and specialized faunal community that has adapted over time to the unique environmental conditions of the pine ecosystem. The fauna found in these forests range from large carnivores like leopards, to ungulates such as barking deer and goral, arboreal primates, and a wide variety of birds, reptiles, and insects.

The faunal diversity associated with Indian pine forests is shaped by several ecological factors:

- The canopy openness that allows sunlight to reach the ground,
- The presence of pine needle litter, which affects soil pH and undergrowth,
- The seasonal variability in temperature and moisture,
- And the proximity to mixed or broadleaf forests in transitional zones, which increases biodiversity.

There are study in Chhatisgarh Although this study focused on the Achanakmar-Amarkantak Biosphere Reserve, it provided insights into the growth performance of various pine species, including *Pinus kesiya*, *Pinus roxburghii*, and *Pinus oocarpa*. The findings indicated that these species produced viable seeds annually, with *Pinus roxburghii* achieving the best diameter growth in high-quality sites. These results offer comparative data relevant to similar ecological zones like Koraput (Nayak, A.P., & Banerjee, K. ,2019 and Nayak et al 2022).

Table 1 Geographical Spread of Pine forests in India :

Sl no	Region	Dominant Species	States
1	Western Himalayas	Chir Pine	J&K, Himachal, Uttarakhand
2	Eastern Himalayas	Blue Pine, Khasi Pine	Sikkim, Arunachal, Nagaland, Meghalaya
3	Central India (plantations)	Exotic Pines	Madhya Pradesh, Odisha
4	Southern Hill Tracts (very limited)	Exotic Pines	Tamil Nadu (Nilgiris), Kerala (Wayanad)



Common hawk cuckoo (Photo Credit Mr S K Malla)



Black Thrush male (Photo Credit Mr S K Malla)



**Black shouldered Kite** (Photo Credit Mr S K Malla)

### **Pine Forests in Odisha**

In Odisha, there are introduced pine plantations by the forest officers during 1968. The plantation as done in cooler and mountainous landscapes in Koraput, Kandhamal regions in elevations of 600-9050 meters. There are 5 species of pines that introduced to the Odisha climate and in world there are about 100 species of pine plants some reach 80-100 metres of height but the average height of trees are about 29 metres i.e , 93 feet high. Th adaptability of various tropical pine species in Koraput's climatic conditions. The research found that *Pinus caribaeavar. hondurensis* exhibited a survival rate exceeding 70%, indicating its suitability for the region. Additionally, the Changmai provenance of *Pinus kesiya* demonstrated favourable growth and survival rates, suggesting potential for plantation development. Mishra, P., & Raghavan, V. ,2008)

### **Pine forests in Koraput district.**

Koraput is a scenic, hilly district situated in the southern part of Odisha, India, bordered by the states of Andhra Pradesh and Chhattisgarh. Known for its rugged, hilly terrain, the region forms a part of the Eastern Ghats, and its diverse topography significantly influences the ecosystem. The district is primarily composed of hills, valleys, and forests, making it a remarkable area for ecological studies. Koraput is also home to a variety of ethnic groups, particularly indigenous tribes such as the Kondh, Paraja, and Gadaba, who have long relied on the forest resources for their livelihoods.

### **2. Study area**

Koraput district spans an area of 8,379 square kilometers, making it one of the largest districts in Odisha. Geographically, it is located between 18° and 19° North latitude and 82° and 83° East longitude. The district's topography is characterized by rugged mountains interspersed with inter montane valleys. Elevations in the hilly terrains range from 900 to 1,400 meters above mean sea level, with the highest peak reaching 1,620 meters. The average elevation of Koraput town itself is approximately 856 meters.

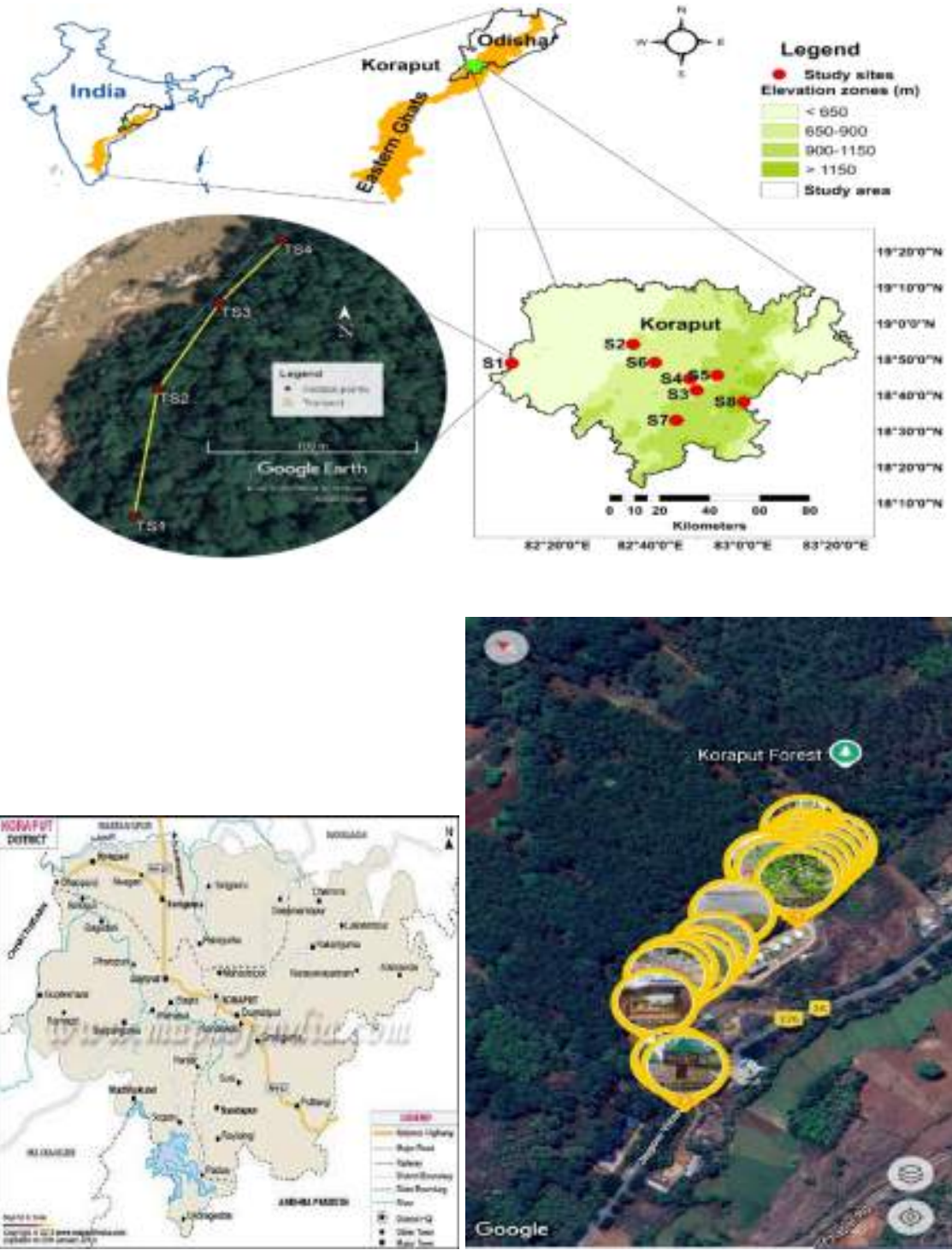


Photo-3 Maps of India, Odisha and Koraput district, Google map points of the study area.

The ecosystem proved food base for secondary consumer level are frogs, tree frogs like hyla and toads like bull toads. The insects provide food for the reptiles, frogs and some insectivorous birds are dragon fly, butter fly, white ants, honey bees etc. Tree association species are Simul, mango, eucalyptus, Champa, jackfruits, fig fruits, jamun, sandal wood Undergroths are Karipatta, *Butea suprba* ( latapalas, Kendu, ) creepers herbs Sugandhi, Ghontkoli( *Zizyphus moretiana*), the weeds are lantana, eupatorium, gazer grass.

**The Climate**

The climate of Koraput is typically tropical, with hot summers, a monsoon season that brings substantial rainfall, and cool winters. This variation in climate, combined with its elevation ranging from 300 to 1,000 meters above sea level, gives rise to diverse ecological zones, including deciduous, evergreen, and coniferous forests. Among these, the pine forests are a significant feature

of the landscape, often found in the higher elevations, with their towering trees and distinct undergrowth. This varied topography of Koraput creates distinct ecological zones, from lower-lying areas with fertile soil to higher, rocky ridges where the environment becomes harsher. The district is known for its mountainous features, such as the Dhamra hills, Sibadi hills, and Malkanagiri hills, which are all part of the greater Eastern Ghats range.

**Elevation Influence:** Both Deomali and Koraput are located in a hilly region (850-1,400 meters), which moderates temperature and increases rainfall compared to coastal Odisha. Summer 20°C – 35°C Moderate to warm. Nights remain relatively cool due to elevation. Monsoon 18°C – 28°C Cool and humid; cloud cover limits temperature extremes. Winter 5°C – 20°C Quite chilly, especially at night; mornings can see mist/fog.

**Hottest Months:** April to June **Coldest Months:** December to January

**Temperature Peak:** Around May, occasionally reaching 35°C

**Temperature Low:** Often drops to 5°C or lower in hillier areas during December January

**Rainfall Patterns -Season Rainfall (mm) Description**

**Southwest Monsoon (Jun–Sept)** 1,000–1,400 mm Accounts for ~75–80% of annual rainfall. **Post-monsoon (Oct–Nov)** 100–200 mm Light to moderate rain; tapering off. **Winter (Dec–Feb)** <50 mm Mostly dry with occasional drizzles. **Summer (Pre-monsoon) (Mar–May)** 50–100 mm Thunderstorms and convectional showers common. **Annual Rainfall:** ~1,300 to 1,600 mm

**Rainy Days:** ~80–100 days per year

**Humidity:** High during monsoon (70–90%), lower in winter (40–60%)

### 3. Materials Methodology

In the study site the sampling area near the eco resorts it was quite covetable during mid-day hours at 1-2 pm hen the team are engaged in different data collection in the silviculture garden. But at the same time it was unbearable hotness at downhill roadsides and the opposite west side hills are like burning sensations during peak noon hours. Early morning forest tracks are walked in the trails. Silence is observed everywhere during the fine forest survey. The tree girths and ocular height is observed in the field At least 15 trees of two species of pine are measured by a 6 feet length tape, the nests counting forests and their height from ground are also recorded. The bird species are recorded by using binoculars and reference book pocket guide book for Indian Birds Richard Grimet. The mammals are recorded by observations from the ground marks, scats, etc. half eaten forest mouse is seen in forest that may eaten by forest owls.

The soil is protected by leaf litters of the pine needles and kept the soil moisture enhancing regeneration of new pine young trees. Soil meso fauna like different insects, white ants which provide food base for varied birds and mammals in the fine forests.

The natural regeneration patterns of Chir Pine. It noted that fire and grazing significantly influenced seedling survival and growth. The study also highlighted the need for controlled burning and silvicultural practices to ensure sustainable forest regeneration (Negi, J.D.S. 1989).

There are studies to evaluated the performance of 12 provenances of Pinuskesiya from the Philippines, Thailand, Vietnam, Zambia, and Assam and Koraput. After nine years, the average survival rate was 47%, with mean height and diameter reaching 10 meters and 16 centimetre, respectively. The research highlighted significant variations in growth among different provenances, emphasizing the importance of selecting suitable seed sources for successful pine cultivation in Koraput ( Das, B.R. ,1982) .

### Objectives of the Study

1. **To analyze the ecosystem composition** of the pine forest in the hilly areas of Koraput district and its importance in climate resilience.

2. **To document biodiversity** (flora and fauna) associated with pine forest habitats in special reference to animal ecology in this region.
3. **To understand the socio-economic relationship** between local tribal communities and the pine forest ecosystem and their importances in ecosystem management and conservation.



**Photo 4-** Myself ( The 1<sup>st</sup> author) Measuring the tree girth at BDH- Brest depth height as a living and standing tree girth, height and girth is measures for the canopy cover of the forest.

The pine forest is a good carbon dioxide sinker in nature that should conserved and further propagated in this regions of Koraput district.

There were human induced increased wildfire activity in western U.S. forests, including pine-dominated ecosystems, to warming temperatures and earlier spring snowmelt. The study highlights the complex interactions between climate change and forest fire regimes, with implications for forest management and policy For Butterflies it is difficult to take photographs by mobile phone cameras as they were very motile. However dead butterflies were collected and photographed for identification (Westerling, A.L., et al 2006).

The Reptiles are recorded during survey and pre survey periods. Tree gecko, garden lizards, Rock lizards, forest skink were seen in the forest trails. Tree frogs and common land Toads are also playing an important role in Food web and Food chain in the pine forests. The Master predator Birds like Serpent eagles, Shikra, Owl and carnivore animal like Jackel are the top predators of the ecosystem.



**Photo-5** Research team members at Pine resorts with the forester and the co- authors.

The ecosystem study in the pine forests of Odisha is new one and innovated one. The animal ecosystem study aspects of animal diversity, conservation are new one and the work done in the fields of pine forest near Koraput is of great value.

Here are some observational materials we bring when studying exploring pine forest

#### **Basic tools for field survey : -**

- Note book & pen/ pencil: For recording notes, sketches, and observations. topo maps
- Camera & smart phone: to document flora, fauna, and landscape.
- Binoculars: for observing birds and animals from a distance.
- Measuring tape and ruler – for measuring pine needles, cones, or tree diameter

#### 4. Results and Discussion

Faunal Diversity Associated with Pine Forests near Koraput town are described as bellow in important animal class categories and lower invertebrate groups such as butterflies, other insects, land mollusc and soil mesofauna. Bird species comes from peripheral bald and podu affected hills to stay in cool and roosting in pine trees. There are observations that wetland dependent birds like cattle egrets, White breasted water then fly away from dry hills and summer paddy fields and take resting and feeding in pine forest grounds. 7-9 species of birds are also did nesting in the pine forests. The tall canopy provide umbrella like shed in the forests, the trees provide nesting to bigger birds like Crested serpent eagle (*Spilornis cheela*), Shikra (*Accipetter badius*). Other birds are seen in the forest area Cuckoo shrike, Cuckoo, Blackhooded oriole, Black drongo, White bellied drongo, Ashy drongo Red vented Bulbul , Rofus tree pie, Jungle crows, spotted doves, and Black thrushes. The reptilian species found are, tree gecko, rock lizards, forest skink, copper headed trinket , rat snake, cobra , tree snake/ vine snake.

The leaf litters fall in a sampling plot of 1 square metre of space is around 650 grams is in 10 square metre of land it is 6 kgs 500grams of leaf litter and in 100 square meter it is 65 kgs. And in 1000 square metre it is 650 kgs. In one Hectare i.e. 100m to 100m plot that equals to 10,000 sq metre it is 6500kgs of leaf litter having carbon sink from Earth atmosphere annually into surface of the forest. As the pine needles stay up to 2 years at tree and shaded randomly without mass leaf fall as in deciduous forest, this pine forest provides greenery throughout year and feels like evergreen vegetation. I provides much more aesthetic values other than deciduous forests in Odisha.

The details insights into Himalayan Forest ecosystems, including Chir Pine forests. The authors discussed the adaptive strategies of species in these ecosystems and emphasized their role in soil stabilization and water regulation. They also noted the limited biodiversity compared to broadleaf forests due to frequent forest fires and human activities (Singh, J.S. & Singh, Surendra Pratap. (1992).

**Table-2 The no of Pinus plants in the Koraput pine forest around the Pine resorts.**

Slno	Pine species	No of trees	Percentage	Vegetation type
1	<i>Pinus kesiya</i>	22360	43%	Most dominant
2	<i>Pinus caribaea</i>	16120	31%	Dominant
3	<i>Pinus occarpa</i>	6240	12%	Moderate
4	<i>Pinus gregil</i>	3120	6%	Nominal
5	<i>Pinus patula</i>	4160	8%	Nominal
6	Total	52000	100%	

There are sustainable management and conservation of pine forest both in Nepal and India. Although broader in scope, this study is relevant for pine forests in hill regions. It discusses how community involvement and decentralized forest governance, like India's Joint Forest Management programs, can help mitigate degradation and promote sustainable use of pine ecosystems (Agrawal, A. & Ostrom, E. 2001).

There are study highlighted the use of Chir Pine in daily life, including as a source of fuel wood, resin, and bedding material. The overexploitation of pine resources was linked to forest degradation and the need for integrating indigenous knowledge into forest conservation strategies.

There are utilized remote sensing techniques to monitor the spread of invasive *Pinus caribaea* in Sri Lanka's Belihuloya region over two decades. The research demonstrated the effectiveness of satellite imagery in tracking invasive species and highlighted the ecological impacts of pine invasions on native biodiversity and water resources (Nandasena WDKV et al 2023 ).

The research presented successful strategies for rehabilitating degraded pine forests. It emphasized the importance of introducing native broadleaf species, reducing grazing, and improving soil conditions to increase biodiversity and resilience.

This research projected the effects of climate change on the global distribution of pine species by 2070. The study predicts significant habitat reductions in certain regions, such as the Mediterranean Basin, while suggesting potential range expansions in northern latitudes. These findings highlight the necessity for adaptive conservation strategies to address shifting species distributions due to climate change (Salazar Tortosa, D., et al. 2024).

One of the paper Investigating the natural stands of *Pinus pinea* (stone pine) in western Turkey, this study emphasized their ecological uniqueness and the threats they face from human activities. The authors advocate for prioritizing these forests in conservation efforts to preserve their biodiversity and ecological functions ( Bonari, G., et al 2020).

#### I). Mammalian fauna in Pine forests of koraput.

Though not as diverse as tropical forests, pine forests support a variety of mammals, particularly those suited for hilly and temperate environments. There are more animals sighted and sheltering in summer from scorching heat in the nearby miscellaneous scrub forests . Birds like cattle egrets, crows, myna, starling myna spent more time in suburb pine forests more times during summer noon hours . The local resident birds also spent more time for cooling ness and go for feeding to miscellaneous forests during afternoon.

- i) Leopards (*Panthera pardus*) – Top predators in many pine forest regions- Occasional visits from Boipariguda and Malkanagiri forest area. The nearest forest patches for leopard occupancy is Deoghat forests of jeypore forest division.
- ii) Sloth Bear (*Ursus thibetanus*) – Found in mixed pine-oak forests
- iii) Barking Deer (*Muntiacus muntjak*) – Common in lower-elevation pine belts
- iv) Spotted deer (*Axix axis*)- Chital or chitra harina – Occasionally seen in undisturbed area , there are hunting pressure on spotted deer as it is diurnal, less adaptive to hilly and dense forests.
- v) Percupine- (*Hystrix hystrix*)I have direct encounter in a garbage dumping site and taking spate food when move on cycle on a winter late evening at Naktidongara and Pine resort.
- vi) Wild Boar (*Sus scrofa*) – Use pine forests for foraging on under growth corms, Yam. Taro, Grass roots, earthworms, other insects and white ants.
- vii) Langurs (*Semnopithecus entellus*) and Reshues (*Macaca mulatta*) Macaques – Including species like Rhesus Macaque, feeding on pine cones and forest fruits.
- viii) Indian hare- *lepus nigricolis*- faecal samples are seen in pine forest meadows and holes hives are seen under leave carpets in slopes and benith stone.
- ix) Three stripped ground squirrels (*Funambulus palmarum* ) are seen in the eco resorts and come to the lawn for taking the seeds of different trees, grass seeds and foods spate by workers.
- x) The white tailed wood rat (*Madromysblan fordi*) seen in the pine forest floor. one half eaten body of this species is seen under a tree during field study confiming nocturnal owl or dirnal rapter using this rat as prime source of food.

Table-3 of mammals and their IUCN status and Wildlife Protection status WPA 1972- (Amendment 2022)

Sl	Common Name	Scientific Name	Order – Family	WPA 1972 Status	IUCN Status	Remarks
1	Leopard	<i>Panthera pardus</i>	Carnivora – Felidae	Schedule-I	EN	Vocalization heard
2	Sloth Bear	<i>Melurusus ursinus</i>	Carnivora – Ursdae	Schedule-I	VU	Common distribution

3	Stripped hyaena	Hyaena hyaena	Carnivora – Hyanidae	Schedule-III	NT	Killed by villagers
4	Golden jackal	Canis aureus	Carnivora – Canidae	Schedule-I	LC	encountered in scrubs
5	Percupine	Hystrix hystrix	Carnivora - Hyaenidae	Schedule-IV	LC	Usual spotting
6	Wild pig	Sus scrofa	Artiodactyla – Suidae	Schedule-III	LC	Commonly seen
7	Barking deer	Moschiola	Artiodactyla -- Cervidae	Schedule-III	LC	Spot by sound
8	Spotted Deer	Axix aaxis	Artiodactyla -- Cervidae	Schedule-III	LC	Rarely seen
9	Indian Hare	Lepus nigricolis	Lagomorpha - leporidae	Schedule-IV	LC	Even seen on at night
10	Five stripped squirrel	Funambulus pennati	Rodentia - Talpidae	Schedule-IV	LC	Seen in lawn
11	Indian moles	Parascaptor leucura	Rodentia - Sciuridae	Schedule-V	LC	Seen in meadow
12	Small white bellied rats	Rattus indica	Rodentia - Muridae	Schedule-V	LC	Seen in caves
13	Small spiny mouse	Mus phillipsi	Rodentia - Sciuridae	Schedule-V	LC	Seen in meadow
14	Leaf nosed bat	Hipposideros galeritus	Chiroptera - Hipposidedae	Not scheduled	CR	Stone caves
15	Hanuman langur	Semnopithecus entellus	Primates- Cercopithecidae	Schedule-V	LC	Roadside / cropland s
16	Rhesus monkey	Macaca mulatta	Primates- Cercopithecidae	Schedule-V	LC	Roadside / temples

## II). Birds- Avifauna data base in Pine forests.

Pine forests are known for their rich avian life, especially insectivorous and seed-eating birds. They also form important corridors for altitudinal migrants.

- Flame back Woodpecker )
- Blue-capped Redstart
- Ashy Drongo and White bellied drongo
- Great Barbet
- Grey Partridges
- Blackshouldered kite
- Serpent Eagle

Birds often nest in the hollows of pine trees and feed on pine seeds, insects under bark, and small reptiles. Previously it was studied the bird diversity in Gupteswar biodiversity heritage site. For the first time it was recorded 120 species birds were recorded in that site (Das et al 2024) In the pine forest area the bird diversity is less than the moist deciduous and dry deciduous sal forests . but it attracts the birds for roosting during summer for extra coolness in around the peripheral scrub forests. The important bird species recorded are as follows.

There are international studies in Spain that analysed how planted and natural pine forests in Spain support bird diversity. Findings indicated that the contribution of pine plantations to bird conservation varies geographically and is influenced by the specific pine species and location. The study emphasizes the need for region-specific management strategies to enhance biodiversity in pine plantations (Martínez-Jauregui et al 2022).

Table- 4 Important Birds in Pine Forests o Koraput

Sl no	Common Name	Scientific Name	Order	Family	IUCN Status
1	Red Jungle fowl	Gallus gallus	Galliformes	Phasianidae	LC
2	Cattle Egrets	Bubulcus ibis	Pelecaniformes	Ardeidae	LC
3	Golden Oriole	Oriolus kundoo	Passeriformes	Oriolidae	LC
4	Large/ Indian Cuckooshrike	Coracina macei	Passeriformes	Campephagidae	LC
5	Jerdon's leaf Bird	Chlorosis jerdoni	Passeriformes	Chloropseidae	LC
6	Crested Serpent eagle	Spilornis cheela	Accipitriformes	Accipitridae	LC
7	Coppersmith barbet	Psilopogonhaema cephalus	Piciformes	Megalaimidae	LC
8	Large Cuckoo shrike	<i>Coracina macei</i>	Passeriformes	Campephagidae	LC
9	Banded bay Cuckoo	Cacomantis sonneratii	Cuculiformes	Cuculidae	LC
10	Yellow tits				LC
12	Malabar Trongon	Harpactes fasciatus	Tringiformes	Tringidae	LC
13	Jungle Owlet	<i>Glaucidium radiatum</i>	Strigiformes	Strigidae	LC
14	Pacific Emerald dove	Chalcophaps longirostris	Columbiformes	Columbidae	LC
15	Common hoopoe	Upupa epops	Bucerotiformes	Upupidae	LC
16	Perhia kite	Milvus migrans	Accipitriformes	Accipitridae	LC



Photo 6. Landscape of the Pine resort area showing canopy cover and Pinus kesiya trees.

**III). Reptiles and Amphibians( Herpetofauna)in pine forests:**

Pine forests, being drier and cooler, support fewer amphibians but are home to some reptiles.

Table-5 Reptiles of the Pine forests in Koraput

Sl no	Common Name	Scientific Name	Order	Family	IUCN Status	Remarks
1	Garden Lizard	Calotes versicolor	Squamata	Agamidae	LC	
2	Peninsular rock agama	Psammophilus dorsalis	Squamata	Agamidae	LC	
3	Skink	Lampropholis guichnoti	Squamata	Scincidae	LC	
4	Tree Gecko	Hemidactylus typhus	Squamata	Geckonidae	LC	
5	House Gecko	Hemidactylus flaviviridis	Squamata	Geckonidae	LC	
6	Bamboo pit viper	Trimerurus stejnegeri	Squamata	Viperidae	LC	open pine forests
7	Indian Cobra snake	Naja naja	Squamata	Elapidae	LC	open pine forests
8	Russell's Viper snake	Daboia russelii	Squamata	Viperidae	LC	open pine forests
9	Monitor Lizards	Varanus salvator	Squamata	Varanidae	LC	in foothill
10	Keeled Indian Mayuba skink	Eutropis craniata	Squamata	Scincidae	LC	Pine forest floor
11	Copper headed trinket snake	Coelognathus radiatus	Squamata	Colubridae	LC	In foot hill and jeypore town
12	Indian rat snake	Ptyas mucosa	Squamata	Colubridae	LC	In foot hill



Photo 7- Project scholars with forester and the co- author Goutam sir

**IV) Amphibians- frogs and toads- tree frogs in pine forests :**

Most of the hill streams are started from the interior part of the pine forests and flows down stream towards Deoghati region. the frogs and toads are the most important part of the food base for various carnivore reptile, birds and mammals. the cattle egrets also feed on frogs in the summer , the snakes, owls directly depends on frogs and toads for living. However the tree frogs have the greater escape from the predators by living in trees and sometimes entered to bathroom tubs , , water pots during summer for escaping heat and desiccation.

Table- 6- Amphibians of the Pine forest and nearest stream site near Deoghati

Sl no	Common Name	Scientific Name	Order	Family	IUCN Con Status	Remarks
1	Common Skimitor / skipping frog	Euphlectis cyanophlyctis	Anura	Dicroglossidae	LC	In stream beds ponds
2	Asian Common toad	Duttaphrynus melanostictus	Anura	Buffonidae	LC	In forest floor and stones
3	Indian Bull frog	Haplobatrachus tigerinus	Anura	Dicroglossidae	LC	In stream beds ponds
4	Common tree frog	Polypedates bengalensis	Anura	Rhacophoridae	LC	In forest and houses
5	Sacreed groove frog-	Raochrestes sanctisilvaticus	Anura	Rhacophoridae	CR	Found in ground scubs

**V) Insects and other invertebrates of the pine forests:**

Despite low understory growth, pine forests host a range of insect life that forms a critical food source for birds and small mammals. The honey bees are the part of the forest ecosystem and sometimes they build nests in buildings, high water tanks and watch towers close to Pine forests. local tribes collect honey in a rare and traditional way that they do catch the honey at night by treating with fire marshals and fly away the shoulders and drones bees , then they shed down the honey comb to down by ropes and gunny bags. They collect the honey by squeezing the combs at forest ground or at home in the next day. They keep the combs at bucket in order to collect the spillage honey . Adulteration is a part of honey business. They mix sugar or jugglery water in dense and mix with original honey in order to bring the volume more and weight.

- Bark beetles – sometimes causing pine dieback
- Butterflies and moths – especially during flowering seasons
- Ants, termites, and spiders – supporting ground-dwelling and arboreal fauna.

there no practice of latex or resin collection practices in the pine forests, however the local women SHG workers in the ecotourism complexes care the pine tree in the resorts from insect attack and dying of the trees due to disease.



**Photo7 – Survey team at information centre of the pine resorts, koraput.**



**Photo-8 Team of Scholars in sequences ( from Left- right of the Viewer, Manjula Pujari , Bharati Majhi , Pangya Priadarshini, Mousumi Nayak, Me- Udaya Kumar Das , Ambika Sethy Chandakiran Satapathy and sarta sona at pine Resort study area, Koraput**



Photo – 9 Cover photo of the MSc dissertation paper submitted to the university.

**Table-1 of photographs having Pine forest vegetation and leaf carpets in the floor**

	
<p><b>Photo- a-</b>Female cones Floerws (Fruits) witout dispersed seeds – Fertile flowers sta almost a year in the mother tree</p>	<p><b>Photo- b-</b>Male cones/ Flowers fall after seasonal flowering and fall after 2-3 months – Both male and female flower seen in a single mother tree.</p>

**Table-2 photographs having animals recorded in around Pine forest of Koraput region**

	
<p><b>Photo-i-</b> Five striped ground squirrel</p>	<p><b>Photo-ii</b> Road kill of a Russels viper young snake</p>
	
<p><b>Photo iii</b> Young Indian hare</p>	<p><b>Photo iv-</b> Young hatchling -Rock agma</p>



**Photo-v- Young hatchling -Rock agama Male**



**Photo vi- Keeled Indian Mabuya (Eutropis carnata)**



**Photo-vii Copper headed trinket snake**



**Photo-viii Indian Skimmer frog**



**Photo-ix -Rock agama( Rock calotees) Female**



**Photo-x tree Gecko- hatchling young**



**Photo-xi- tree frogs (Hyla)- Polypedates**



<b>bengalensis</b>	<b>Photo-xii- garden lizard – Calotees versicolor I Pine forest ground cover herbs</b>
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**Photo- 10 Spotting of a Emerald dove at Naktidongor, close to deoghati Pine forest- New record to Jeypore area.**

### **Conclusion**

Understanding the faunal composition and their ecological roles within this specific habitat contributes to filling crucial knowledge gaps in regional wildlife studies. The findings of this research will help in identifying species that are sensitive to environmental changes, thereby serving as indicators of ecosystem health.

Academically, the study contributes to the scientific literature on faunal ecology in hill forest ecosystems, providing a baseline for future research and ecological monitoring in the Koraput region and similar forested landscapes across India.

Though the pine forests is an introductory ecological landscape in Koraput, it provide ample aesthetic, recreational and conservation value to human and other wildlife species in this region. . The nearby scrubs are prone to encroachment, podu, ragi and maize cultivation, the pine forest indirectly provide income generation through promoting ecotourism. the interior undisturbed part of the pine forests provide safe resting place for bears and other wild animals. The Bear is an iconic species for conservation in Koraput region. the most part of the habitat is disturbed by hunting,

podu and dominance maize cropping. The maize production is commercially motivated by contract vendors like migrated crop hackers from Bihar, Andhra, and Maharashtra. They promote encroachment land tree cutting in standing peripheral trees and do cultivation. This practice should be stopped in a bureaucratic manner and ecotourism based livelihood should be practised. It will help to restore the local biodiversity and livelihood of the local tribal community.

### Acknowledgements.

The authors are highly acknowledged to Shri Suresh Panth, IFS Pr CCF and HOFF. Sir, for promoting research on wildlife and forest diversity in Koraput region. We are also grateful to Registrar for co-ordination in the work. We are also thankful to Sri Pratap Ku Behera, OFS SB DFO Jeypore for co-ordination in the field and logistics. We are also thankful to RAN Solar for little contribution in field logistics and publication expenditures. We are also grateful to other field persons for preparation of food and water. We are also great full to Silviculture staff of Forest dept Rayagada for encouraging in the research work.

**Citation as** - Das, U. K.; Sethy, A.; Majhi, B., Satapathy, C.; Pujari, M.; Nayak. M., ; Priyadarshini, P.; Sarita ,S.; Beniya ,G.; Nayak. A.P.- Hilly ecosystem of Pine Forest in Koraput-an overview for faunal diversity and their conservation in Eastern Ghats of Southern Odisha, India. ( April 2025)

**Conflict of Interests-** The authors have no conflicts of interests and have equal shares to the credits of the publications.

**Financial Support-** Director/ Prop Ran Solar, Pokhoriput, Bhubaneswar, Odisha

**Administrative Support-**, DFO Koraput division, DFO Silviculture division Rayagada, Registrar, Shri Maheswar Chand OAS and V. C, Prof Devi Prashad Mishra, VDU Jeypore, Odisha.

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