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### **RESEARCH ARTICLE**

#### **ENDEMISM, ETHNO BOTANY, AND INVASIVE ALLIED SPECIES OF ODISHA- A BIO-GEO-DIVERSITY STUDY.**

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#### **Abstract**

The aboriginal and ethnic people of Odisha in India are accustomed to living in most hostile and extreme climate under diverse meteorological conditions. The coastal state has immense rich biodiversity and possesses a rich ecosystem. The congregated bionetworks (marine, brackish, estuarine, inland and hilly) have different uniqueness in flora, fauna, aqua-fauna. Odisha, along the east coast of India is running parallel for 480Km to the Bay of Bengal including the largest brackish water lagoon Chilika and vast dry rainforests of the Eastern Ghats. The state has an area of about 155707 Km<sup>2</sup>, forest area recorded 51345Km<sup>2</sup> (31.38%) and home to about 7,000 plant species including 120 Orchids, 63 varieties of Mangrove trees constituting the state as second largest mangrove ecosystem in India. Many of the ethnic medicinal plants of the state which are not prioritized in the National Ayush Mission list have been investigated. The enumeration and preservation planning of endemic and threatened species of flora, fauna, avifauna of Odisha reveals that the coastal ecosystem is richer than inland ecosystem of Odisha.

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#### **Introduction:-**

Bio (living) diversity (variety) is the capriciousness among living species of different forms includes terrestrial, marine and other aquatic bionetworks and the ecological complexes. The biodiversity can have a direct or indirect impact on one ecosystem. The direct impacts are consumptive and productive uses whereas the indirect impacts are social, cultural, ethical, aesthetic and environmental services. The globe has 12 mega diversity areas and 35 biodiversity hotspots (covering 2.3% of the world's land) and lost 70-75% of its endemic habitats. India has four hotspots among them (the Western Ghats, Deserts, Eastern Himalayas, Indo Burma and Sunda Lands). India is ranked as the 7th megadiversity country with 4 mega centers and 26 micro-centers.

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**Biogeography of Study area:**

Odisha, (17° 49' N - 22°0 34' N Lat. & 81° 29' E -87° 29' E Long.) located in NE coast of India having geographic area 155707km<sup>2</sup> (4.7% of India), It has a population of 45.79 million in 2018 (predicted), and average population density 236person/km<sup>2</sup>. The state is rich in all types' biosystems and ecosystems area except deserts and snow **Fig 1**. Anthropocene Working Group (AWG) has claimed that the earth is in the great acceleration period of the Anthropocene Epoch based on biotic, geo-chronologic and chrono-stratigraphic changes. A basic distinguishing feature of geology/bio-geography/ecology of Odisha is in **Table 1**. The state is included in the Oriental biogeographic realm and is partly influenced by Palearctic realm. The state is adjacent to the Eastern Himalaya's mega- biodiversity zone.

**Table 1:-**Distinct feature of geology/geography/ ecology, Odisha (Rawat et. al., 2008<sup>[1]</sup>, Sharma et al ,2017<sup>[2]</sup>)

#	Division/geological construction	Dist. Unit	Area/ % state Km <sup>2</sup> / %	Forest cover Km <sup>2</sup>	Major ecosystem	Geological Formations
1	Coastal Plains, Phanerozoic, Cenozoic, Quaternary	11	40191/ 25.81%	7598	i.Brackish water lagoon mangroves Chilika ii..Bhitarkanika	Alluvial sediments, interstratified Quaternary
2	Northern Plateau, Precambrian, Proterozoic	04	28433 /18.26%	14046	Malayagiri(1188m), Mankarnacha (1177 m), Meghasani (1116 m) hill ranges	Granites, Iron, manganese, gold & base metals Meta-sedimentary/medium metamorphic grade
3	Central Tablelands, Mesozoic, Gondwana	07	37256 / 23.9%	10536	A central table, Rivers the Baitarani, the Brahmani and the Mahanadi	The river floodplains, sedimentary, low stratigraphy, coal deposits.
4	Eastern Ghats, Precambrian, Proterozoic	08	49,827 / 32%	17041	Mahendragiri (1500 m), Singh araju (1515 m), Turiakonda (1599 m), Deomali(1,673 m)	Granulites, Khondalites, Charnockite, Migmatite, Anorthosite, alkalinerocks

The aim of the present study is to report present status of species in Odisha. The research includes the listing of inland biodiversity and onshore marine biome of Odisha. Some selected enriched flora and fauna were studied which is less/poorly proclaimed places in Odisha. The investigation comprises of disclosing some poorly prioritized ethical medicinal flora and fauna of the state. . The summary of biogeographic information is in **Table -2**

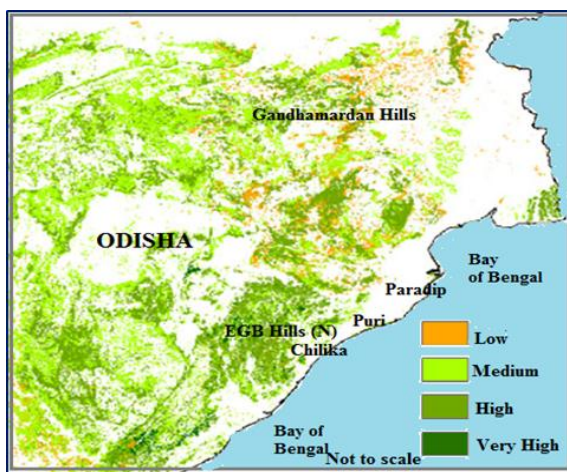
**Table 2:-**The demography, biodiversity and biogeographic Information, Odisha

#	The parameters	Unit	India	Odisha	% (India)	Remarks
<b>A</b>	<b>Demography</b>					
1	Geographical area	Km <sup>2</sup>	3287469	155707	4.74	No Snow & desert area
2	Coast line length	Km	7517	480	6.39	Under erosion and deposition
3	Mangrove wetland	Ha	6749	243	3.60	Sahu et al 2015 <sup>[3]</sup>
4	Population (2018)	Millions	1355.3	45.79	3.38	<a href="http://indiapopulation2018.in/population-of-odisha-2018.html">http://indiapopulation2018.in/population-of-odisha-2018.html</a>
5	Av. Popul <sup>n</sup> density	Popl./Km <sup>2</sup>	412.26	269.55	65.38	
<b>B</b>	<b>Forest</b>					
6	Forest cover (2017)	Km <sup>2</sup>	708273	51345	7.25	900Km <sup>2</sup> more w.r.t. 2015, <a href="http://fsi.nic.in/isfr2017/odisha">http://fsi.nic.in/isfr2017/odisha</a> , <a href="http://www.odishawildlife.org/">http://www.odishawildlife.org/</a> ,
7	Forest/treecover-17	Km <sup>2</sup>	802088	58136	7.25	
8	Coastal mangroves	Km <sup>2</sup>	<b>4921</b>	656 (2015)	13.33	
<b>C</b>	<b>Inland Species</b>	<b>Fauna</b>				<a href="http://www.wildlifeorissa.com/fauna-of-orissa.html">http://www.wildlifeorissa.com/fauna-of-orissa.html</a> as per IUCN report, Mishra et al, 2018 <sup>[4]</sup> . <a href="http://www.bsienvi.nic.in/Database/Status_of_Plant_Diversity_in_India_17566.aspx">http://www.bsienvi.nic.in/Database/Status_of_Plant_Diversity_in_India_17566.aspx</a> , <a href="https://fish.mongabay.com">https://fish.mongabay.com</a>
9	Mammals	Numbers	423	87	20.57	
10	Birds	Numbers	1232	479	38.88	
11	Amphibians	Numbers	342	20	5.85	
12	Fishes (fresh water)	Numbers	994	186	18.71	
13	Fishes (Marine)	Numbers	2546	1121	44.03	

14	Reptiles	Numbers	526	110	20.91	/data/India.htm, <a href="http://odishasbb.nic.in/index.php?option=com">http://odishasbb.nic.in/index.php?option=com</a>	
15	Endangered	Numbers	3022	288	9.53		
D	<b>Inland Species</b>	<b>Flora</b>					
16	Plant species	Numbers	≈18000	7000	38.89	ZSI 2013 for Odisha and ZSI 2014 for India statistics, <a href="http://cesorissa.org/soe/Bio-diversity">http://cesorissa.org/soe/Bio-diversity</a> . <a href="http://www.odishawildlife.or/adm">http://www.odishawildlife.or/adm</a> in ocument /complogo/Information,	
17	Orchids	Numbers	4011	120	2.99		
18	Mangrove Specis	Numbers	4011	63	1.57		
19	<b>Endemic Vertebrates</b>	Flora	Numbers	11264	142		1.26
		Fauna	Numbers	7781	695in2015	8.92	
20	<b>Endangered Verte- 2018</b>	Flora	Numbers	2781(201	134(2006)	4.82	<a href="http://odishasbb.nic.in/index.php?option=com">http://odishasbb.nic.in/index.php?option=com</a>
		Fauna	Numbers	675	74 (2006)	10.96	

### Literature review:

The vegetation of Odisha comes under four types: (i) Odisha Semi-evergreen forests (ii) Tropical moist deciduous forests (iii) Tropical dry-deciduous forests and (iv) Littoral and Tidal swamp forests Champion et al., (1968)<sup>[5]</sup> and Panigrahi (1983)<sup>[6]</sup>. Ethnobotanical uses of flora and fauna can be ascertained by the method of questionnaire Mallik et al 2012<sup>[7]</sup>. The mining processes cause deforestation and surface vegetation losses on a gigantic scale and finally cause an imbalance in ecosystem Kosmas C. et. al.,(1997)<sup>[8]</sup>. Traditional medicines were from the major floral and faunal system in human civilization, yet uses of some of the medicinal herbs yet unknown. It is important to know the medicinal use of humans and the plant and the animal kingdom Odisha is one among the biodiversity regions in SE Asia. Saxena and Brahmam (1995<sup>[9]</sup>,1996<sup>[10]</sup>) reported 2,727 species of plants under 228 families and 1062 genera of which 2561 species are Indigenous and 166 species are cultivated. This includes 141 species of pteridophytes under 41 families and 66 genera, 10 species of gymnosperms (3 Indigenous species), 124 species of orchids. Out of this 1831 species under 148 families and 747 genera are dicotyledons and 745 species under 37 families and 247 genera are monocotyledons Kumar S., 2011<sup>[11]</sup>.



**Fig 1:-**The forest map of Odisha and density of forests (place of Biological richness, Odisha)

About 200-300 species of plants have been added to the list of angiosperms and pteridophytes, bringing the total floral checklist to around 3,000 and Mishra et al., 2004<sup>[12]</sup> reported 132 species are from Odisha. Apart from angiosperms, gymnosperms and pteridophytes the lower cryptogams such as algae, bryophytes and lichens of Odisha were studied by a different researcher from time to time. Mohapatra et al., 2013<sup>[13]</sup>, had reported that 473 species of birds, 131 species of reptiles, 27 species of amphibians and > 600 species of fishes (marine and freshwater) existed in Odisha.

Biswal et. al, 2008<sup>[14]</sup> has reported that 117 taxa of flowering plants, nonflowering and ferns claim to the rank of Odisha biodiversity conservation. As per IUCN norms, 19 taxa of them are enlisted as threatened taxa while 7 were found to be near-threatened, 28 are vulnerable, 22 were data deficient and 21 were not evaluated. In terms of growth form these species represent 47 trees, 20 shrubs, 19 climbers, 27 herbs and 3 ferns. Amphibians are an indicator of ecosystem health as they are sensitive to variations in their environment Welsh et. al., (1998)<sup>[15]</sup>; Sheridan et al., (2003)<sup>[16]</sup>; Malhotra et. al.,(1999)<sup>[17]</sup>.

**Climate of the study area:-**

Odisha is a part to Indian peninsular subtropics with a tropical climate, sub-humid climate, the temperature variation of 10 to 45<sup>o</sup> C and 75 to 80% rainfall of amount 1450-1500mm occur due to Southwest monsoon during months June to October. The monthly potential evaporation is minimum 40- 45mm in January and maximum 320mm and more during the hottest days of May. The rivers in the area are rain fed and the largest river is the Mahanadi-Brahmani- Baitarani system which has an arcuate shaped delta of 9500 km<sup>2</sup> Mishra et. al., 2017<sup>[18]</sup>.

**Forests Odisha:**

Odisha has 480km coastline, 58,136 Km<sup>2</sup> forest area comprising of reserved forest (RF) of 26329km<sup>2</sup> (15%), protected forest (PF) of 15525 km<sup>2</sup>, and unclassified forest (UF) of 16282 km<sup>2</sup>. GIS studies, 2017, reveal that the state has increased 900 Km<sup>2</sup> of forests with the base year 2015 <http://www.fsi.nic.in/sfr/2003/orissa>. As per the report of Forest Survey of India, the forest cover in the state comprises of 48855Km<sup>2</sup> lying in the Eastern Ghats and Chhota Nagpur plateau which constitutes 31.38% of the geographical area of the state (**Fig 2**). Various forest categories of Odisha are given in **Table 3**.

**Table 3:-**Various forest types, category, area and % of Odisha and coverage in districts

#	Type of forest	Type	Area (Km <sup>2</sup> )	% state	Found in Districts
1	Semi Evergreen Forest	2B/C3	106.01	0.20	Mayurbhanj, Puri, Dhenkanal, Cuttack, Nayagarh, Gajapati, Koraput & Kalahandi.
2	2ndary moist bamboo Brakes	2/2S1	253.9	0.48	Mayurbhanj and Keonjhar
3	Southern moist mixed Deciduous (Monsoon Forest)	3B/C2	1142.8	2.15	Mayurbhanj and Keonjhar
4	Southern Secondary dry Mixed Deciduous Forest	38/2S1	351.6	0.66	Balangir, Kalahandi, Khariar, Sambalpur, Cuttack, Deogarh,
5	Peninsular (coastal)Sal Forest	3C/C1d	4.9	0.01	Mayurbhanj, Sundargarh, Sambalpur, Boudh, Sonapur
6	Moist Peninsular High level Sal	3C/C2e	2697.64	5.08	
7	Coastal mangroves		656	0.42	Balasore, Jagatsinghpur, Kendrapada, Puri

**Marine forest along Odisha Coast:**

Mangroves, the tropical coastal ecosystem is the tidal forests and most luxuriant near estuaries of rivers including trees, shrubs, creepers, ferns and palms. The onshore and estuaries of rivers the Brahmani and the Baitarani, the Bhitarkanika mangroves is ranked 2nd in India after Sundarban. The mangroves have also unique faunal diversity. The onshore coastal tract of Odisha is enriched with coastal vegetation. Chilika the brackish water lagoon has its unique fragile marine-brackish- fresh water ecosystem.

**Review of Literature**

The vegetation of Odisha are of four types: (i) Semi-evergreen forests (ii) Tropical moist deciduous forests (iii) Tropical dry-deciduous forests and (iv) Littoral and Tidal swamp forests **Champion et al., (1968)<sup>[5]</sup> and Panigrahi (1983)<sup>[6]</sup>**. The mining cause deforestation and surface vegetation losses on a gigantic scale and finally causes an imbalance in ecosystem **Kosmas C. et. al.,(1997)<sup>[8]</sup>**. Ethnobotanical uses of flora and fauna can be better ascertained by the method of questionnaire as traditional ancient uses **Mallik et al 2012<sup>[7]</sup>**. Traditional medicines were from the major floral and faunal system in human civilization, yet uses of some of the medicinal herbs yet unknown. It is important to know the medicinal use of faunal extracts, the different parts of plants and the avifauna kingdom of Odisha which is one among the important biodiversity regions in SE Asia. **Saxena and Brahmam (1995<sup>[9]</sup>,1996<sup>[10]</sup>)** reported 2,727 species of plants under 228 families and 1062 genera of which 2561 species are indigenous and 166 species are cultivated. This includes 141 species of pteridophytes under 41 families and 66 genera, 10 species of gymnosperms (3 indigenous species), 124 species of orchids. Out of this 1831 species under 148 families and 747 genera are dicotyledons and 745 species under 37 families and 247 genera are monocotyledons **Kumar S., 2011<sup>[11]</sup>**.

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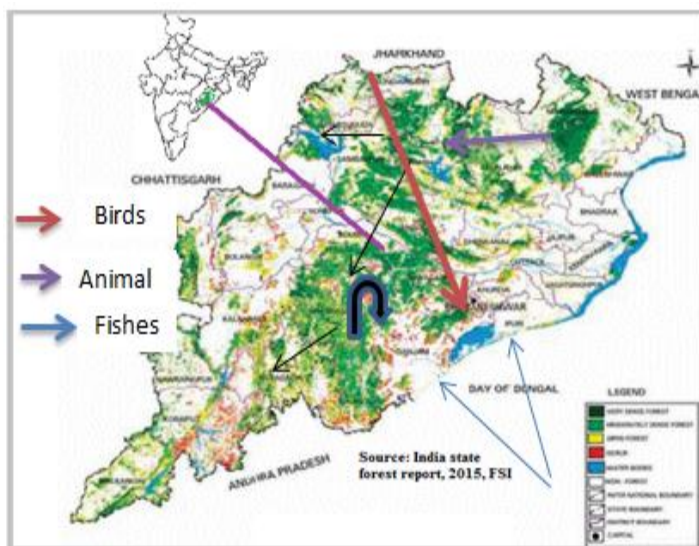


Fig. 2:- Index map of biodiversity of Odisha & their mobility

### Methods and Methodology:-

The old literature, electronic searches were made to enumerate the species. The strategic mega diversities places of Odisha were visited and the people-animal and human-plant interactions were studied. Photographic evidence was collected where the human-species interactions were noticed. During study, the authors visited most of the sites and collected photographs of the species where they found justified. They are of opinion that silent warriors are the common people who combat with the destroyers and poachers. They put their effort to protect and conserve the species both animals and plants. A list of local medicinal plants was collected with reference to a local book written by Rai Saheb Laxman Mishra IPS, which describes about some important and commonly available plants, herbs used by ethnic and primitive people to cure their diseases. It is also reported that some medicinal plants which are not prioritized by National Ayush Mission (NAM), India.

### Migration of flora and fauna in Odisha:

The flora and fauna of an ecosystem adjust to the climate, food and habitat availability. They migrate and adjust their lively hood according to their necessity. The faunal species leave the eastern Indian hills and enter the Raj Mahal Hills, and bifurcate. A group move west via Ramgarh Hills, Maikela range, Satpura range and Ajanta range, and finally enter the Western Ghats Hills belt join the species in hills of west India and move south. The other group migrates through the Garhjat Hills range and enters the Eastern Ghats Hills range and move southwards. Mostly the faunal species take the river bank courses for food and water.

The migratory avifauna takes their annual path (Palearctic route) and dwell for their fertilization during the winter season and even settle for seven-eight months till the chicks are capable enough to fly back to their native places. The large water bodies and their adjoining areas preferred in Odisha are Hirakud reservoir, Bhitarkanika and the Chilika lagoon by such migratory guest avifauna.

Similarly some species like red crabs, some tortoise and Irrawadi dolphin's priorotise Odisha's coastal ecosystem for their guest house in their live journey for food and hatching. The Odisha coast is one of the best hatcheries for

the Olive Ridley turtles, red crabs and some types of marine molluscs in the coast and the estuaries of the rivers. These turtles move far from Thailand coast (Sinda Lands) via Andaman Nicobar Islands to Bahuda, Rushikulya and gahiramatha coast and estuaries of the distributaries of the Mahanadi and the Rushikulya system. The red crabs (*Tachypleus gigas*) or Horseshoe crabs (found in Balaramgadi beach, Hukitola sands, Mahisali estuary, and Khandia estuary) in the northeast coasts of Balasore and even Puri - Chilika coast are popular places. These crabs move from Myanmar coast, reach Odisha via Tripura- Bangladesh- Calcutta.

#### Endemic floral species of Odisha:

About 5000 species of flowering and 320 species of food plants are endemic to India. Based on the location, topography, flora and fauna, Odisha Biodiversity Board (OBB) has recognized 20 major biodiversity clusters in Odisha. In total 48flora, 7types of shrubs, 7climbers, 6types of bamboos and canes, 3specis of mangroves, 18 varieties of mammals, 14types of birds and 16 types of reptiles are the endemic species of Odisha. The floral biodiversity of Odisha has 2,727 species of foliage including 228 families and 1062 genera. They contains indigenous (2561 species) and foreign (166 species). The floral kingdom consists of pteridophytes (141 species) of 41 families and 66 genera, 10 species of gymnosperms (3 Indigenous), 124 species of orchids. Saxena et al., 1995<sup>[9]</sup> and 1996<sup>[10]</sup>. Bhitarkanika, marine estuarine biome has recorded 72 species of plants comprising of numbers of species resulted as Tree (14), Herb (20), Shrub (16), Creeper (2), Climber (17), Fern (3) The list of endemic floral species of Odisha are in **Table 4**.

**Table 4:-**List of endemic floral species of Odisha (Source: Odisha Bio-Diversity Board)

#	Local Name	Botanical Name	#.	Local Name	Botanical Name
1	Achhu	<i>Morinda tinctoria</i>	25	Kumbhi	<i>Careya arboria</i>
2	Ambada	<i>Spondias mangifera</i>	26	Kusum	<i>Schleichera oleosa</i>
3	Arjuna	<i>Terminalia arjuna</i>	27	Lodha	<i>Symplocos recemosa</i>
4	Asana / Sahaja	<i>Terminalia tomentosa</i>	28	Mahala	<i>Ailanthus excels</i>
5	Ashoka	<i>Saraca indica</i>	29	Mahula	<i>Madhuca indica</i>
6	Bandhan	<i>Ougeinia oogenesis</i>	30	Mai	<i>Lanea coromondelica</i>
7	Bela	<i>Aegle marmelos</i>	31	Mankada Kendu	<i>Diospyros embryopteris</i>
8	Chandan	<i>Santalum album</i>	32	Nageswar	<i>Messua ferrea</i>
9	Char	<i>Buchanania lanjan</i>	33	Nimba	<i>Azadirachta indica</i>
10	Chhuin patuli	<i>angustifolium</i>	34	Nirmala	<i>Strychnos patatorum</i>
11	Dhauranja	<i>Holoptelia integrifolia</i>	35	Pahadi Sisoo	<i>Dalbergia latifolia</i>
12	Gambhari	<i>Gmelina arboria</i>	36	Phanphana	<i>Oroxylon indicum</i>
13	Genduli	<i>Sterculia urens</i>	37	Phasi	<i>Anogeissus acuminata</i>
14	Handiphuta	<i>Butea parviflora</i>	38	Piasal	<i>Pterocarpus marsupium</i>
15	Harida	<i>Terminalia chebula</i>	39	Piasal/ Bijasal	<i>Pterocarpus marsupium</i>
16	Hinjal	<i>Barringtonia acutangula</i>	40	Rakta Chandan	<i>Pterocarpus santalinus</i>
17	Jarasanda	<i>Litsaea sebifere</i>	41	Ritha	<i>Sapindus emarginatus</i>
18	Kamini	<i>Murraya paniculata</i>	42	Sahada	<i>Streblus asper</i>
19	Kangada	<i>Xylia xylocarpa</i>	43	Sal	<i>Shorea robusta</i>
20	Karada	<i>Cleistanthus collinus</i>	44	Salai	<i>Boswellia serrate</i>
21	Kasi	<i>Bridellia retusa</i>	45	Samarsinga	<i>Cordia macleodii</i>
22	Kendu	<i>Diospyros melanoxylon</i>	46	Simili	<i>Bombax ceiba</i>
23	Khaira	<i>Acacia catechu</i>	47	Teak / Sagan	<i>Tectona grandis</i>
24	Khirkoli	<i>Monilkra hexandra</i>	48	Tentuli	<i>Tamarindus indica</i>
SHRUBS			CLIMBERS		
1	Bana Tulasi	<i>Perilla ocmoides</i>	1	Akanabindhi	<i>Cissamplelos perira</i>
2	Bisalya Karani	<i>Tridex procumbens</i>	2	Atundi	<i>Combretum decandrum</i>
3	Kia Ketaki	<i>Pandanus tectorius</i>	3	Dantari	<i>Acacia torta</i>
4	Patalgaruda	<i>Raowolfia serpentine</i>	4	Guluchi	<i>Tinospora cordifolia</i>
5	Pengu- Lai Lata	<i>Celastrus paniculata</i>	5	Kankada	<i>Memordica dioica</i>
6	Sabai grass	<i>Eulaliopsis binata</i>	6	Siali	<i>Bauhinia vahlii</i>
7	Satabari	<i>Asparagus recemosus</i>	7	Takua Lai	<i>Vitis repanda</i>
HERBS			Bamboos/ CANES		

1	Apamaranga	Achyranthus aspera	1	Beta	Calamus tenuis
2	Bhuinnimba	Andrographis paniculata	2	Daba Baunsa	Bambusa Var-gigantea
3	Gheekuanri	Aloe vera	3	Dangi Baunsa	Schizostachyum pergracile
4	Kashatandi	Saccharum spontaneum	4	Kanta Baunsa	Bambusa bambos
5	Palua	Curcuma aromatica	5	Pani Baunsa	Gigantochloa robusta
6	Salaparni	Desmodium gangeticum	6	Salia Baunsa	Dendrocalamus strictus
7	Saptapheni	Opuntia dillenii	MANGROVES		
Mangroves			2	Hentai	Phoenix paludosa
1	Bani	Avicinia officinalis	3	Sundari	Heritiera littoralis

### Endemic faunal Biodiversity Odisha:

Odisha has its unique biodiversity present in its inland, marine and brackish water areas. It is estimated that 473 species of birds, 131 species of reptiles, 27 species of amphibians and more than 600 species of fishes (marine and freshwater) and 87 mammals including 18 flagships hosts the huge faunal biodiversity of Odisha whose details are given in **Table 5**.

**Table 5:-**List of endemic/Flagship faunal species of Odisha (Source: Odisha Bio-Diversity Board)

#	Local Name	Zoological Name	#		
	<b>Mammals</b>			<b>Birds</b>	
1	Asian Elephant	Elephas maximum Linnaeus	1	Adjutant Stork	Leptotilos
2	Blackbuck	Antilope cervicapra	2	Dalmatian Pelican	Pelecanus philippensis
3	Fishing Cat	Felis viverrina Bennett	3	Eastern White Stork	Ciconia ciconia boyciana
4	4 horned antelope	Tetracerus Blainville	4	Forest Spotted Owlet	Athene blewitti
5	Gangetic Dolphin	Platanista gangetica	5	Giant Heron	Ardea goliath
6	Gour	Bos gaurus	6	Indian Peafowl	Pavo cristatus Linnaeus
7	Honey Badger/Ratel	Mellivora capensis	7	Indian Skimmer	Rynchops albigollis
8	Indian Pangolin	Manis crassicaudata Gray	8	Large Whistling Teal	Dendrocygna bicolor
9	Indian Wolf	Canis lupus pallipes	9	Hair-crested Adjutant	Leptotilos javanicus
10	Irrawaddy Dolphin	Orcaella brevirostris	10	Malabar Pied Hornbill	Anthraceros malabaricus
11	Leopard	Panthera pardus	11	Osprey	Pandion haliaetus
12	Leopard Cat	Felis bengalensis	12	Shaheen Falcon	Falco pere. peregrinator
13	Finless porpoises	Neophocaena phocaenoides	13	White-bellied Sea Eagle	Haliaeetus leucogaster
14	Marbled Cat	Felis marmorata	14	White Spoonbill	Platalea leucorodia
15	Mouse Deer	Tragulus meminna		<b>REPTILES</b>	
16	Pallas's Cat	Felis manul Pallas	7	Indian Rock Python	Python molurus
17	Swamp Deer	Cervus duvauceli G.Cuvier	8	Ind. Soft-shelled Turtle	Trionyx Gangetic
18	Tiger	Panthera tigris Tigris	9	Indian Tent Turtle	Kachuga tecta
	<b>REPTILES</b>		10	Leatherback Sea Turtle	Dermochelys coriacea
1	Com. Ind. Monitor	Varanus bengalensis	11	Mugger	Crocodylus palustris
2	Desert Monitor	Varanus griseus	12	Olive Ridley Turtle	Lepidochelys olivacea
3	Gharial	Gavialis gangeticus	13	Peacock shelled Turtle	Trionyx hurum
4	Green Sea Turtle	Chelonia mydas	14	Saltwater Crocodile	Crocodylus porosus
5	Hawksbill Turtle	Eretmochelys imbricate	15	Water Monitor	Varanus salvator
6	Ind.Flap-shelled Turtle	Lissemys punctata	16	Yellow Monitor	Varanus flavescens

### Coastal Marine Biodiversity Odisha

The coastal track was covered including the mangroves and the ( the brackish water lagoon, Chilika 1011 Km<sup>2</sup> Mishra S. P., (2016)<sup>[19]</sup> and estuarine backwater at Bhitarkanika (672 Km<sup>2</sup>) and Gahiramatha (1435 Km<sup>2</sup>). About 1121 marine fishes of 166 families are found in Bay of Bengal in the onshore and offshore coastal zones of the east coast of India. The endemic and threatened species of aquafauna found along the east coast are 51 and 63 species respectively Mishra S. S. et al (2013)<sup>[20]</sup>. Coastal Biodiversity of India has marine flora algae (844 species), Seagrass (14 species), Mangroves (39 species), flora (420 species), fauna (1862 species), Crustaceans (2934 species),

Molluscs (3370species), Echinoderms (765species), Corals (218 species), Fishes (2546species), Reptiles (31 species) and mammals (28species) including Irrawadi and Ganga river Dolphins and Dungang.

Odisha has a 480km coastline, 26000 Km<sup>2</sup> continental self, 73 landing centers and 815 fishing villages. Odisha has marine fish production of 293869 MT (2013-14) (Statistics Dept, GOO, 2016). Amidst the deltas of the rivers Brahmani and Baitarani there is a large patch of mangroves which is ranked 2nd in India after Sundarban. The list of coastal biodiversity areas (ICMBAs) given by Saravanan et al., (2013)<sup>[21]</sup> is updated and given in **Table 6**

The state, Odisha is rich in species in species like mammals, birds, freshwater fishes and reptiles (vertebrates). The plant and birds species diversity is very high (>38%) in comparison to most of the coastal states of India. The marine ecosystem of Odisha possesses 261 species of fishes, 34 species of crabs and 28 varieties of prawns living in the Chilika and Bhitarkanika. A total of 695 species, out of which amphibians (20), reptiles (110) including 3 crocodiles, 479 aves and mammals (86) have been enlisted in Odisha. About 54 species comprises of reptiles (17), birds (15) and mammals (22) are reported threatened as per criterion of IUCN Red Data Book. Rare species like white crocodiles, Irrawaddy Dolphins, Olive Ridley sea turtles are the marine species for which Odisha attracts Lakhs of tourists.

**Table 6:-**Coastal and Marine Biodiversity Areas (ICMBAs) in Odisha (Saravanan et al 2013)

District	Identified estuary	Lat. North	East	Forest Km <sup>2</sup>	Area (Km <sup>2</sup> )	Suggested category
Balasore	Talseri- Udaipur	21 ° 36.340	87 ° 28.842	1.35	3.5	Cons. / Comm. Reserve
Balasore	Hukitola Island	21 ° 33.720	87 ° 24.281	7.76	38	Cons. / Comm. Reserve
	Chandipur	21 ° 27.071	87 ° 02.413		81.56	Cons. / Comm. Reserve
Bhadrak	Dhamra/karanjmal	20 ° 51.152	86 ° 56.835	29.35	90	Cons. / Comm. Reserve
Kendrapara	Bhopali	20 ° 29.600	86 ° 44.584	51.24	30	Com. / Cons. Reserve
	Jambudweep	20 ° 24.075	86 ° 43.260		95	Cons. / Comm. Reserve
J.singhpur	Paradip	20 ° 15.530	86 ° 40.736	149.87	260	Cons. / Comm. Reserve
Puri	Devi	19 ° 58.810	86 ° 19.528	3.46	88.38	Cons. / Comm. Reserve
Puri	Chilika/Nalabana	19 ° 41.336	85 ° 17.659	1.0	15.53	Wildlife Sanctuary
Ganjam	Rushikulya	19 ° 22.799	85 ° 04.355	30.74	18.85	Marine protected area

#### Brackish, marine and inland biodiversity, Odisha:

About 800 types of faunal species including 24 mammalian and 37 species of amphibians and reptiles are harboring in the lagoon including Dugong (Dugong dugon), Irrawadi dolphins, Green sea turtle (Chelonia mydas), Limbless skink (Ophiomorus punctatissimus) and Fishing cate (Prionailurus viverrinus) as the rare and anadromous species and the faunal and floral distribution in Marine, brackish and inland. A comparison of the richness of flora and fauna indicate the wetlands and the estuarine mangroves have a better distribution of flora and fauna than inland hills of Odisha **Table -7**.

**Table 7:-**The distribution of flagship species in marine, brackish water and inland hills of Odisha

#	species (2016) Chilika (brackish)	Types/Number	#	Bhitarkanika, 2014 Species (marine)	Number	#	Species Similipal (Inland)	Number
A	<b>Vertebrates</b>		B	Vertebrates		C		
1	Mammals	24	1	Birds	76268	1	Mammals	42
2	Crocodiles	04	2	Crocodiles	700	2	Elephants	432
3	Amphibians	37	3	Spotted deers	1872	3	Birds	264
4	Marine	150	4	Wild boars	1213	4	Amphibians	12
5	Freshwater	27Fish, 2 prawn	5	Monkeys	1522	5	Reptiles	29
6	Brackish	119	6	Jackals	305	6	Fishes	37
7	Prawn	28	7	Langur	39	7	R. Bengal Tigers	99
8	Crab	38	8	Otter	38	8	Fishes	66
9	Fish	261	9	Reptiles	217	9		
10	Dolphin Irrawaddy	152,(2017)	10	Dolphine	45	10		



11	Bottle nose	12	11	Bottle nose	92	11		
12	Raptors	14	12	Sambar	17	12		
13	Birds	≈ 1 million	13	Jungle cat	11	13	Plants, Reserve area	≈3000
14	<b>Plants</b>		14	Fox	10	14	Plants	1076
15	Flowering	726	15	Wolf	7	15	Orchids	96
16	Grasses	05	16	Mongoose	7	16	Medicinal plants	≈200
17	Mangrove Artificial	1.48Km <sup>2</sup>	17	Fishing cat	3	17		
18	Phytoplanktons	128 species	18	Hyena	1	18		
19	Diatoms	79 species	19	Mangrove	71	19		
20	Alage	18 species	20	Plants	229	20		

Source: Indian Express 28<sup>th</sup> Aug. 2018, <http://natureconservation.in/bhitarkanika-national-park-complete-detail-updated/>, <http://odishawildlife.org/bhitarkanika.html>, <http://natureconservation.in/simlipal-national-park-complete-detail-updated/>, <http://odishawildlife.org/similipalbiosphere.html>, World bank 2009 for Siilipqal, Sarkar S. K. et al, 2012<sup>[22]</sup>.

### Nontraditional Medicinal Plants Odisha:

Odisha is home for over 750 species of medicinal plants. Till date 200-300 species of plants have been added to the list of angiosperms and pteridophytes, as medicinal plants. Mishra, 2004<sup>[12]</sup> reported that 132 species are in Odisha. Mohapatra et al., 2014<sup>[13]</sup> have mentioned about 473 species of birds, 131 species of reptiles, 27 species of amphibians and more than 600 species of fishes (including marine and freshwater). Many endemic plants in Odisha are used for herbal medicine by the common people. Some of them are also used as medicinal plants and included in prioritized National Ayush Mission (NAM) plants, Rao P. P. 2013<sup>[23]</sup>. Some plants and herbs of Odisha are yet to be included in the Ayush prioritized list are given in **Table 8**

**Table 8:-**List of herbs and plants found in Odisha and not prioritized as National Ayush mission plants, India.

Local name	Scientific name	Parts Used	Medicinal Use
Amari (T)	Bryophyllum plannotum	Leaves	Dysentery, Diarrhea,
Apamaranga	Achyranthes aspera	Root ashes	infected skin by maggots /worms
Atta	Annona reticulata	Leave paste	poulticed on boils, abscesses and ulcers
Ada	Zingiber officinalis	root	stomach upset, dysentery, nausea, vomiting
Akanishi	Cissampelos pareira	Leaves (Worm)	applied on wounds to purulent pus
Aswastha	Ficus religiosa	stem	Healing cracks and fissures
Amba	Mangifera indica	Gum, stem paste	cuts, wounds, and cracks of the heels
Agasthi	Sesbania grandiflora	Flower: Leaf:	microbial, antioxidant -cancer, Anti-Anti ,analgesic ,AnxiolyticHepatoprotective,
Bisalyakarani	Tridax procumbens	Leaf	boils, cuts, sores, wounds and eczema
Banakulathi	Tephrosia purpurea	Tree, leaf	Topical use to cure injuries
Bara	Ficus benghalensis	Bark, fruit, leaves	Antioxidant, aphrodisiac, treat spermatorrhoea and gonorrhoea, dysentery
Balbalua	Portulaca quadrifid	plant	The decoction is for skin diseases
Brudhadarak	Mentha pepper	leaf, leaf, extract,	relieve irritation and inflammation
Bainchaikoli	Flacourtia indica	Stem bark paste	treatment of eczema
Bana chakunda	Cassia tora or occidentalis	Leave paste,	Skin diseases, scabies
Chara	Buchnanania lanzan Spreng	Root, bark	Cure old wounds
Champa	Michelia champaca	Leaf, bark	Remove lice and dandruff, skin diseases
Sarpa Gandha( H )	Ranwolfia Serpentina	Root	Hyper tension, insomnia.
Chintamani	Plumbago zeylanica	Leaves green	Scabies, eczema, and ringworm
Dalimba	Puncia granatum	Leaves, fruit	Antioxidants, Vitamin C.,anti-Cancer Anti-Alzheimer'sdisease, Digestion, Anti-inflammatory, Arthritis, Heart disease
Databasing	Justicia adhatoda	Leaves paste	Topical use for scabies and ringworm
Dhala Arakh	Calotropis gigantea	Latex+Haldi+ oil	Scabies and eczema

Goudapuruni	Boerhavia diffusa	Leaf decoction	Scabies and ringworm
Henna/Mehdi ( S )	Lawsennia dermis	Lea, Flower, Seed	Burning, Steam, Anti Inflammatory
Gambhari	Gmelina arborea	Root & bark	Septic wounds
Gayasa	Leucas aspera	Paste of leaves	Ringworm (Topical use)
Kantasaga	Amaranthus spinosus	Worm leaves	Boils and burns
Pedipedika	Abutilon Indicum	Green leaves	Ringworm
Rakta Chitrak( H )	Plumbago Indica	Root, Root bar	Indyspeipsia, colic, inflammation, cough.
Kochila ( T )	Strychnine's nuxvomica	Seed	Nervous, Paralysis, healing wound.
Kusum	Schleichera oleosa	Bark, stem, seed	Scabies, itching, removes white patches
Sada Bahar ( H )	Vincea rosea	Whole Plant	Leukemia, Hypotensive, Antispasmodic,
Gokhur ( H )	Tribulus Terrestris	Whole Plant	Aphrodisiac, appetizer, Digestive, UTI.
Pokasungha (H)	Vernonia cinerea	Pastes of leaves	skin disease, threadworm,&wounds
kantakusum	Argemone mexicana	Green leaves	Eczema
Saitamba	Anacardium occidentale	Oil from seeds	Skin diseases
Jeutha	Artocarpus cucha	Bark	boils, cracked skin and pimples.
Nag Champa ( T )	Mesua Ferrea	Bark, Leaf, lower	Asthma, Skin, Burning, Vomiting, Piles.
Benachar/Khuskhus,	Vetiveria Ziziinoides	Root	Hyperdisia, Burning, ulcer, Skin, Vomit.
Tutamuli	Elephantopus scaber	plant	Remove balder stone
Kacha/bhalia ( C )	Mucuna Truriens	Root, , Seed, Leaf	Nervous disorder, Constipation, Contraceptive(seed), Nephropathy, Strangury, Dropsy.
Kurai ( S )	Holorheena antidysentrica	Bark, Seed	Scabies, Antipyretic, Amoebic dysentery.
Palas	Butea monosperma	Paste from seed	Skin diseases
Polanga	Calophyllum inophyllum	Oil from seeds	Scabies & eczema
Sinari	Cassia fistula	Green leaf Paste	treat injuries/ wounds
Nagalinga	Couroupita guianesis	Leaf paste	Skin diseases
Nandababulii	Crotonsparsiflorus Morong	Green leaves	over the cut for blood clotting
Kaladudura	Datura metel	Worm leaves	Applied on pimples
Kerua	Holarrhena pubescens	Paste from roots	cut, abscess & boils
Lankajada	Jatropha curcas	Paste of leaves	eczema, scabies and ringworm infection.
Nagairi	Lantana camara	Paste of leaves	insect stings, skin eruptions, measles.itch
Lajkuli	Mimosa pudica	Paste of leaves	cuts and wounds to promote healing
Karanj	Pongamia pinnata	Barks, oil	treat eczema, scabies and ringworm
Kantakari ( H )	Solanum Xanthocarpum	Plant, Fruit, Seed	Diuretic, Anti-inflammatory, Appetizer,

Source:<http://orienvic.nic.in/index1.aspx?lid=623&mid=1&langid=1&linkid=424>,and<http://orienvic.nic.in/index1.aspx?lid=623&mid=1&langid=1&linkid=424>From the above it can be concluded that most of the nonconventional ethnic medicinal trees in Odisha not prioritized by Ayush category are for healing skin diseases and wounds.

### Critically endangered species of Odisha:

Regional plant resource center, Odisha has identified 29 species of plants, shrubs and herbs which are under the IUCN category of threatened plants to Eastern Ghat region. The red data book of Indian plants reports Odisha harbors 142 numbers of rare and endangered plant species out of which 72 numbers are rare and rest 70 are endangered. Botanical Survey of India, has reported about 45 plant species are critically endangered (CR), 113 species endangered (EN), 89 species vulnerable (VU), 7 species extinct (EX) and two species are extinct in wild (EW), <http://wccb.gov.in/>. Some flora, fauna are considered vulnerable and endangered and are earmarked that need special attention before they will go to extinct in the wild or extinct. These endangered species are Barkud limbless skink (*Barkudia insularis*) (**Fig 12.b**), Eastern India limbless skink (*Sepsophis punctatus*), golden gecko (*Calodactyloides aureus*) of Chilika area, and bush frog (*Phyllautus similipalensis*) considered endemic and endangered Dutta-Roy et al., 2013<sup>[24]</sup>. Some orchids like arachnids *Peucezia harishankarensis* (a spider) and some earthworms of genera *Lenogaster*, *Eutyphoeus*, *Octochaetona*, *Ramella*, *Glyphidrilus* and *Thatonia* are also

endemic and endangered species of Odisha Biswas 1975<sup>[25]</sup>, Dash and Saxena 2012<sup>[26]</sup>, the pot-worms (Annelida: Oligochaeta: Microdrili). Some species like Baer's Pochard (*Aythya baeri*), White-rumped Vulture (*Gyps bengalensis*), Indian vulture (*Gyps Indicus*), red-headed vulture (*Sarcogyps calvus*) and gharial (*Gavialis gangeticus*). Some of the species of this category like the forest owlet (*Heteroglaux blewitti*) and pink-headed duck (*Rhodonessa caryophyllacea*) have not been sighted in Odisha since over 50 years ZSI 2010. Some vultures, birds and mammals of Odisha are critically endangered such as Ind. Royal Bengal tiger (*Panthera tigris*), fishing cat (*Prionailurus viverrinus*), Asiatic elephant (*Elephas maximus*), wild dog (*Cuon alpinus*), wild buffalo (*Bubalus arnee*), black-bellied tern (*Sterna acuticauda*) and Egyptian vulture (*Neophron percnopterus*), as per IUCN.

#### Anthropogenic Conservation of biodiversity in Odisha:

Forests, water bodies, plants and animals are spared in the name of religion and specially dedicated to some deities in Odisha. Prohibition for poaching, haunting and cutting of trees are implemented in the name of some deity. Malhotra et. al., 2001<sup>[17]</sup> reported that sacred grooves in India are more than  $\approx 10000$ . Malhotra, 1998 also reported there are 17320 numbers of the sacred grooves in India out of which 10192 numbers (Khan et. al., 2008) reported are covering an area  $>42278\text{Ha}$ . There are also 322 numbers of Sacred Grooves in Odisha comprising of area 50ha. The eastern ghat Hills, Deomali, Daringbadi, Dandakaranya, Devagiri, Niyamgiri, and Mahendragiri Mountains are the high mountainous ranges and harbored with huge flora and fauna. The Jungles are demarcated in names of gods and goddesses as Jahera and Thakuramma. The tribals do not cut Sal, Phasi, Bela, Neem, Aswasasth, and Arjuna Jungles as it is the dwelling places for gods and goddesses. Some trees in the Hindu system are also believed to be the living places of ghosts, witches and spirits (Sahada, Tamrind etc.). Even those trees or plants from those jungles are not cut for human use. The state has a protected area of  $8352.19\text{ Km}^2$  in 21 units for the conservation of Wildlife in Odisha. Out of which wildlife sanctuaries (19), national park (2), biosphere reserve (1), tiger reserves (2) and elephant reserves (3) out of 26 in Odisha. The other protected areas are Bhitarkanika National Park ( $672\text{ Km}^2$  with core area of  $145\text{ Km}^2$ ), Chandaka Elephant Reserve ( $175.79\text{ Km}^2$ ), Kapilash national wildlife sanctuary of  $125.5\text{ Km}^2$ , Debrigarh Wildlife Sanctuary, Nandankanan National Park ( $4\text{ Km}^2$ ) and Sanctuary ( $5\text{ Km}^2$ ) Simlipal National Park ( $845\text{ Km}^2$ ), Ushakothi Wildlife Sanctuary, Tikarpada Wildlife Sanctuary and the Similipal Tiger Reserve. The details of zoos/ sanctuaries /botanical gardens in Odisha are given in **Table 9**. <https://www.orissatourism.org/wildlife-in-Orissa.html>.and <http://natureconservation.in/state-wise-list-of-wildlife-sanctuaries-of-india-updated>



Fig 3:-The national parks, Zoos, WLS, Bird sanctuaries of Odisha (Source Forest Department: GOO)

In addition there are two tiger reserves and three elephant reserves in the State. The other 11 mini Zoos have been identified for ex-situ conservation and running of wildlife national parks, reserves and sanctuaries of Odisha are shown in **Fig 3**.

**Table 9:-**The numbers of forest/mangroves/national parks/ and sanctuaries in Odisha (FSI Report 2017)

State	Forest area/% of the Total area	Reserved forest area	Mangrove area	National Park (NP)	Total WLS No/ Area	protected Area	Total core Area
	Km <sup>2</sup> / %	Km <sup>2</sup>	Km <sup>2</sup>	No / Km2	No / Km2	Km2	Km <sup>2</sup> /%
India	774740/23.40 %	7 08273 .km <sup>2</sup> ISFR-2017	4627.6	103/40500	544/118932	162072.5	122803
Orissa	58136 /(37.34%)	26329	213	2/ 990.70	19/ 6969.15	15525	6969 (05.7%)

**Faunal Biodiversity Odisha:**

The coastal tract of the state has 17 estuaries (small or large) and one estuarine Lagoon, Chilika whose spread area varied to 775Km<sup>2</sup> from 1011Km<sup>2</sup> Mishra S. P. 2016<sup>[27]</sup> is a biodiversity hotspot. Odisha also has one marine national park (Bhitarkanika, 145 sq. km) and two marine sanctuaries (Bhitarkanika Wildlife Sanctuary, 672 sq. km and Gahirmatha marine sanctuary, 1435 sq. km), covering a total area of 2252 sq. km Barman et al 2007. There are almost 17 small to large estuaries along the coastline of Odisha which are of the mixed type of bar-built estuaries and coastal plain estuaries. The habitat biodiversity of Odisha comprises three types coastal, inland and mountainous. There are of mammals (87 species) Odisha forest Dept. report, aves (473 species), reptiles (131 species), and amphibians (27 species). Above 600 species of both marine and freshwater fishes out of which mammals (23 species), avifauna (16 species) and reptiles (17 species) are considered threatened. Odisha is also home for more than 300 species of Butterflies, 101 species of Odonates (Nair, 2011), 48 species of marine Molluscs, 14 species of Dermoptera (Arthropoda: Insecta), 31 species of Isoptera, 32 species of land Molluscs, 48 species of Nematodes and 46 species of Oligochaete as per recent documentation by Zoological Survey of India (ZSI, 2009-10). The Important Birds Areas (IBA'S) are seven such as Chilika, Mangalajodi, Bhitarkanika, Chandaka-Dampara, Ansupa Lake, Similipal, Satkosia and Upper Kolab and Indravati reservoir area of Koraput district.

**Man-animal conflict in Odisha**

The predators such as Elephant, Tiger, Lion, Bears, and Crocodile are measured as keystone species as they regulate all other species population directly and indirectly. So they are the prioritized conservation animals. Man-animal conflict is growing up during current years in Odisha. The most risked animals are elephants, lions, crocodiles and bear. Human and bovine losses, habitat destruction & crop losses by these predators are common. Retaliatory killing of wild animals by people of Odisha were rampant in past. Only 3425 cases of depredation were recorded between financial years 1994-95 to 2003-2004. About 454 people and 2,261 animals (including 388 elephants) were killed between 2010-16, Zee news, Oct 21st, 2016, 15:28 PM IST. In spite of human-elephant conflict, Elephants are 1930 in numbers in Odisha jungles and there are 14 corridors for their dwelling (Census survey 2012 of the Odisha Biodiversity Board -2017). In spite of enormous killing of elephants, the population of elephants in Odisha is increasing @8.15% from 1827 in 1999 to 1976 during 2017.

Mohanty et al 2017<sup>[28]</sup> has reported 82 people were killed and 55 injured during 2017-18 by human-elephant conflict in Odisha. Retrospectively, Poachers had killed 143 wild animals including 11 elephants, 10 leopards, 1 tiger and 119 deer during 2014-18 OTV news, Mar 28, 2018 - 16:47:50. Particularly Elephants are the worst sufferers. Statistic reveals the death of elephants were 33/ year (1990 -2000), the figure was bred to @ 46/ year (2000- 2010) and present raised maximum to an average of @ 73 /year from 2010-18. The anthropogenic causes of death of elephants were poaching (95) and electrocution (87); trains killed 23, two died in road accidents and seven elephants died falling into open wells. Apart from other predators the Soath bear is a problem to people of Odisha mostly where Mohul (Madhuca longifolia) trees are more. The reported districts involved more in the human-animal conflict in Odisha are given in **Table 10**.

**Table 10:-**The Geo-biodiversity richness in different districts of Odisha state, India,

#	Human vs.animal	Richness Districts	Depredation/fatalities	population 2016-17	Killed	Source
1	Elephant	Keonjhar, Sambalpur, Sundergarh, Dhenkanal	2010-18 : 569 people killed 157 injured, 2016-07: 66, 2017-18	1976	(2010 – 18): 591	<a href="https://www.wildlife.odisha.gov.in/WebPortal/">https://www.wildlife.odisha.gov.in/WebPortal/</a>

			(Feb): 82			WildlifeCensus.aspx http://www.indiaenvironmentportal.org.in/content/36667/,TheHindu 4-5- 2018
2	Tiger	Raigada, Angul, Sunder-garh, Deogarh, Phulbani	No report	40	(2014): 20	
3	Leopard	widespread odisha Nua-pada,sambalpur, sonapur,	1991-2003 :78	318	1988-2003 :8,	
4	Estuarine Crocodile	Kendrapada	1998-2007 :31	1694	1996-2002.: 14	

The other predators on Odisha, Gharial/Maggar (Inland crocodiles) are 227 in numbers, Dolphins of different varieties (257 in number) out of which Irrawaddy in Chilika-121, outside 60, spotted-5, Bottle Nose-31, Humpback-34 <https://odishatv.in/odisha/body-slider/>. The endangered black bucks were 1982 (2008 census) in Odisha. Besides variable migratory Palearctic birds visit to different places in Odisha annually are about Chilika (9.24lakh), Bhitarkanika (0.76 lakh) & Hirakud Reservoir (0.78lakh) and nomadic marine Olive Ridley turtles to fertilize along Odisha coast in an average about 9.75 Lakhs annually **Fig 5**.

#### Invasive Alien Species (IAS), Odisha:

IAS species are exotic, introduced, foreign, and nonnative which may develop invasive after entry. They drive out native species for resources food, nutrients, light, physical space, and water. Species invasion is geospatial and dynamic but slow and complicated. IAS is contributed by trade, transport, travel, and tsunamis allied extremes and tourism (5-T's). The IAS species have high reproductive potential, dispersal rate, greater adaptability, and hefty genetic variability which is influenced by geologic, geomorphic and meteorology of the area. Habitat destruction to inland/endemic species has enhanced threat to world biodiversity, and are through invasive alien species.

#### Invasive Alien Flora, Odisha:

India has 1599 alien species of alien plants of 841 genera and 161 families Reddy C. S. 2008<sup>[29]</sup>. ZSI has identified 173 IAS flowering species in India. Major IAS plants in Odisha, their nativity with their local name are in **Table 11**.

**Table 11:-**Major invasive alien plants in Odisha, their nativity with their local name

#	The local name of Species	Scientific name	Nativity	Host countries, India and Odisha	Source
1	Shama Millet (climbing shrub)	Echinochloa colona	South America, Madagascar	India, Odisha in all districts	Aggressive colonizer. Grass fields and paddy fields
2	India rubber vine (Shrub) or Purple allamanda	Cryptostegia Grandiflora	Madagascar than in India	Philippines, USA, Australia, Oceania, Singapur, Africa	<a href="http://www.flowersofindia.net/catalog/slides/Rubber%20Vine.html">http://www.flowersofindia.net/catalog/slides/Rubber%20Vine.html</a>
3	Bilati data (Water hyacinth, aquatic)	Eichhornia crassipes	South America	India, Odisha, in all districts,	Aggressive colonizer, Introduced Odisha (1914-16)
4	Congress grass (Noxious)	Parthenium hysterophorus	Tropical America	India, Odisha, in all districts	Pandey et al 2009 <sup>[30]</sup> Allergy-prone
5	Spiny Burr Grass (Noxious)	Cenchrus tribuloides	Australia & Russia	Odisha, imported with wheat 2006-07)	<a href="http://zeenews.india.com/news/eco-news/invasive-weeds-threatening-Indias-biodiversity_620516.html">http://zeenews.india.com/news/eco-news/invasive-weeds-threatening-Indias-biodiversity_620516.html</a> , Pawan Kumar et. al., 2009 <sup>[31]</sup> , <a href="http://www.Arvindguptatoys.com">http://www.Arvindguptatoys.com</a>
6	European field Pansy (Noxious)	Viola arvensis	Australia & Russia	Odisha, imported with wheat 2006-07)	
7	Hound's Tongue (Noxious)	Cynoglossum officinale	Australia & Russia	Odisha, imported with wheat 2006-07)	
8	Horse nettle (Noxious)	Solanum carolinense	Australia & Russia	Odisha, imported with wheat 2006-07)	
	Giant Ragweed (S) (Noxious)	Ambrosia artemisiifolia	Australia & Russia	Odisha, imported with wheat 2006-07)	
9	Pokasungha, Nagbairi (H)	Lantana camara,	Tropical/subtropical America	India and one of the most Invasive species	Ornamental shrub during AD 1809-1810 India.

10	Dodders(parasitic weeds 13 types identified)	Cuscuta spp.	Mediterranean	From shrubs to trees jungles, India, Odisha (mountainous ranges).	Petunia, Calibrachoa, begonia Sweet potato Marigold etc
11	Asteraceae	<i>Mikania micrantha</i>	Tropical/subtropical America	Odisha in Dhenkanal district (Anti-bacterial Potential) Rourkela	Nayak et al, 2017 <sup>[32]</sup>
13	Guguchia grass	<i>Dinebra retroflexa</i>	Trop. America	India, Odisha, in all districts,	Aggressive colonizer. Grass fields and paddy fields
14	Beruhna	<i>Cyperus iria</i>	Trop. America	India, Odisha, in all districts,	In rice fields, ditches and edges of the tank
15	Snakeweed	<i>Chamaesyce hirta</i>	Trop. America	India, Odisha, in all districts,	In rice fields, ditches and edges of the tank
16	Wool flower	<i>Celosia argentea</i>	Africa	Peninsular India, Odisha, in all districts,	Aggressive colonizer. weed of cultivated fields & scrublands
17	Arakha, Madar, Swallow Wort	<i>Calotropis procera</i>	Trop. Africa	India, throughout Odisha	Seed propagation
18	Prickly Puppy	<i>Argemone mexicana</i>	Trop. Central & South America	India, throughout Odisha	Aggressive colonizer. fields, scrublands
19	Amari (morning glory)	<i>Ipomeas</i>	Mexico, Cent America	All over Odisha	One of the most invasive species of India and World

#### **Invasive Alien Fauna, Odisha:**

The Zoological Survey of India (ZSI) has identified, a list of 157 IAS faunal in 2017 excluding the invasive microbe species. These IAS faunas have fast reproduction, rapid growth, and wide dispersal ability. They can survive on different diet, diverse environmental settings and can easily adapt to phenotypic plasticity. Inland alien faunal species enumerated are 58 numbers inland and fresh water and 99 in marine zone. The inland IAS animals comprise of fish species (19), arthropods (31 species), mollusks (3), birds (3), reptile (1) and mammals (2). Out of 316 species of mammals, 30 are IAS, from 1221 Birds 4 are alien invasive, 2546 species of fishes 300 are invasive alien, 54430 species arthropods includes 1100 species as IAS in India. (The Hindu, 16<sup>th</sup>, Dec, 2017) Very less invasive inland vertebrates are found in Odisha. The common IAS fauna found in Odisha are Giant African Snail (*Achatina fulica*) found all along Odisha coast. *Pterygoplichthys pardalis* (Amazon sailfin catfish) is destroying the fish population in fresh water..

#### **Biodiversity hubs in Odisha**

Human endeavors persistently protect and preserve the ecosystem from past. Though the government imparts measures through forest reserves, WLS, BS and zoos, it is inadequate. Ethnic people preserve the flora & fauna in some areas in the name of religion and utilities. Some villagers in Odisha are taking care of wild animals and protect plants as Grama Jungle. The biodiversity hubs protected in Odisha are in **Table-12**.

**Maneshwar:** In Maneshwar, Sambalpur dist of Odisha, the local people have conserved the Indian soft-shelled turtle (*Asperadetus gangeticus*), which is also known as the vulture of the water in a huge temple pond. The soft-shelled turtle is facing an extinction threat due to over-hunting for meat and habitat destruction as anthropogenic activities in different part of the country (**Fig 4**).



**Fig 4:-**Co-habitation of man and inland Tortoises at Maneswar Sambalpur Odisha

These monstrous eating habits of these species could maintain the harmful invasive species (HIS) and protect the environment and maintain the water quality. The Indian soft-shelled turtles are distributed in large river systems like Mahanadi, Ganges and Indus. These also occur in large ponds and water bodies in the mainland. Besides Maneswar, these turtles are also getting protection in places like Parvati Sagar Pond in Puri, Champeshwar at Cuttack and Golia in Ganjam district. Maneswar is also. The jungle cats, small-clawed otters, jackals and various water birds are found in village jungles of Maneswar.

**Golia (Reptile preservation):**

Bhetnoi, Golia village in Buguda Block, Ganjam district in south Odisha, is famous for the conservation of freshwater tortoise in a pond measuring of about 3 acres area is known as Nila Pokhari (Blue colored pond). The villagers consider about 300 reptiles of the pond as sacred and established an intimate relation and preserve them as an act of people's participation and also along Rushikulya Estuary (**Fig 5**)



**Fig. 5:-**Hatchery for Marine Tortoises at Rushikulya R. and Bahuda R. Estuary Ganjam Odisha

**Huma, the leaning temple of Lord Shiva:**

The famous Leaning Siva Temple on the left bank of the River Mahanadi to 23km south of Sambalpur was like the leaning tower of Pisa in Italy. These holy fishes of the river are the 'Kudo' fish (Mahashir fish -Tormosal mahanadicus) are beyond catch. Pilgrims feed foodstuffs by their hands of the spectators. The architectural ecstasy is the main temple tilted to one direction and other small temples and even the boundary walls are tilted to some other direction. (**Fig 6**)



**Fig 6:-** The worshipping of aqua fauna near tilting temple at Huma, and preserving biome, worshipping trees

#### **Ushakothi:**

The Ushakothi WLS, in Sambalpur exist running parallel to NH.6 is 43Km long ( NE stretches for more than 130Km) . The Sanctuary harbors Elephants, Tigers, Gours, Sambars, Black Panthers, Spotted Deer, and Wild Bears etc. The population of these mammals/species needs to be recorded for future IUCN counts Fig-7.



**Fig.7:-** The Species the native Bison and Chausingha in Ushakothi sanctuary

**Balipadar-Bhetnoi:** The Indian Blackbuck (*Antelope cervicapra*), is one of the endangered species (IUCN red list) found in Odisha (**Fig 8**). These endemic animals were plenty (1200 to 1300 in the 1960's) in India but their number was reduced to about 500 to 600 in 1990's. They were listed in Schedule-I of Wildlife (Protection) Act, 1972 and is designated as Vulnerable as per Red Data Book (1994). These rare species were traced at present in Balasore, Puri, Kendrapara Bolangir and Kalahandi and Ganjam Districts. The people of Balipadar-Bhetnoi (58.402 km<sup>2</sup>), areas in Ganjam District are kind to preserve them. In Konark-Balukhand WLS area they are also increasing.



**Fig 8:-** Black Buck, Bhetnai, Asika, Ganjam – Where they roam freely with villagers.



### Biodiversity protected areas of Odisha

There are huge reserved forests in the 30 districts of Odisha. There are a number zoos and reserved forests inside the state. The coastal corridor possesses 12 numbers of estuarine/ brackish flora and fauna that adorned the coast and keep the state in a special position in the country. Odisha has a total Protected area of 8352.3.km<sup>2</sup> (5.36%) of the state), 19 WLS of area 8352.19 Km<sup>2</sup> in Odisha, one NP (Bhitarkanika, 145 Km<sup>2</sup>) and the proposed NP (Similipal, 845.70 Sq. Km.). Apart from the above Odisha has 3 Elephant Reserves, 14 Elephant corridors, 2 Tiger Reserves. The state has one large zoo (Nandankanan), 2 small zoos and 8 mini zoos. The list of WLS in Odisha is in **Tab-12**

**Table 12:-**The list of wildlife sanctuaries, in Odisha, their discovery and area cover in Odisha state.

#	Place	State	discovered	Area
1	Badrama WLS	Orissa	1962	304.03
2	Baisipalli WLS	Orissa	1981	168.35
3	Balukhand Konark WLS	Orissa	1984	71.72
4	Bhitarkanika WLS	Orissa	1975	525
5	Chandaka Dampara WLS	Orissa	1982	175.79
6	Chilika (Nalaban) WLS	Orissa	1987	15.53
7	Debrigarh WLS	Orissa	1985	346.91
8	Gahirmatha(Marine) WLS	Orissa	1997	1435.00
9	Hadgarh WLS	Orissa	1978	191.06
10	Karlapat WLS	Orissa	1992	147
11	Khalasuni WLS	Orissa	1982	116
12	Kotagarh WLS	Orissa	1981	399.5
13	Kuldiha WLS	Orissa	1984	272.75
14	Sunabeda WLS	Orissa	1988	500
15	Lakhari Valley WLS	Orissa	1985	185.87
16	Nandankanan WLS	Orissa	1979	14.16
17	Satkosia Gorge WLS	Orissa	1976	745.52
18	Simlipal WLS	Orissa	1979	1354.30
19	Kapilash WLS	Orissa	NA	125.50

### Similipal Reserved forest:

The national park at <http://www.fsi.nic.in/sfr2003/orissa.pdf> and a tiger reserve in the Mayurbhanj district in the state with deciduous trees and Sal forests. It is part of the Similipal-Kuldiha-Hadgarh Elephant Reserve, includes three protected areas — Similipal Tiger Reserve (2750.00 km<sup>2</sup>), Hadgarh Wildlife Sanctuary (191.06 km<sup>2</sup>) and Kuldiha Wildlife Sanctuary (272.75 km<sup>2</sup>). Similipal National Park, the 2<sup>nd</sup> largest national park in India derives its name from the abundance of semul (red silk cotton trees) that bloom here (**Fig 9**).



**Fig 9:-** Mega Diversity of Flora and Fauna at Simlipal reserve forest Mayurbhanj Odisha

Simlipal is home to 99 royal Bengal tigers and 432 wild elephants. Besides Simlipal is famous for gaurs (Indian bison), chausingha (four horned antelope), as well as an orchidarium. This reserve is part of the UNESCO World Network of Biosphere Reserves since 2009.

#### **Bhitarkanika NP, Odisha:**

Bhitarkanika National Park is a national park located in Kendrapara district of Odisha in eastern India. It spreads over 672 km<sup>2</sup> and is surrounded by the Bhitarkanika Wildlife Sanctuary. It was designated as a national park on 16 September 1998 and as a Ramsar site on 19 August 2002. Gahirmatha Beach and Marine Sanctuary lies to the east, and separates swamp region cover with a canopy of mangroves from the Bay of Bengal (Fig 7).

Bhitarkanika, a rich, lush green vibrant eco-system is lying in the estuarine expanse of the rivers Brahmani-Baitarani in the North-Eastern corner of Kendrapara district of Orissa. The area is intersected by a network of creeks with Bay of Bengal on the East. The alley between the meandering creeks and rivers, houses the second largest viable mangrove eco-system of India. Bhitarkanika is a hot-spot of biodiversity. During 2002, the Bhitarkanika mangroves were discovered having an area of 2672km<sup>2</sup> and were declared as a Ramsar site being a wetland of international importance. The biodiversity possesses 63 species of mangrove plants, 172 species of different types of birds, and 1840 numbers of reptiles including snakes and crocodiles 33, Upadhyay V.P et al, 2008<sup>[33]</sup>.



**Fig 10:-**The marine mega-biodiversity in Bhitarkanika Estuary

Bhitarkanika is home to India's largest population of giant saltwater crocodile, the largest crocodile on earth. Also It is home to more than 215 species of avifauna including amazing eight variety of Kingfishers **Fig 10**. It is the second largest viable Mangrove Eco-System along with a large number of estuarine crocodiles. There are 80 estuarine crocodiles found in 2017 whereas the reports 75 and 70 in the year 2016 and 2015. Three giant male crocodiles measuring more than 20 feet long were reported by enumerators. This included a 21-foot long reptile which finds a pride of place in the Guinness Book of World Records as the longest living crocodile. As many as 40 large-size crocodiles measuring 14 to 19 feet were sighted during the annual headcount operation conducted between January 3 and 10 in 2017 **Fig 11(b)**.



**Fig 11 (a):-**The paradise for guest birds in the sanctuary Fig 11(b) Sunbathing crocodiles at Bhitarkanika

Other vertebrate and reptile species found in the park were leopards, fishing cats, hyenas, sambar deer and Gangetic dolphins, olive ridley turtles etc. regarding flora and fauna the mangrove maintains 11 species out of 70 species of

the globe. In the above ecosystem the other species found are The national park is home to Saltwater crocodile (*Crocodylus porosus*), White Crocodile, Indian python, King cobra, black ibis, darters and many other species of flora and fauna. It hosts a large number of mangrove species and some migratory avifauna Fig 11 a.

#### **Mega biodiversity of Chilika lagoon:**

Chilika lagoon, in southern BOB coast of Odisha is divided into four regions due to its rich biodiversity. It was declared as a “Ramsar Site” i.e. a wetland of international importance during the fag end of 20th century. The migratory waterfowls are its significance. The Chilika is the place of the congregation of varieties of guest birds occurs from September to January “The Nalabana Bird Sanctuary”, a marshy land of 15.53sq.km in the central sector of the lagoon is located which provide lodging to 5-7 lakhs for 147 species of avifauna. The Irrawadi Dolphins, the Limbless skinks and rare bird species of in Chilika Lagoon, Odisha are rare and endangered **Fig 12..**

Chilka, the largest brackish water lagoon in south Odisha, is a mega biodiversity hotspot and also was included in IUCN and Ramada sites. About 1010Km<sup>2</sup> pear-shaped lake was 3000 years old and was a gulf during the post-Holocene period. The barrier spit separates the ecosystem to a fragile marine-semi marine-freshwater biome. The lake habitats are about vertebrates (400 numbers), crocodiles (4 types), mammals (24 types), and reptiles/amphibians (37 types). It is also rich in floral diversity (726 types) five types of grasses and mangroves (Fig 9). There are 150 species of marine strata, 119 numbers brackish water species and 24numbers of freshwater species.



**Fig 12:-** The Irrawadi Dolphins, the Limbless skinks and rare bird species of in Chilika Lagoon, Odisha

This is only possible due to salinity ingredient and vertical mix from the mouth of the lagoon to the emanating point of the river Daya and Bhargovi. Some aqua species enter the fragile system which favorable for hatching and laying eggs. Birds from Mongolia, Asia and Himalaya fly to Chilika lagoon every year due to abundant food, a good place for habitation during winter from October to January. Some of the birds lay eggs during that period and nourish the tiny birds to make them fit for air travel after air travels. Similarly olive ridley in very large numbers swim for thousands and kilometers and reach some coasts Rusikulya mouth, Golia, Debi Mouth and Gahiramatha to lay eggs only. After some days when the eggs have hatched the tortoise with their babes fly back to their parent place of habitation.

Last 30 years, the people from in an around the area were massively Poaching the birds and along with dogs and the eggs were destroying the eggs for their food. But people’s participation in conserving the biodiversity has been initiated. Presently the local people are vigilant about the poaching and destruction of eggs to conserve the Faunal biodiversity.

#### **Discussion:-**

Tropics have isolated hills, fragmented forest patches, which is the façade of the old primeval diversity of plants and animals. Species richness is not only the prime feature of biodiversity and ecosystem but also an assemblage of bonds between climate vs geomorphology, man and species, predator and prey or pollination and plant. Habitat

destruction, climatic changes and proliferation of invasive allied species (IAS) and anthropogenic interventions are the major decimation of species. The over-exploitation of flora, fauna, aquafauna, and avifauna resources are adding to lean their population density, in a polluted environment. Simultaneously, meteorological extremes, natural calamities, geologic, limnology adversities, anthropogenic and species interactions are continuously deteriorating the biosystem.

CO<sub>2</sub> concentrations in the air have increased considerably compared to the pre-industrial era level to 280 ppm. But in the 21<sup>st</sup> century, the average concentration has changed significantly @ 2% /year and reached 410ppm in April 2018. Elevated CO<sub>2</sub> and NO<sub>2</sub> have been reported to affect the distribution of plants by controlling the plant growth. Significant increases have also occurred in the levels of methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). The current concentration may be the highest in the last 20 million years. As of April 2018, the average monthly level of CO<sub>2</sub> in Earth's atmosphere exceeded 410 parts per million. This alarming GHG level can produce an adverse impact on the evenness, richness and level of biodiversity of the state so also of the globe. About 82.1652 million tons of CO<sub>2</sub> (@ 1.02 per capita emission) and 0.025 million tonnes of CH<sub>4</sub> is produced from energy, mining, transport and Industrial sector which is the major cause for deforestation and defaunation of Odisha (Data 2013, SPACC, GOO) <http://www.niti.gov.in/content/forest-cover-percent-total-geographic-area#>

The best possible action plan needs to include for surveillance of flora and fauna are identification, segregation such as (endemic and IAS species), confirmation (Surveillance or monitoring), Processing (category wise), Screening (Not evaluated (NE), data deficient (DD), Least Concerned (LC), Nearly threatened (NT), Vulnerable (VU), Endangered, (EN) , critically endangered (CR), and collapsed (CO). Further reporting to proper corner is important so that pertinent action plan shall be prepared by the competent authority.

#### **State Policies on biodiversity Odisha:**

At Government of India's level, different rules in vogue are The Environmental Protection Act 1986, The Forest Rights Act, 2006 (FRA -06), the latest draft National Forest Policy,(NFP) 2018 proposed by MOEFCC, GOI is in hot discussion at present as pro-Anthropocene, anti-aboriginal, against ecology and cynical to indigenous community. The role of Gram Sabha and forest rights holders, the custodian of the biodiversity has been relegated in the FRA and PESA (Panchayats Extension to Scheduled Areas Act, GOI, 1996) whereas commercialization and privatization (in PPP mode) is invigorated. Encouraging plantation of Eucalyptus and Teak instead of fruit producing trees shall encourage the corporate sector affecting the aboriginal community invoking our Jungle as a bureaucratic Jungle. The Odisha State Wildlife Organization was made on 14th August 1974, contemplating Wildlife (Protection) Act, 1972; and promulgation of the Wildlife (Protection) (Odisha) Rules, 1974 and the WL(P) Amendment Act, 2002. The CF's (Conservator of Forests) was designated as the Ex-Officio Chief Wildlife Warden, Odisha. A separate Wildlife Organization was created in the year 1976 to safeguard the wild animals.

#### **Conclusion:-**

In the 21<sup>st</sup> century in the pick period of sixth extinction the vulnerable/endanger species must be conserved to save the world from the apocalyptic clutches Anthropocene epoch. Either the name of God or through mummification participation attempt has made in Odisha for the preservation of the endemic/endangered and vulnerable species which is not enough. The herbal Ayurveda medicines should be encouraged by identifying them. The endangered species left must be safeguarded to increase their productivity and they should not leave unattended to be extinct. The enumeration of plant and animal species and vigilant about their growth, migration should be noticed specifically in the onshore and offshore areas.

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