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### RESEARCH ARTICLE

#### BEACH FLORA ALONG THE COAST OF GAHIRMATHA MARINE WILDLIFE SANCTUARY (ODISHA), INDIA

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#### Abstract

Beach flora along the maritime ecosystem is very sensitive and fragile in nature. Studies on floral species composition and their ecological role in the sensitive coastal and marine ecosystem of Indian coast in general and coast of Odisha in particular are scanty. Keeping in view, a detailed survey along the coast of Gahirmatha beach in Kendrapara district, Odisha was conducted. A total of 67 species under 62 genera belonging to 36 families of flowering plants were collected and identified at different localities from the shoreline towards inland of the coastline. The floral composition of sandy beach of Gahirmatha coast was found to be rich and diverse. The sensitive ecosystem need to be protected from habitat degradation in order to provide congenial niche for the diverse beach elements that caters the ecological functioning and also supporting the associated floral as well as faunal assemblages in the area.

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#### Introduction:-

Where the land meets the ocean and sea it is called the seashore or beach. The word 'beach' is used by most people to the sandy area that separates the sea from the land ( Emery, 1961). In fact this sandy area is only a part of the beach system. The beach begins in the sand dunes above the high tide mark, the farthest point where the sand has been carried by wave action (Rao and Sastry, 1972). The beach extends to the depth beyond which the wave action does not have sufficient force to move the sand particles. The beach is a sensitive, dynamic environment that provides habitat for a variety of plants and animals and microorganisms (Rao & Sastry, 1974). Sandy coastal ecosystems play pivotal role all over the tropics due to their location near ocean having potential spots for eco-tourism and recreation ground (Rao, 1971). They also provide ecosystem services to mankind in the form of buffer zones against storm surges and reduce beach erosion. The forces that create, mold and destroy sandy coastal deposits are basically wind, sea level oscillations and the presence or absence of vegetation. A profile of these sandy deposits represents a time series, from young beach sands to older often stabilized inland deposits. Ecological zonation is clearly demonstrated on sandy coasts especially as one walks from the beach inland. The natural forces create an extremely varied landscape, from tall dunes and beach ridges where the water table lies deep below the soil surface to meet slacks that lie between these dunes and beach ridges, some of which are permanently flooded. Thus diverse vegetation types and relatively large numbers of plant and animal species are generally found along the coast. Excessive use of the beach can lead to the gradual degradation of habitat. The beach vegetation and coastal sand dune system throughout the world are under increasing threat from pressures of population, developmental activities, tourism etc. (Rao & Meher Homji, 1985). Whereas the dunes are adapted to natural coastal processes,

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they are fragile and easily damaged by human activities (Morton *et al.*, 1993). The plant communities in sandy coastal ecosystems are seriously threatened owing to anthropogenic pressure of many kinds.

Odisha coast extends along the Bay of Bengal covering a distance of 480 Kms from Talasari in the North to Sonepur in the South (Pattnaik *et al.*, 2008). Within the limits of Odisha coast the mangrove vegetation of Devi estuary, Mahanadi delta, Bhitarkanika and Balasore & Bhadrak coast are met with. The Gahirmatha Marine Wildlife Sanctuary, which bounds the Bhitarkanika Wildlife Sanctuary to the east, was created in September 1997 and encompasses Gahirmatha beach and an adjacent portion of the Bay of Bengal. It is the only marine wildlife sanctuary of Odisha. The Marine Sanctuary comprises an area of 1435 km<sup>2</sup> out of which 1408 km<sup>2</sup> is the territorial waters of the Bay of Bengal and 27 km<sup>2</sup> is the landmass supporting mangroves and associated vegetation. It is located between 86° 45' 57" to 87° 17' 36" East Longitude and 20° 17' 32" to 20° 46' 58" North Latitude (Fig. 1). Gahirmatha beach attracts huge number of Olive Ridley Marine Turtles (*Lepidochelys olivacea*) every year from far off places for nesting on its beaches. The beach had been traditionally the nesting ground of Olive Ridley Marine Turtles which came to light of the scientific world during 1970s by Dr. H.R. Bustard, Chief Technical Adviser to Government of India from UNDP/FAO.

Kendrapara is one of the 30 districts of Odisha state and is one among the 6 coastal districts along the Bay of Bengal. The coastline of Odisha extends over 6 districts viz. Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Puri and Ganjam from north to south direction. The stretch of sea beach between Maipura and Hansua river extends over a distance of 43 Kms are known as Gahirmatha beach. The beach has been interrupted at couple of points in Maipura river mouth and Baunsagarh river mouth. Gahirmatha beach is more or less flat with scattered sand dunes and free from rocks and stones. The landmass of Gahirmatha Marine Sanctuary is of deltaic formation and it is almost level. The sea bed has gradual slope outwards into the sea. The beach of Gahirmatha is uneven and there is tremendous pressure of natural forces for beach erosion. This impact led to shrinkage of nesting ground of Olive Ridleys near Agarnasi, Nasi-I & Nasi-II islands and similarly along the beach near Barunei, Satabhaya, Habalikhathi & Ekakula. The impact of past cyclonic storms like Hud Hud, Phailin, Fani and Amphan not only posed devastation of Mangroves, beach elements and shelter belt *Casuarina* vegetation along the coast of Gahirmatha but also caused drastic beach erosion in the above sites. The silt particles deposited by the natural forces at the extreme points of Hetamundia FB, Hukitola RF and near the Hansua river mouth near Barunei has augmented new plant succession on the mudflats. The area receives rainfall mostly from south west monsoon. Around 80% of rainfall occurs during the months of June to October. The average annual rainfall is around 1300mm. Gahirmatha (Marine) Wildlife Sanctuary is one of the six Marine Protected areas of the country and only such area of the State.

The coastal vegetation of Odisha falls under littoral and tidal swamps under the tropical forests (Champion & Seth, 1968). However, the vegetation of Gahirmatha coast mainly constitutes beach type vegetation, mangrove vegetation and *Casuarina* plantation. The vegetation is influenced by the rivers namely Mahanadi, Luna, Gobari, Hansua, Baunsagar etc. Unfortunately, the beach vegetation of Gahirmatha is facing tangible shrinkage in their population owing to various anthropogenic pressure such as fuel wood collection, boat traffic too close to the shoreline, celebration of festive occasions along the sea coast, over grazing and trampling by livestock. Besides these factors, the beach flora are also seriously threatened owing to climate change that aid to rise in sea level, oil spills at sea and artificial protection measures like sea walls made of stones. The detailed study on beach flora of Gahirmatha coast has not been done so far, although some sporadic reports are available on different aspects of the coastal flora and vegetation (Subudhi & Choudhury, 1989; Banerjee *et al.*, 2002; Subudhi *et al.*, 2002; Pattanaik *et al.*, 2008; Sahu & Misra, 2010; Sahu & Misra, 2013; Sahoo *et al.*, 2014). Realising this, an attempt has been made to study in detail the beach flora along the coast of Gahirmatha Marine Wildlife Sanctuary in the state of Odisha.

### Materials and Methods:-

Prior to study the coastal sand dune species of Gahirmatha coast, literature survey was carried out thoroughly. Field studies were undertaken in different seasons during January 2019 to September 2020 with the aim of enumerating the floral wealth extant in the sandy beach of Gahirmatha coast. Plant specimens were collected for taxonomic identification from different parts of the study area. All the specimens collected from the field were identified with the aid of regional flora (Saxena and Brahmam, 1994-96). The voucher specimens after due processing have been housed in the Herbarium of Mangrove Forest Division (Wildlife) Rajnagar, Kendrapara. The angiospermic beach flora along Gahirmatha coast with scientific names of species, families, local names (wherever available) and habit is presented in Table 1. Name of the species are arranged alphabetically.

## Results and Discussion:-

Beach vegetation is probably the best known of all the plant communities found on sandy shores. They are otherwise known as psammophytes. The psammophytes are plants, which are adapted to grow successfully in sandy areas. Along Gahirmatha coast the beaches form the major habitats for psammophytes. The coast is indented with numerous river mouths, bays, creeks, sand dunes and long beaches. In order to obtain moisture content for physiological activities the roots of these plants are deeply penetrated into the loose sandy soils. Any one while walking along a sandy shore can observe strand plants that grow on the shifting sands of the upper part of the beach. These plants form a dense cover on sheltered beaches where storm surges are uncommon and there is some degree of protection from strong winds. The dominant species in this community are pioneer plants as they are the first flowering plants to colonize the sand deposited by wave action. Storm surges sometimes destroy these plants or bury them in sand, but as the storm abates, the beach profile becomes stable once more and long runners of *Ipomoea pes-caprae* or *Canavalia maritima* etc. soon appear and grow towards the water's edge.

Low creeping plants usually form sparse cover on fore dunes, increasing in density inland along a disturbance-inundation gradient. Many of these species are grasses, sedges or creepers that have long, fast growing stolons or rhizomes to keep pace with sand burial. Some plants also have succulent leaves and stems as a mechanism for water storage. This is the case of *Hydrophyllax maritima*, *Launaea sermentosa* and *Sesuvium portulacastrum* the pioneer plants that inhabits beaches and dunes along Gahirmatha coast. The spiny bushy shrub *Spinifex littoreus* on fore dunes near Dobandhi along Gahirmatha coast naturally regenerated by the globose acicular bulbils that are dispersed from one place to other through wind and germinate to form new patches along the coast. Beach vegetation forms a very narrow strip on the upper beach in Gahirmatha. *Casuarina* plantation along the coast is a barrier of the beach which has been facing lot of devastation in recent past. The tidal surges generated from the Bay of Bengal has resulted beach erosion and the sea invades towards inland resulting loss of many beach elements. This situation occurred near Satabhaya, Habalikhathi & Ekakula of Gahirmatha beach.

**Table 1:-** Systematic enumeration of beach flora along Gahirmatha coast, Odisha.

Sl. No.	Name of Species	Family	Local Name (Odia)	Habit
1	<i>Achyranthes aspera</i> L.	Amaranthaceae	Apamaranga	Herb
2	<i>Ageratum conyzoides</i> L.	Asteraceae	Pokasunga	Herb
3	<i>Alternanthera paronychioides</i> St. Hil.	Amaranthaceae	—	Herb
4	<i>Alysicarpus vaginalis</i> (L.) DC.	Fabaceae	—	Herb
5	<i>Argemone mexicana</i> L.	Papaveraceae	Agara	Herb
6	<i>Aristida setacea</i> Retz.	Poaceae	Ghodalanji	Herb
7	<i>Boerhavia diffusa</i> L.	Nyctaginaceae	Puruni	Herb
8	<i>Bulbostylis barbata</i> (Rottb.) C.B.Cl.	Cyperaceae	—	Herb
9	<i>Caesalpinia bonduc</i> (L.) Roxb.	Caesalpiniaceae	Gila	Shrub
10	<i>Calotropis gigantea</i> R.Br.	Asclepiadaceae	Arakha	Shrub
11	<i>Canavalia maritima</i> (Aubl.) Thouars	Fabaceae	Luna Simba	Creeper
12	<i>Cassia occidentalis</i> L.	Caesalpiniaceae	Chakunda	Herb
13	<i>Cassytha filiformis</i> L.	Lauraceae	Nirmuli	Parasitic Vine
14	<i>Casuarina equisetifolia</i> L.	Casuarinaceae	Jhaun	Tree
15	<i>Cayratia trifolia</i> (L.) Domin	Vitaceae	Amala Lata	Climber
16	<i>Clerodendrum inerme</i> (L.) Gaertn.	Verbenaceae	Chiani	Shrub
17	<i>Crotalaria juncea</i> L.	Fabaceae	Chhanapata	Herb
18	<i>Crotalaria verrucosa</i> L.	Fabaceae	—	Herb
19	<i>Croton bonplandianus</i> Baill.	Euphorbiaceae	Gandhi	Herb
20	<i>Cyperus arenarius</i> Retz.	Cyperaceae	Luni Mutha	Herb
21	<i>Cyperus compressus</i> L.	Cyperaceae	Chancha	Herb
22	<i>Dactyloctenium aegyptium</i> (L.) P.Beauv.	Poaceae	Kakhuriya	Herb
23	<i>Datura metel</i> L.	Solanaceae	Dudura	Shrub

24	<i>Dodonaea viscosa</i> (L.) Jacq.	Sapindaceae	Mahada	Shrub
25	<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	—	Herb
26	<i>Eragrostis tremula</i> (Lam.) Hochst. ex Steud.	Poaceae	—	Herb
27	<i>Evolvulus alsinoides</i> (L.) L.	Convolvulaceae	Bichhamalia	Herb
28	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	—	Herb
29	<i>Fimbristylis acuminata</i> Vahl	Cyperaceae	—	Herb
30	<i>Fimbristylis ferruginea</i> (L.) Vahl	Cyperaceae	—	Herb
31	<i>Fuirena ciliaris</i> (L.) Roxb.	Cyperaceae	—	Herb
32	<i>Gisekia pharnaceoides</i> L.	Molluginaceae	Susni	Herb
33	<i>Glinus oppositifolius</i> (L.) A. DC.	Molluginaceae	Pitasaga	Herb
34	<i>Hedyotis corymbosa</i> (L.) Lam.	Rubiaceae	Gharpodia	Herb
35	<i>Hedyotis herbacea</i> L.	Rubiaceae	—	Herb
36	<i>Hemidesmus indicus</i> (L.) R. Br.	Periplocaceae	Anantamula	Twiner
37	<i>Hybanthus enneaspermus</i> (L.) F.v.Muell.	Violaceae	Madanmastak	Herb
38	<i>Hydrophylax maritima</i> L.f.	Rubiaceae	—	Herb
39	<i>Ipomoea pes-caprae</i> (L.) R. Br.	Convolvulaceae	Kansarilata	Creeper
40	<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	Baigaba	Shrub
41	<i>Launaea sarmentosa</i> (Willd.) Sch.-Bip ex Kuntz.	Asteraceae	—	Herb
42	<i>Leucas aspera</i> (Willd.) Link	Lamiaceae	Gayasa	Herb
43	<i>Lindernia crustacea</i> (L.) F.v.Muell.	Scrophulariaceae	—	Herb
44	<i>Mimosa pudica</i> L.	Mimosaceae	Lajakuli	Herb
45	<i>Murdannia spirata</i> (L.) Brueck.	Commelinaceae	—	Herb
46	<i>Opuntia vulgaris</i> Mill.	Cactaceae	Nagapheni	Shrub
47	<i>Pandanus fascicularis</i> Lam.	Pandanaceae	Kia	Shrub
48	<i>Pedaliium murex</i> L.	Pedaliaceae	Bada Gokhara	Herb
49	<i>Perotis indica</i> (L.) Kuntz.	Poaceae	—	Herb
50	<i>Phyla nodiflora</i> (L.) Green.	Verbenaceae	Gosingi	Herb
51	<i>Polycarpaea corymbosa</i> (L.) Lam.	Caryophyllaceae	—	Herb
52	<i>Polygala arvensis</i> Willd.	Polygalaceae	—	Herb
53	<i>Saccharum spontaneum</i> L.	Poaceae	Kasatandi	Herb
54	<i>Scoparia dulcis</i> L.	Scrophulariaceae	—	Herb
55	<i>Sebastiania chamaelea</i> (L.) Muell.-Arg.	Euphorbiaceae	—	Herb
56	<i>Sesuvium portulacastrum</i> (L.) L.	Aizoaceae	Goda Bani	Herb
57	<i>Sida cordifolia</i> L.	Malvaceae	Bajramuli	Herb
58	<i>Solanum virginianum</i> L.	Solanaceae	Ankaranti	Herb
59	<i>Spermacoce articularis</i> L.f.	Rubiaceae	—	Herb
60	<i>Spinifex littoreus</i> (Burm.f.) Merr.	Poaceae	Rabana	Herb
61	<i>Tephrosia purpurea</i> (L.) Pers.	Fabaceae	Banakulthi	Herb
62	<i>Tribulus terrestris</i> L.	Zygophyllaceae	Gokhara	Herb
63	<i>Triumfetta rhomboidea</i> Jacq.	Tiliaceae	—	Herb
64	<i>Waltheria indica</i> L.	Sterculiaceae	—	Herb
65	<i>Ziziphus oenoplia</i> (L.) Mill.	Rhamnaceae	Kanteikoli	Shrub
66	<i>Zornia diphylla</i> (L.) Pers.	Fabaceae	—	Herb
67	<i>Zoysia matrella</i> (L.) Merr.	Poaceae	—	Herb

The beach or strand area is characterized by maritime climate with a low organic content (Arun *et al.*, 1999). The prevailing climate along the shore of Gahirmatha is sub-humid. Although a number of species are associated with the sea beaches only some species show fidelity to the beach or strand habitat. On the basis of floristic survey the sandy vegetation of Gahirmatha beach may be categorised under the following groups.

### Foredune shrubs

Foredunes close to Satabhaya exhibit some shrubby species which arrest the sand particles and check for further movement towards hinterland. Notable species under this category are *Caesalpinia bonduc*, *Calotropis gigantea*, *Opuntia vulgaris*, *Pandanus fascicularis*, *ziziphus oenoplia* etc.

### Sand binding creepers and spreading herbs

Plants of this category are very tolerant of the exposed conditions of the beaches and high salinity. These plants spread along the sand rooting at nodes. They could be seen from the tree line along the backshore to almost the high tide mark. Notable species of this category include *Ipomea pes-caprae*, *Spinifex littoreus*, *Launaea sarmentosa*, *Hydrophylax maritima*, *Cyperus arenarius* and *Canavalia maritima* which are gregariously grown near Dobandhi and Agarnasi. These species possess high sand binding ability thus checking coastal erosion against natural forces. Smaller spreading herbs like *Sesuvium portulacastrum*, *Glinus oppositifolius* associated with *Ipomea pes-caprae*, *Launaea sarmentosa* and *Hydrophylax maritima* are well covered in Nasi-II (Outer wheeler island). *Cassytha filiformis* a parasitic twiner is plentifully present here along with the creepers forming thick mats. All these species play major role in arresting the movement of sand they can also tolerate burial in sand to certain extent.

### Erect herbs

Notable erect herbs associated with the exposed part of Gahirmatha beach near Babubali, Dobandhi, Talang and Madali are *Pedaliu murex*, *Crotalaria juncea*, *C. verrucosa*, *Saccharum spontaneum*, *Cyperus arenarius*, *Cassia occidentalis*, *Argemone mexicana* etc.

### Rainy season herbs

Profusion of herbs appears along the sea beach when the salinity is lowered during the rains. Most of these flower and fruit during September to November and complete their life or persist for longer time in shade and in wet spots. Some of them perennate also by their underground parts. These include *Emilia sonchifolia*, *Eragrostis tremula*, *Hedyotis herbacea*, *Hedyotis corymbosa*, *Leucas aspera*, *Lindernia crustacea*, *Murdannia spirata*, *Polycarpaea corymbosa*, *Waltheria indica* etc. Most of these are not fidelity species and they are herbs with wider distribution other than in beaches also.

Sand dune vegetation comprising of many species have high ecological values (Rao & Sastry, 1972; Banerjee, 1994). They bind sand particles, develop and stabilize sand dunes, check sand erosion, enrich substratum with humus, increase soil water holding capacity etc. Some species are considered to possess potential medicinal properties also (Pattanaik *et al.*, 2008).

### Floristic Diversity

During the present study, 67 angiospermic plant species were recorded comprising of 62 genera under 36 families (Table 1). Poaceae contributed the largest number with 7 species followed by Fabaceae and Cyperaceae with 6 species each. Among all the species, herbs were found to be more (52 sp.) followed by shrubs (9 sp.), climbers (5 sp.) and trees (1 sp.). From observation it is revealed that the species diversity gradually increases from seaward to inland. The notable elements like *Launaea sarmentosa*, *Ipomoea pes-caprae*, *Spinifex littoreus*, *Canavalia maritima* and *Hydrophylax maritima* are excellent sand binder and protect the coastal sand dune from erosion.

### Conclusion:-

Gahirmatha Marine Wildlife Sanctuary of Odisha has much significance from ecological, biological and geomorphological background. It has rich floristic diversity and great variability at species and ecosystem levels consisting of different types of vegetation in different habitats representing both mangroves and sand dune vegetation. The psammophytes play a vital role in protecting the coast from erosion and flooding. Some of the beach plants possess medicinal properties and are used by the local inhabitants for curing various types of ailments. Beach vegetation comprising of many species act as an ecological storehouse enriched in genetic diversity. They bind sand particles, develop and stabilize sand dunes, check sand movement, produce humus and increase soil water holding capacity. Along the Gahirmatha coast, local historical accounts reveal that there was good vegetation once upon a time. The seaward face of the sand dunes was well carpeted with grasses, sedges and creepers and the dunes more inland covered with characteristic shrubs and trees. The relic vegetation present today along the beaches is indication enough of their rich vegetational history. The sand dune species are not only ecologically important but also cater other basic needs of local community. Disturbance of this coastal vegetation has caused growing concern in recent years. More attention should be focused on understanding the physical and ecological events that take

place in these vulnerable habitats. For effective management of the beach ecosystem, conservation and judicious utilization of existing beach elements is inevitable for posterity. A sustainable management plan involving local community is also required which will ensure living standard of the people and ecological balance of the coastal habitats.

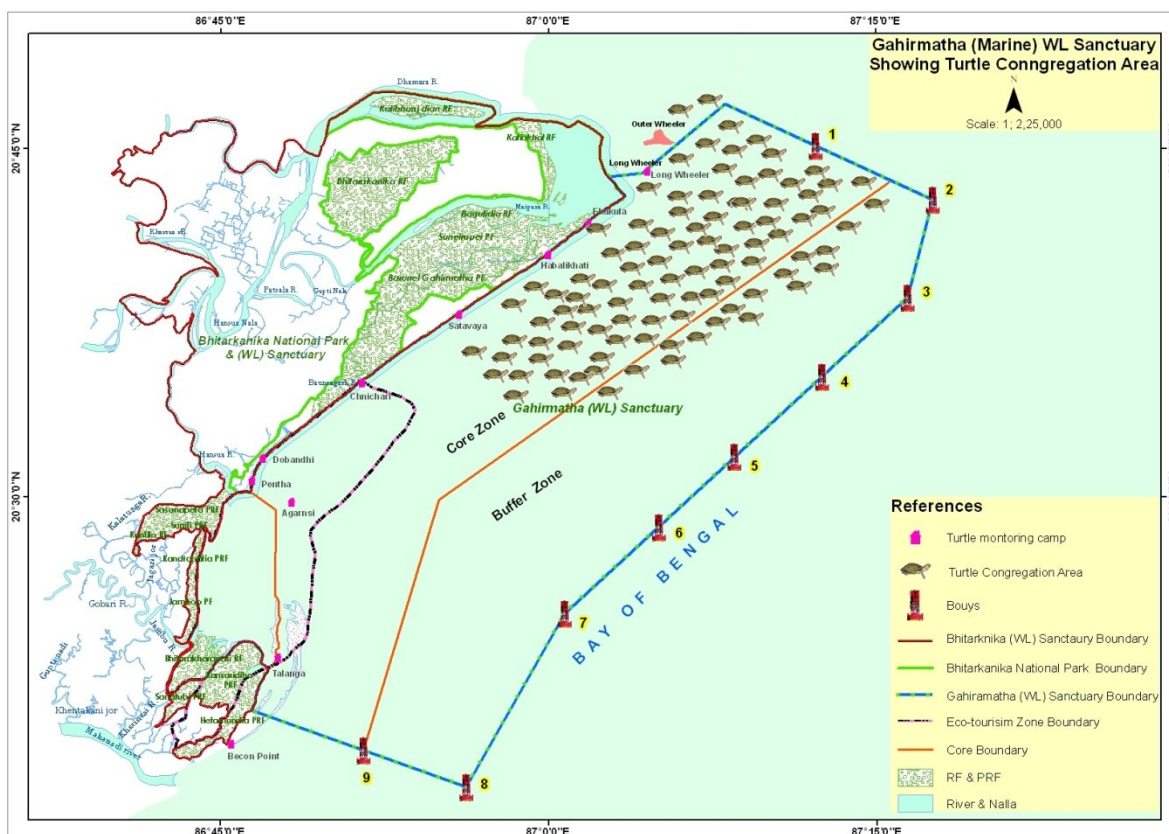


Fig. 1:- Map of Gahirmatha Marine Wildlife Sanctuary.

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