

# **Impacts of Invasive Alien Species on Island Ecosystems of India with special reference to Andaman Group of Islands**



Centre for Biodiversity Policy and Law  
**National Biodiversity Authority**

**2019**



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**Islands are natural textbooks that reveal to us  
how life has developed on Earth – William H. Amos**



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# I. Introduction

Convention on Biological Diversity (CBD) has mentioned that “an alien species is a species, subspecies or lower taxon, introduced outside its natural past or present distribution, which includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce” (CBD 2002)

Negative impacts of Invasive Alien Species (IAS) on global biodiversity is well recognized, which resulted in extinction of several species of flora and fauna in different ecosystems around the world (Baillie *et al.*, 2004; Early *et al.*, 2016; Sandilyan 2016). Studies have also established that invasive taxa can alter the species composition in a community and structure of ecosystems by repressing or excluding the native species directly by outcompeting them for resources or indirectly by changing bio-geo chemical cycle. Sometimes the entire ecosystem may be placed at risk through knock-on effects due to intensive invasion, which results in irretrievable loss of endemic species (GISP, 2004, Levine *et al.*, 2003).

All the major taxonomic groups including viruses, fungi, algae, mosses, ferns, higher plants, invertebrates, fishes, amphibians, reptiles, birds and mammals have been recognized for their invasion potential in different habitats. However, plants, insects and mammals comprise the most common types of invasive aliens in terrestrial environment (Rejmanek and Richerdson, 2000; Sujay *et al.*, 2010), whereas in aquatic habitat, molluscs, fishes, algae, floating and submerged plants are the predominant invasive taxa (Anil, 2002; Sandilyan, 2016). Mammals especially rodents e.g., rat and squirrel, large herbivores such as elephants and

deer, reptiles, amphibian and fishes and a variety of plants are reported as major invasive taxa in islands (Ali, 2004; Mulongoy *et al.*, 2006).

Ever-increasing globalization and the ongoing environmental changes significantly facilitate the dissemination of invasive species (Early *et al.*, 2016). In this connection, a recent survey highlighted that 17% of the global land area is highly prone to invasion (except Antarctica and glaciated Greenland). The report also states that 16% of the globally important “biodiversity-sensitive areas” are highly vulnerable to invasions (Early *et al.*, 2016). Reports also emphasized that invasive species are one of the important reasons for the species extinction. Further, the highest degree of species extinction was reported in islands due to invasive species (50% in the past 20 years (1984-2004)) (Baillie *et al.*, 2004).

In island ecosystems, the impacts of invasive species on biodiversity, agriculture, economy, health and culture are much stronger than in mainland (Russell *et al.*, 2017). The impacts of invasive species, however, vary within island systems and mostly the impact alter the island biogeography and human development (Russell *et al.*, 2017).

On several occasions, invasion of alien species drastically alters the native diversity of the islands and leads to the extinction of several unique island species which the result of million years of evolution. For example, the predatory brown tree snake *Boiga irregularis* was introduced into Guam (Western Pacific Ocean, southernmost of the Mariana Islands), during the early 1950s that resulted in the extinction of several indigenous vertebrate species including birds, fruit bats, geckos and lizards (Gurevitch and Dianna, 2004; Mulongoy *et al.*, 2006). Despite government spent nearly five million USD per year to get rid of this problem (Fritts, 2002; Mulongoy *et al.*, 2006).

Invasive alien plants can also destroy the island diversity in large scale. For instance, the South Pacific archipelago of French Polynesia, Tahiti is the largest island which was highly affected by the invasion of Lantana (*Lantana camara*), the trailing daisy (*Wedelia trilobata*) and miconia (*Miconia calvescens*). Interestingly

all the three plants were introduced as ornamental plants into Tahiti islands and in due course of time they managed to escape to the wild and invaded thousands of hectares of native rain forest and coastal areas of Tahiti islands (Mulongoy *et al.*, 2006).


Globally, approximately 600 million people depend on islands for their livelihood. Many of the islands provide freshwater, food, wood, fuel, fibre, medicines, and other important raw materials to humankind. Besides, island ecosystems well recognized for their ecosystem services, and also known for their ability to withstand natural disasters such as cyclone and tsunami (Fritts, 2002; Mulongoy *et al.*, 2006).

India is known for its vast coastal habitat diversity. The Indian coastal and inland areas support nearly 1,208 islands and many of them are uninhabited (Sandilyan, 2009; Pande *et al.*, 2013; Wikipedia, 2017a).

A number of Indian island species are at bay due to invasion. For example, the native vegetation of Andaman group of islands is highly affected and is altered by the introduced herbivore species such as elephant and chital. The spotted deer (chital) continuously feed on the saplings of the native plant species. Studies also confirmed that the introduced mammals are the main agents for the local extinction of some native plant species in Andaman group of islands (Ali, 2004).

Likewise, the marine ecosystem of Andaman and Nicobar islands was invaded by snowflake coral *Carijoa riisei*. A recent report by Zoological Survey of India (ZSI) stated that a 100-m-long abandoned jetty of Kundol region of Nicobar Islands was completely covered by *C. riisei* to a depth of 3–20 m (Raghunathan *et al.*, 2013). The other marine protected areas including Goa and parts of Tamil Nadu also reported the invasion of snowflake coral (Raghunathan *et al.*, 2013). However, more studies are needed to confirm the impacts of the species in each trophic level.

Globally, a number of studies have highlighted that invasive species cause significant damage to the biological and ecological diversity of islands and



destabilize the economy of some island nations (Mulongoy *et al.*, 2006). Ironically, ever-increasing globalization and the ongoing environmental changes significantly facilitate the dissemination of invasive species (Early *et al.*, 2016).

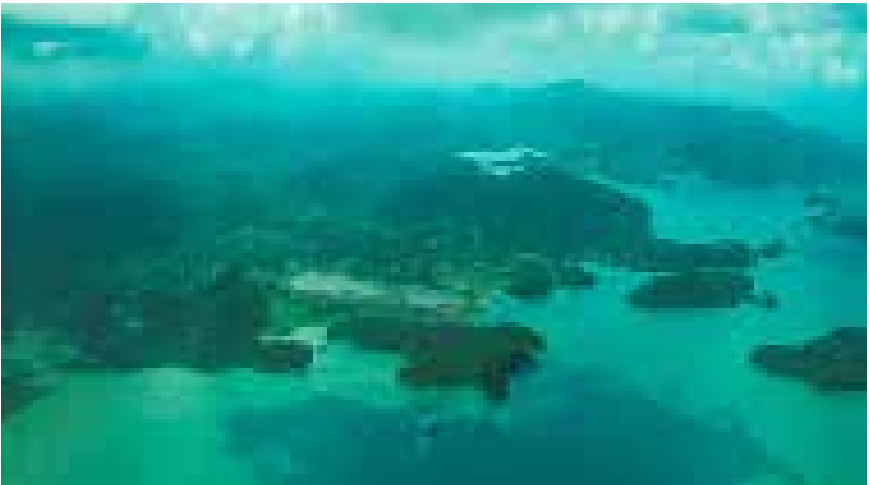
Obviously, the need of the hour is to develop a robust scientific planning to detection and eradicate invasive species in island ecosystems. A task force including taxonomists, ecologists, and resource managers should be established for prevention and effective management of invasion in Indian islands. Formulating new strategies and action plans with updated technology will be helpful for better invasive species management in islands.



## II. Introduction to Islands

The International Convention on the Law of the Sea defines an island in article 121 of Part VII as “an island is a naturally formed piece of land surrounded by water on all sides, emerging above the surface of the sea at the highest tide, capable of sustaining human habitation or economic life on its own, and with dimensions that are smaller than that of a continent” (MEA 2005).

Naturally, islands are also unique in their physical, biological, climatic, social, political, cultural, geological, geomorphologic, geography and ethnic characteristics and settings (Maul, 1993; Leatherman, 1997; MEA, 2005). Based on the aforesaid, islands are also classified into several kinds and the major classification details are provided in Table 1.



Aerial Photo of Andaman Islands (Photo by Ashwini V Mohan)

Table 1. Major island types

S. No	Kinds of islands	Definition	Source
1	Continental	A continental island is simply an island that rests on the continental shelf. These islands are always quite close to a given continent/mainland. The water level around a continental island is very shallow, typically less than 600 feet (e.g. Madagascar)	<a href="http://geologys.hol.es/what-are-continental-islands/">http://geologys.hol.es/what-are-continental-islands/</a> Accessed on 13/11/17
2	Oceanic	Island that arises from the deep sea floor is termed an oceanic island. Oceanic islands vary greatly in size from only a few specks of rock or sand to huge land masses (e.g. Hawaii)	<a href="http://geologys.hol.es/island-types/">http://geologys.hol.es/island-types/</a> Accessed on 13/11/17.
3	Coral	Coral island is formed from coral detritus and associated organic material. Normally they occur in tropical and sub-tropical areas, typically as part of coral reefs which have grown to cover a far larger area under the sea	<a href="https://en.wikipedia.org/wiki/Coral_island">https://en.wikipedia.org/wiki/Coral_island</a> . Accessed on 13/11/17.

S. No	Kinds of islands	Definition	Source
4	Desert	An island, especially in a warm region, where no people live	<a href="https://dictionary.cambridge.org/dictionary/english/desert-island">https://dictionary.cambridge.org/dictionary/english/desert-island</a> . Accessed on 13/11/17
5	Atoll/ islets/ cays/keys	An atoll is a ring-shaped coral reef, island, or series of islets. An atoll surrounds a body of water called a lagoon. Sometimes, atolls and lagoons protect a central island.	<a href="https://en.wikipedia.org/wiki/Atoll">https://en.wikipedia.org/wiki/Atoll</a> . Accessed on 13/11/17.
6	Eyot or holm	An island in a river or lake may be called (e.g., Montreal Island, Quebec, Canada)	<a href="https://en.wikipedia.org/wiki/Island">https://en.wikipedia.org/wiki/Island</a> . Accessed on 13/11/17
7	Artificial	Man-made islands are called artificial islands. It can be built using natural materials such as earth, rock and sand (e.g., Honshu islands of Japan)	<a href="https://en.wikipedia.org/wiki/Island">https://en.wikipedia.org/wiki/Island</a> . Accessed on 13/11/17.

## a. Biological Importance of Islands

Natural beauty, unique landscapes and wildlife always attracts more number of tourists towards islands. The islands deserve global attention as a conservation priority because of its high endemism and proportionate vulnerability to species extinction (Mulongoy *et al.*, 2006).

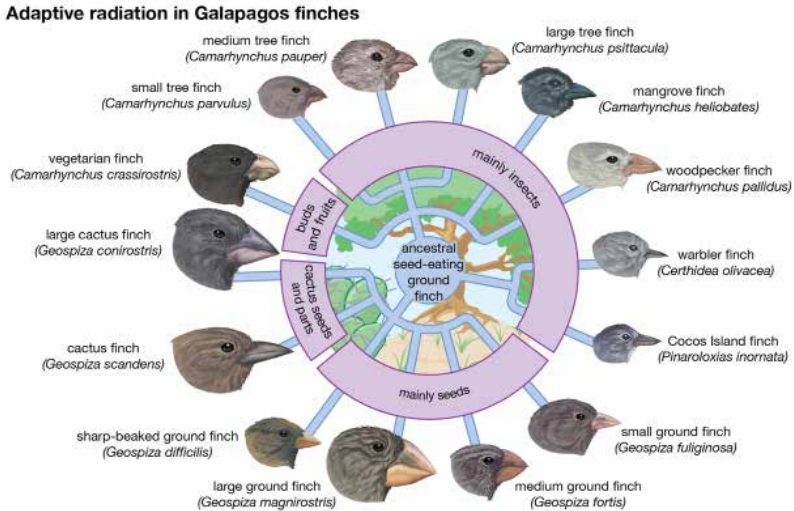
Interestingly, out of 35 global biodiversity hotspots, 20 are in islands, which shows the biodiversity importance of islands (Pande *et al.*, 2013). Globally thousands of islands are reported from different countries and continents. Of, this 150 are large islands and have nearly 200 different ecoregions which support unique plants and animals such as carnivorous plants e.g., *Nepenthes mirabilis*; *N. abalata* *N. abgracilis*; *N. beccariana* and animals like giant monitor lizards, iguana, giant tortoise, orangutans, and numerous resident and migratory birds (Ziemer, 1988; Mulongoy *et al.*, 2006; Wikipedia, 2017).

Considerable proportions of the reported species in islands are endemic to the particular island. For instance, Galapagos Islands 1,000 km away from the coast of Ecuador area harbours 2,194 terrestrial plant and animal species. Among them 1,187 (i.e. 54%) are endemic to this island (Galápagos archipelago 2017). Another study by Rosabal (2004) revealed that more than 80% of vascular plants recorded in Saint Helena and the Hawaiian Islands are endemic to that island.

Researchers highlighted that the size, distance, and period of isolation from large land masses often ended in high levels of adaptive specialization which resulted in high levels of endemism (Whittaker, 1998; Dullo *et al.*, 2002). Obviously, isolation, as a by-product of biogeographic insulation plays a key role in evolutionary changes and alters the genetic makeup of island population, distinct from that of the nearby main land populations (Whittaker, 1998; Dullo *et al.*, 2002). For instance, in Galapagos, only a few species were colonized in the beginning and subsequently radiated into a multitude of unique species. Even now, Darwin's finches stand as a classic example of this adaptive radiation phenomena and also laid the stone for Darwin's theory of evolution (Galápagos archipelago 2017) (Fig 1).



Figure 1. Adaptive radiation documented in Galapagos finches



Courtesy : Encyclopedia Britannica inc

Naturally island species tend to be concentrated in small areas (7% of the land surface) but the contribution of islands to global biodiversity is higher than the land area. In fact, one in six of earth’s known plant species occur on oceanic islands (Mittermeier *et al.*, 1998; Fisher, 2004).

The theory of island biogeography states that species richness is maintained by equilibrium between opposing rates of colonization and speciation, and of extinction. This equilibrium between extinction and immigration rate is determined by two major factors: distance from the mainland and island size. Larger islands can support more species and have lower extinction rates than small ones because they cover larger areas, with a greater diversity of habitats and resources. Less isolated islands tend to support more species than remote ones, because they have higher rates of immigration (MacArthur and Wilson, 1967).

Humans have introduced alien species that would not have been able to immigrate to islands under natural conditions; bearing little resemblance to island biota, their effects on native species are highly unpredictable. The introduced mammals have been reported to be the most serious invasive in islands (<https://www.cbd.int/island/invasive.shtml>). Invasive plants and animals introduced by humans often do not follow island biogeography predictions. Studies established that invasive alien species frequently have effects that far exceed what would be predicted by the equilibrium theory of island biogeography. For example, alien species are entering Hawaii about 2 million times faster than the natural rate (IUCN, 2002).

Number of studies pointed out the several island species are in the verge of extinction due to high level of anthropogenic pressures such as pollution, sea level rise, poaching, invasion etc. However, recent studies confirmed that invasive species emerged as a primary threat to island diversity and have caused serious ecological and economic damage and high social costs (e.g. Mulongoy *et al.*, 2006; Courchamp *et al.*, 2003). Even a single species immigration in to a island may cause large scale species extinctions and drastically alter the physical environment (IUCN, 2002).

Recently the IUCN assessed 432 Galapagos species and found 4 native species have already become extinct and 301 species face a huge threat due to invasion. The report also suggested that removing invasive species will allow threatened plant and animal populations to come back (Galápagos archipelago, 2017). Apart from conservation, a number of small islands have a strong traditional dependence on marine and coastal biodiversity for their food, tools, industry, medicine, transport and waste disposal (MEA, 2005).

Apart from the wild animal diversity, island also supports unique aboriginal tribes who might represent the direct descendants of early human migrants, speaking distinct languages and history of isolation. For instance, Andaman and Nicobar

group of islands support Onges, Jarwas, Sentinals, Andamanese, Nicobaries and Shompans (Barik *et al.*, 2008). Obviously island biodiversity conservation is the need of the hour.

## **b. Indian Islands and Its Biodiversity**

India has a total land area of 31,66,414 km and a coastal line of over 7,517 km which extends across nine coastal states and five union territories including Puducherry, Dadra and Nagar Haveli, Daman and Diu, Andaman and Nicobar and Lakshadweep. The inland and the coastal areas of India harbour nearly 1,208 islands which includes many uninhabited islands (Pande *et al.*, 2013; Wikipedia, 2017a). A number of smaller islands are reported in several states and union territories and a partial list of such islands is provided in Table 2. Besides, Lakshadweep and Andaman and Nicobar islands form the major archipelago in India, comprising 36 and 572 islands, respectively (Pande *et al.*, 2013).

The Lakshadweep Islands lie 220 to 440 km off the coast of Kerala in the Arabian Sea. The Andaman and Nicobar archipelagos situated in the Bay of Bengal. The two major islands of India support unique biodiversity (Pande *et al.*, 2013). Studies revealed that from time immemorial these two archipelagos receive more attention due to their rich biodiversity; besides, they provide livelihood to over 4,00,000 people (Pande *et al.*, 2013). On the other hand, there has been no comprehensive information about biodiversity wealth of smaller islands in India even though most of them are close to mainland (Pande *et al.*, 2013). However the available scientific studies clearly documented the species and habitat diversity in such islands. For example, the Gulf of Kutchh of Gujarat, and the Gulf of Mannar of Tamil Nadu support unique coral reefs and associated species including the endangered sea cow Dugong dugon. Nevertheless based on its ecosystem and biodiversity importance some of the smaller islands are also declared as protected area by the state and central government (e.g. Gulf of Kutchh and Gulf of Mannar declared as marine national park, Chorao Island of Goa declared as a bird sanctuary and Haliday Island Wildlife Sanctuary declared

as a part of Sundarbans Biosphere Reserve). A list of marine protected area are provided in annexure for reference.

There is no literature available in smaller islands and their biodiversity. Especially the inland islands of India are poorly addressed so far (Pande *et al.*, 2013). Based on the available literature a comprehensive list of species reported in smaller islands is provided in Annexure 1. On the other hand limited studies are available about biodiversity of Andaman, Nicobar and Lakshadweep Archipelago. A list of important species reported in these islands is provided in Annexure 2 - 4.

**Table 2.** Important islands supported by major Indian states and union territories

S. No	Name of the state	Major islands
1	Andhra Pradesh	Bhavani Island, Diviseema, Hope, Sriharikota
2	Assam	Dibru Saikhowa Island, Majuli Island, Umananda Island
3	Bihar	Raghopur Diyara Island
4	Gujarat	Kutch Island, Gangto Bet Island, Islands of the Gulf of Kutch Islands of Eastern Indus Delta.
5	Jammu & Kashmir	Char Chinar (Ropa Lank), Zainul Lank
6	Karnataka	Basavaraj Durga Island, Kurumgad Island, Netrani Island, Nisargadhama, Pavoov Uliya, Srirangapatna, St. Mary's Islands Uppinakudru
7	Kerala	Kavvayi Islands, Edayilakkad, Ezhumanthuruthu, Gundu Island, Kavvayi Islands, Kothad, Kuruvadweep, Moolampilly Island, Vallarpadam, Venduruthy, Vypin, Willingdon Island.
8	Madhya Pradesh	Mandhata Island
9	Maharashtra	Cross Island, Elephanta Island, Gowalkot, Hog Island, Mumbai Khanderi Island, Marve Island, Middle Ground Isle, Sinoy Hill Island, Suvarnadurg Island, Underi Island, Yeshwantgad Island.
10	Manipur	Keibul Lamjao Island, Floating Islands.

S. No	Name of the state	Major islands
11	Odisha	Abdul Kalam Island(Wheeler Island), Cattle Island, Hukitola Kalijai Island, Kanika Sands, Nalbana Island, Parikud Island
12	Tamil Nadu	Pamban Island, Hare Island (Muyal Theevu), Krusadai Island, Nallathanni Theevu, Pullivasal Island, Pullivasal Island, Srirangam Island, Upputanni Island, Quibble Island, Kattupalli Island, Katchatheevu,.
13	West Bengal	Ghoramara Island, Gosaba Island, Haliday Island, Henry Island, Namkhana Island, Nayachar Island, New Moore Island, Patharpratima Island, Sagar Island
<b>Union Territory</b>		
1	Daman Diu	Diu island
2	Goa	Chorao Island , Sao Jacinto Island, Anjadip Island
3	Lakshadweep	Lakshadweep is an archipelago of twelve atolls, three reefs and five submerged banks, with a total of about thirty-nine islands and islets with a total of 39 Islands
4	Andaman & Nicobar	The Andaman and Nicobar Islands contain a group of 572 islands.  Great Andaman islands, North Andaman island, Port Blair island.  Nicobar Islands – Car Nicobar island, Greater and little Nicobar islands

Source: Wikipedia 2017a

## c. Invasive Alien Species in Andaman Group of islands

Global research has clearly stated that islands are highly prone to large-scale invasion and in recent times, the invasions have emerged as unprecedented threat to the unique island diversity. A number of studies in India also documented the vulnerability of island diversity due to invasion (e.g. Mohanraj *et al.*, 1999; Ali 2004; Mohanty *et al.*, 2015). However, major studies in India are from Andaman and Nicobar islands.

From the past few decades, Andaman and Nicobar islands are continuously exposed to high levels of alien species introduction from mainland people. As a whole, so far 3 snail, 4 insect, 12 mammal, 13 marine fish and 19 bird and 566 plant species have been introduced into these archipelago. Besides, a number of exotic species are yet to be documented (Mohanraj *et al.*, 1999; Rajan and Pramod 2013). Among the introduced, few species only exhibited their invasive character. For example, among the 19 introduced bird species, common myna *Acridotheres tristis* and house crow *Corvus splendens* evolved as invasive to Andaman Islands (Rajan and Pramod 2011).

Interestingly, some of the introduced domesticated mammals such as cats and dogs evolved as feral and cause more menace to the native species of Andaman and now they are categorized as invasive by some researchers. Reports also underscored that feral dogs are the main reason for the decline of sea turtles in Andaman Islands. The egg depredation behaviour of feral dogs already leads to decline of sea turtle population in some areas (Ali, 2004; Murugan, 2004).

Pertaining to Andaman and Nicobar islands more studies are focused on the impacts of invasive herbivores on native vegetation. Three species of deer (Chital *Axis axis*, Barking deer *Muntiacus muntjak* and Hog deer *Axis porcinus*) and the Asian elephant (*Elephas maximus*) are important introduced large herbivores to this archipelago (Ali, 2004). However, chital and elephant caused huge damage to the native vegetation and are tagged as the worst invasive mammals of these archipelago (Ali, 2004). Among these two species, chital has been reported in

almost all the Andaman group of islands. Researchers have pointed out that chital have adapted to becoming good swimmers and easily cross the sea and reach all the islands. However, chital is not reported in Little Andaman and South Sentinel Islands so far. On the other hand, the elephants are restricted to Interview islands to North Andaman Islands (Ali, 2004).

Apart from the large mammals, some of the birds are started to exhibit some invasive character in this island. A report from Salim Ali Centre for Ornithology and Natural History (SACON) disclosed that 19 bird species were introduced to the Islands from mainland India during the first half of the 19<sup>th</sup> Century. However, six bird species have a commendable population and some of them are shown some invasive attributes. Especially Common Myna *Acridotheres tristis*, House Sparrow *Passer domesticus* and House Crow *Corvus splendens* may have the chance to become worst invasive in near future (Rajan and Pramod 2013). Besides, in the recent past, the Indian bullfrog *Hoplobatrachus tigerinus* was emerged as a big threat to native species. A study from Mohanty and Measey (2018) established the invasive potential of the species and underscore that some of the endemic reptiles are at risk due its food habits/preference.

Pertaining to invasive alien plants, few checklists are available about the occurrence of alien plants. However, water hyacinth, eupatorium and parthenium are reported everywhere in the Andamans. To confirm the impacts of the species at ecosystem level further studies are needed.



Island Photo (Photo by Ashwini V Mohan)





### III. Impacts of Invasive Alien Species on Indian Islands

Even though Indian political boundary supports more than 1000 islands, Andaman and Nicobar Islands and Lakshadweep islands are considered as major islands. The biodiversity wealth of these islands is periodically documented by the ZSI, BSI and other research institutions. However, there is no adequate documentation on invasion issues so far, in particular, a handful of studies are available about the impacts and they do not address the issues in detail. Due to the lack of literature, the current report is focused only on the issues prevailing in

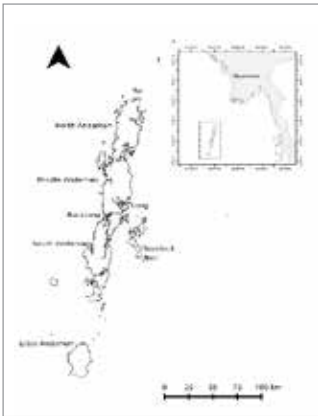


Figure 3. Andaman group of Islands

Andaman group of islands. The list of invasive animal species and the alien plant species is provided in the annexure.



Figure 2. Map and Aerial View of Andaman group of islands ( Photo by Ashwini V Mohan)

The Andaman group of islands are the tropical group of islands in the Bay of Bengal, situated between latitude 10° 30' N and 13° 40' N, and longitude 92° 10' E and 93° 10' E (Figs 2 and 3). This island group is divided into two major parts: Great Andamans and Little Andaman Island separated by a distance of ca. 50 km. These islands were once a part of the Asian mainland but got detached some 100 million years ago during the Upper Mesozoic Period due to geological upheaval.

## **a. Impacts of Introduced Large Mammals in Andaman Group of Islands**

Andaman group of islands are known for its floral diversity, especially it is recognized for its endemic plant species (14% endemism). Recent studies from this island disclosed that most of the plant species are facing huge risk due to the invasion of large mammals like elephant and chital. Studies established that the sites/habitat which support these two species witnessed large-scale forest degradation (Ali and Pelkey 2013).

On the other hand, studies (e.g. Ali, 2004) also opined that invasive alien plants also pose a serious threat to this unique habitat and plant species diversity (Ali, 2004). However, there are no in-depth studies about the impacts of the established invasive species in each trophic level. Besides researchers also register their concern on the occurrence and damage caused by other animals including the feral dog and cat, African snail and Indian bullfrog.

### **a1. Impacts of Elephant on Andaman Group of Islands**

The introduction of elephants (*Elephas maximus*) in Andaman group of islands took place during early days of 20<sup>th</sup> century. The elephants were mainly brought into Andaman for forestry-related operations especially for timber extraction operation. Even today, some elephants are being used for timber operation in selected parts of this island (Ali, 2004; Kumara *et al.*, 2012).

During the 1950s, P.C. Ray Timber Company brought 40 elephants to Interview Island for timber operation. However, due to the failures in timber operation around 1960s the company abandoned the elephants at Chainpur forest of North

Andaman and Interview Island. The abandoned elephants in the Chainpur forest apparently travelled up to Diglipur Forest Division. However, reports confirmed that the elephants which were abandoned in Interview Island managed to escape from this island by swimming to North Andaman island and in due course of time they turned feral and started to trouble public in that area (Sivaganesan and Kumar 1994).

Besides, studies also established that the abandoned/escaped elephants caused huge damage to the native vegetation, especially they caused huge damage to canes and bamboos. Numbers of wild trees were debarked and uprooted by elephants, which in turn created artificial fragmentations in the dense forest area. On the other hand, the fragmented habitats were instantly occupied by the native seedlings. However, most of the palatable seedlings were consumed by elephants and chital in a large extent and only non-palatable native plant species escaped from the predatory pressure (Sivaganesan and Kumar 1993, 1994; Ali, 2004).

Ali (2004) opined that the elephant population created more gaps in the forest system and accelerated the growth of non-palatable plant species. In due course of time this process slowly changed natural zonation pattern of the forest and led to huge artificial food scarcity to herbivores such as chital and elephants in this islands. To support this, a study by Sivaganesan (unpublished study) reported the changes in the food plant species preference among abandoned elephant population in this island. The study highlighted that the elephants also started to brows plants species which were not consumed by them earlier which indicated that the feral elephant population started to face a food shortage (Anil, 2004).

The Government of India declared the place as Wildlife Sanctuary in 1985 in order to protect the feral elephant population of Interview Island. But the recent report by Kumara *et al.*, (2012) provided an estimate of 0.109 elephants per sq. km in the Interview Island Wildlife Sanctuary, and reported that feeding or the damage caused by feral elephants has affected the native vegetation. While Sivaganesan and Kumar (1994) recorded 9 tree species debarked by elephants on Interview Island, Kumara *et al* (2012) recorded 16 tree species debarked; the

latter study also recorded that the density of non-food plants was also affected by feeding or damage by the feral elephant. The researchers suggested for constant monitoring of the feral elephant population is essential for long-term management (Sivaganesan and Kumar, 1994; Ali, 2001, 2004; Kumara *et al* 2012).

Besides, there are no in-depth studies carried out by any agencies/researchers about the impacts of the elephant on the native diversity of Andaman. The available studies established the impacts but undoubtedly failed to quantify the impacts in a scientific way.

## **a2. Impacts of Chital on Andaman Group of Islands**

Chital (*Axis axis*) has been identified as potential threat to native floral and faunal diversity of the Andaman islands. Chital was introduced into the Andaman around 1914–1930s. Comparatively the Interview Island harbours high deer population than the other smaller islands. Studies on the impacts of the chital population in Interview islands disclosed the occurrence of high-level sapling and seedling mortality, forest cover change and degradation (Ali and Pelkey 2013; Mohanty *et al.*, 2016; Mohanty and Ravichandran, 2017) (Fig 4).



*Figure 4. Degraded under-storey cover due to over-browsing by chital.  
(Photo by Nitya Prakash Mohanty)*

Changes in the vegetation cover negatively influence the abiotic factors including temperature, moisture, light intensity of that region which may have some unwanted impacts on soil-dwelling/depending organisms such as microbes, insects and other smaller invertebrates and vertebrates, thereby cascading its impacts on the natural food web (Co'te ´ et al 2004).

Recent study by Mohanty *et al.* (2016) highlighted that grazing behaviour of chital drastically extended the availability of barren forest floor in Andaman islands (Fig 4). This phenomenon directly and indirectly affects the native lizard population in these islands. It is worth to mention here that these islands support 42 species of terrestrial reptiles (20 lizards, 22 snakes) and most of them are endemic to the islands (Harikrishnan *et al.*, 2010).

In Andaman it was noticed that the survival of the subterranean egg-laying agamids such as *Coryphophylax* species and skinks (e.g. *L.bowringii*) was affected due to the changes in the vegetation cover (Mohanty *et al.*, 2016). Further, species such as *C. subcristatus* generally roost on saplings and under-storey leaves of the forest (Figs 5 and 6). The ongoing reduction of sapling density by chital limited the perching and roosting sites for this lizards (Mohanty *et al.*, 2016). However, it is not yet systematically quantified by the researchers in Andaman group of islands.



Figure 5. Endemic Bay Island forest lizard *Coryphophylax subcristatus* in Andaman (Photo by John Measey)

Studies from various region confirmed that, arboreal and forest floor lizards are highly prone to predation when there is a reduction in the forest cover (North *et al.*, 1994) and this was also reported in Interview Island by Mohanty *et al.* (2016).

Apart from the lack of perching and roosting sites, the non-availability of folivorous arthropod also led to the decline of insectivorous lizard population and altered the natural species composition (Mohanty *et al.*, 2016). However,

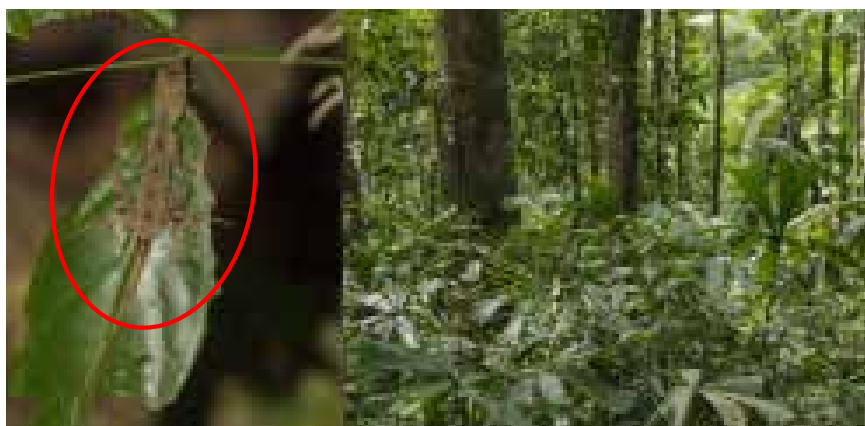


Figure 6. Endemic short-tailed Bay Island Lizard *Coryphophylax brevicaudus* recorded in its typical habitat in the evergreen forest. (Photo by Nitya Prakash Mohanty)

there is no study about the impacts of diminishing vegetation cover on microbes and other beneficial organisms and how it altered the natural food web of this region.

Mohanty *et al.* (2016) also suggested the need for detailed investigation on the utilization of affected/altered habitats by invasive plant species. It was already well established that disturbed habitats are highly prone to new invasion (Sandilyan ,2015).

## **b. Impacts of Indian Bullfrog**

Globally amphibians are considered as one of the worst invasive groups, and several studies have established the detrimental impacts of amphibians in the introduced/invaded ecosystems (Pitt *et al.*, 2005; Kraus 2015). Recent reports from Andaman confirmed the occurrence of invasive frog species and reported about the impacts.

Andaman group of islands supports ten species of amphibians, the common Asian toad (*Duttaphrynus melanostictus*) is the largest one (Harikrishnan and Vasudevan 2013). However, during 2000–2013 Indian bullfrog *Hoplobatrachus tigerinus* (Fig 7) was introduced into Andaman group of islands (Harikrishnan

and Vasudevan 2013; Mohanty and Measey in review). Some have reported that the bull frog was brought by some farmers from West Bengal and released into rice fields in Mayabunder, presumably for local consumption (Harikrishnan and Vasudevan 2013). In due course of time with their huge invasive potential this frog extended its territory to several parts of the islands. Local people reported that the bull frogs feed on invertebrates and small vertebrates including domesticated small chickens (Harikrishnan and Vasudevan 2013).



Figure 7. Indian bullfrog *Hoplobatrachus tigerinus* (Photo by Harikrishnan.S)

Mohanty and Measey (2018) studied the food preference of the invasive frog *H. tigerinus* and found that there is a significant dietary overlap with the native *Limnonectes* spp. and opined that it will lead to competition. Besides it was also inferred from the study that a number of endemic animals are consumed by the invasive bull frog. Especially the endemic snake *Typhlops oatesii* (Fig 8), giant



Figure 8. The endemic snake *Typhlops oatesii* (Photo by Nitya Prakash Mohanty)



Figure 9. The endemic giant centipedes (Photo by Nitya Prakash Mohanty)

centipedes (Fig 9), gecko *Phelsuma andamanens* (Fig 10) are consumed by the Indian bull frog. However, there is no systematic study about the impact of bull frog on these endemic species population.

### c. Impacts of Indian Myna

Common myna *Acridotheres tristis* has been introduced from mainland India. However, there is no systematic studies about the impacts of the species on native diversity. Continuous surveys established that there is a constant increase of the species in this island. Further, common myna started to replace the Glossy Stare (*Aplornis panayensis*) in number of sites, compete with the native birds species for food, and shelter (Koenig, 2003). However, a long term systematic studies are needed to quantify the loss.



Figure 10. The endemic gecko *Phelsuma andamanens* (Photo by Nitya Prakash Mohanty)





## IV. Recommendations

### Prevention

- Strengthen quarantine regulations to try to limit the entry of invasive species into the island from mainland and from other destinations.
- Develop regional invasive species management strategies and action plans with robust planning methods and guidelines.
- Create specific awareness programmes for the public, policy makers and civil society organisations on the impact of IAS in island ecosystems.
- Promote mission mode research programmes on invasive species management in island ecosystems.
- Explore the possibility for the coordination work among the key regional research institutions including ZSI, BSI and CMFRI.
- Establish a task force of experts to address the emerging issues in major islands
- Promote research on modeling dynamics of native and invasive species to guide prioritization of management actions

## Control and Eradication

- Prioritise management programmes for IAS in the island and the highly impactful species such as elephant and chital should be restricted to defined area.
- Develop action programme to manage potential plant invasive species in the island

## Restoration

- Eradication is often sufficient to allow the return of the original native wildlife. However, active management, such as replanting of native flora and reintroduction of native fauna is frequently necessary to fully restore a damaged area. Once an area is restored, prevention is also required to keep an invasive species from returning to the island.

## References

- Ali R, Pelkey N .2013. Satellite images indicate vegetation degradation due to invasive herbivores in the Andaman Islands. *Curr Sci* 105:209–214.
- Ali, R. 2004. The effect of introduced herbivores on vegetation in the Andaman Islands *Current Science*, 86(8); 1103-1112.
- Anil, A. C., Venkat, K., Sawant, S. S. et al., 2002. Marine bioinvasion: Concern for ecology and shipping. *Current Science*; 83(3); 214-218.
- Azeez, P.A., Murugesan, M. and Nikhil RAJ, P.P. 2011. Impact Assessment of LNG Terminal Augmentation Project by M/s PLL on the Terrestrial Flora and Fauna at Puthuvypeen, Kerala. Coimbatore: Salim Ali Centre for Ornithology and Natural History. 72 pp.
- Baillie, J., Hilton-Taylor, C. and Stuart, S.N. 2004. IUCN Red List of Threatened Species: A Global Species Assessment. Gland: IUCN.
- Barik, S.S.etal. 2008. Detailed mtDNA Genotypes Permit a Reassessment of the Settlement and Population Structure of the Andaman Islands. *American Journal of Physical Anthropology* 136:19–27 (27)
- Borges, D.S. 2002. Studies on the Ecology of Wader Birds in the Mandovi Estuary of Goa, India. PhD thesis, Goa University, Goa.
- CBD (Convention on Biological Diversity), 2002. Decision VI/23 (Annex, footnote): Alien species that threaten ecosystems, habitats and species. Document UNEP/CBD/COP/6/23. Convention on Biological Diversity Secretariat, Montreal, Canada. Available from <https://www.cbd.int/decision/cop/?id=7197>, (accessed 11.01.15).
- Co`te ´ SD, Rooney TP, Jean-Pierre T, Dussault C, Waller DM (2004) Ecological impacts of deer overabundance. *Annu Rev Ecol Syst* 35:113–147
- Courchamp F, Chapuis J-L, Pascal M (2003) Mammal invaders on islands: impact, control and control impact. *Biol Rev* 78:347–383.
- Daniels, R.J.R., Ramachandran, S. V., Vencatesan, J., Ramakantha, V. and Puyravaud, P.J. 2007. Dispelling the myth of tropical dry evergreen forests of India. *Current Science* 92 (5): 586-588.
- Dineshbabu, A.P. and Zacharia, P.U. 2007. An assemblage of marine ornamental shrimp, *Rhynchocinetes durbanensis* off Karnataka coast. *Marine Fisheries Information Service, Technical and Extension Series* 192: 14.
- Dixit, A.M., Kumar, P., Pathak, K.D. and Patel M.I. 2010. Economic Valuation of Coral Reef Ecosystem in Gulf of Kachchh. Gandhinagar: Gujarat Ecology Commission.

- Dulloo, M.E., S.P. Kell, and C.G. Jones, 2002: Impact and control of invasive alien species in small islands. The International Forestry Review, Special Issue on Forestry and Small Island Developing States, Commonwealth Forestry Association, Bicester, United Kingdom, pp. 277–285.
- Early, R. *et al* 2016. Global threats from invasive alien species in the twenty-first century and national response capacities Nature Communication..DOI: 10.1038/ncomms12485.
- Fritts, T.H., 2002: Economic costs of electrical system instability and power outages caused by snakes on the Island of Guam. International Biodeterioration and Biodegradation, 49, 93–100.
- Galápagos archipelago a paradise threatened by invasive alien species. 2017. (<https://www.islandconservation.org/wp-content/uploads/2015/09/Galapagos-Brochure.pdf>. Accessed on 15/11/17).
- GISP (2004). Africa Invaded: The Growing Danger of Invasive Alien Species. Global Invasive Species Programme, Cape Town. (<http://www.gisp.org/downloadpubs/gisp%20africa%202.pdf>).
- Gopl, G. V and Pandav, B. 2007. Avifauna of Bhitarkanika Mangroves India. Zoos Print Journal 22 (10): 2839-2847.
- Gurevitch, J. and Dianna, K. Padilla, 2004. Are invasive species a major cause of Extinctions. Trends. Ecol. Evol., 19(9): 470474.
- Harikrishnan S, Vasudevan K. 2013. Recent introduction and spread of Indian bullfrog *Hoplobatrachus tigerinus* (Daudin, 1802) into the Andaman Islands. Aliens, 33:42–43.
- Harikrishnan, S., Vasudevan, K. and Choudhury., BC.2010. A review of herpetofaunal descriptions and studies from Andaman and Nicobar islands, with an updated checklist. In: Ramakrishna, Raghunathan C, Sivaperuman C (eds) Recent trends in biodiversity of Andaman and Nicobar Islands. Zoological Survey of India, Kolkata, pp 387–398.
- Ibrahim, A.M. and Manal, MAC. 2012. Ballast Water Review: Impacts, Treatments and Management. Middle-East Journal of Scientific Research 12 (7): 976-984.
- ICMAM. 2002. Critical Habitat Information System for Cochin Backwaters-Kerala. Chennai: Integrated Coastal and Marine Area Management.
- IUCN, 2002. Turning the tide: the eradication of invasive species (proceedings of the international conference on eradication of island invasives) (Occasional Paper of the IUCN Species Survival Commission No. 27. Veitch, C. R. and Clout, M.N., eds. 2002.).
- Jeganathan, S., Saravanan, K.R., Choudhury, B.C. and Sivakumar, K. 2006. Vegetation Status in the Offshore Islands of Gulf of Mannar Marine National Park, Tamil Nadu. Dehradun: National Institute for Coastal and Marine Biodiversity (NICMB), Wildlife Institute of India.

- Kraus F. 2015. Impacts from Invasive Reptiles and Amphibians. *Annual Review of Ecology, Evolution, and Systematics*, 46, 75-97.
- Kumara, H.N., Manchi, S.S., Ashwin, H.P., Pethe, H. and Mane, A. 2012. Estimation of abundance of feral elephants in Interview Island Wildlife Sanctuary, Andaman and Nicobar Islands, India. Technical Report submitted to the Forest Department, Andaman and Nicobar Islands, Port Blair.
- Lobo, A.S. 2006. Sea Snakes of the Gulf of Mannar Marine National Park: The Species and Their Conservation. Technical report submitted to the Rufford Foundation. 61 pp.
- Manakadan, R., Sivakumar, S., David, P. and Murugan, S.B. 2013. The mammals of Sriharikota Island, southern India, with insights into their status, population and distribution. *Journal of the Bombay Natural History Society* 110 (2): 114-121.
- Maul, G.A., 1993: Ocean science in relation to sustainable economic development and coastal area management of small islands. In: *Small Islands: Marine Science and Sustainable Development*, G.A. Maul (ed.), American Geophysical Union, Washington, D.C., pp. 1–17.
- MacArthur R. W. & Wilson E. O. 1967. *The Theory of Island Biogeography*. Princeton University Press, Princeton.
- Millennium Ecosystem Assessment (MEA). 2005. Assessment report, Chapter 23, Island System; in *Ecosystems and Human wellbeing: Current State and Trends*. [www.millenniumassessment.org/documents/document.292.aspx.pdf](http://www.millenniumassessment.org/documents/document.292.aspx.pdf). Accessed on 29/09/2017.
- Mittermeier, R.A., N. Myers, J.B. Thomsen, G.A.B. Fonseca, and S. Olivieri, 1998: Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. *Conservation Biology*, 12, 516–520.
- Mohanraj P., Veenakumari, K., and Bandyopadhyay, A. K., 1999. Perilous aliens. Central Agricultural. Research Institute, Port Blair. 8-9pp.
- Mohanty . S. Harikrishnan . K. Sivakumar . Karthikeyan Vasudevan. 2015. Impact of invasive spotted deer (*Axis axis*) on tropical island lizard communities in the Andaman archipelago. *Biol Invasions* DOI 10.1007/s10530-015-1006-0.
- Mohanty NP, Measey J. 2018. What’s for dinner? Diet and trophic impact of an invasive anuran *Hoplobatrachus tigerinus* on the Andaman archipelago. *PeerJ Preprints* 6:e26544v1 <https://doi.org/10.7287/peerj.preprints.26544v1>.
- Mohanty, N.P. and Ravichandran. .2017. Introduced herbivores and their management in the Andaman Islands. *Current Science*, 112(3); 445-446.
- Mohanty, N.P., Harikrishnan, S., Sivakumar, K. *et al.* 2016. Impact of invasive spotted deer (*Axis axis*) on Tropical Island lizard communities in the Andaman archipelago.

Biological Invasion 18: 9. <https://doi.org/10.1007/s10530-015-1006-0>.

- Mukhophadhya, S.K., Biswas, H., Das, K.L., DE, T.K. and Jana, T.K. 2001. Diurnal variation of carbon dioxide and methane exchange above Sundarban mangrove forest, in NW coast of India. *Indian Journal of Marine Sciences* 30(2): 70-74.
- Mulongoy, K.J., Webbe, J., Ferreira, M. & C. Mittermeier (2006). *The Wealth of Islands-A Global Call for Conservation*. Special Issue of the CBD Technical Series, Montreal, vi+23 pages.
- Murugan, A. 2004. Sea turtles and their conservation in Andaman and Nicobar Islands. *Proceedings of the International Symposium on SEASTAR 2000 and Bio-logging Science (The 5th SEASTAR2000 Workshop)* (URL <http://hdl.handle.net/2433/44095>)
- Nagi, H.M.H. 2008. *Environmental Studies of Mangrove Cover Changes in Goa and Its Resident Crassostrea Population*. Ph.D. thesis, Goa University/National Institute of Oceanography, Goa, India.
- North SG., Bullock, DJ, Dulloo, ME .1994. Changes in the vegetation and reptile populations on Round Island, Mauritius, following eradication of rabbits. *Biol Conserv* 67:21–28.
- Pande, A *et al.*, 2013. In book: *ENVIS Bulletin on Coastal and Marine Protected Areas in India: Challenges and Way Forward*, Edition: 15 (2013), Chapter: Biodiversity of Coastal Islands of India, Publisher: Wildlife Institute of India, Dehradun, India, Editors: K Sivakumar, pp.190-214.DOI: 10.13140/RG.2.1.2276.5285.
- Pierce, R. H. and Henry, M. S.2008. Harmful algal toxins of the Florida red tide (*Karenia brevis*): natural chemical stressors in South Florida coastal ecosystems. *Ecotoxicology*, 17(7): 623–631. doi:10.1007/s10646-008-0241-x.
- Pitt W, Vice D, Pitzler M. 2005. Challenges of invasive reptiles and amphibians. *Proceedings of Wildlife Damage Management Conference*.
- Raghunathan, C., Venkataraman, K., Satyanarayana, Ch. and Rajkumar. R. 2013. An Invasion of Snowflake Coral *Carijoa riisei* (Duchassaing and Michelotti 1860) in Indian Seas: Threats to Coral Reef Ecosystem.. K.Venkataraman *et al.* (eds,),in *Ecology and Conservation of Tropical Marine Faunal Communities* pp 381-393.
- Raghunathan, C., Venkataraman, K., Satyanarayana, Ch. and Rajkumar. R. 2013. An Invasion of Snowflake Coral *Carijoa riisei* (Duchassaing and Michelotti 1860) in Indian Seas: Threats to Coral Reef Ecosystem. K. Venkataraman *et al.* (eds,), in *Ecology and Conservation of Tropical Marine Faunal Communities*,pp 381-393.
- Rajan, P. and Pramod, P., 2013. Introduced birds of the Andaman & Nicobar Islands, India. *Indian Birds* 8 (3): 71-72.
- Rajeswari, M.V. and Thangavel, B. 2014. Distribution, diversity and taxonomy of marine

angelfishes (Pomacanthidae) of Tamilnadu, southeast coast of India. *International Journal of Fisheries and Aquaculture* 6(2): 20-31.

- Rao, R.J. 1985. Conservation of marine turtles in Andhra Pradesh. *Marine Fisheries Information Service, Technical and Extension Series*64: 20-21.
- Rejmanek, M. and Richardson, D.M., 2000, What makes some conifers more invasive? *Proceedings of the Fourth International Conifer Conference*.
- Rosabal, P., 2004: Protected areas: benefits to islanders. *INSULA Special Issue February 2004*, pp. 21–28.
- Russel, J.C., Meyer, J.Y., Holes, N.D and Pagad, S. 2017. Invasive alien species on islands: impacts, distribution, interactions and management. *Environmental Conservation* 44 (4): 359–370.
- SAC. 2012. *Coastal Zones of India*. Ahmedabad: Space Application Centre (ISRO), Government of India. 597 pp.
- Sandilyan, S. 2009. Habitat quality and waterbird utilization pattern of Pichavaram wetlands, southern India. Ph.D. Thesis, Bharathidasan University, Tiruchirappalli
- Sandilyan, S. 2015. Highways of India: A heaven to invasive alien plants. *Science India*. Vol. 18, No. 12, p 33-36.
- Sandilyan, S.2016. Occurrence of ornamental fishes: a looming danger for inland fish diversity of India. *Current Science*, 110 (11): 2099-2104.
- Savithamma, N. and Narayana, R.K. 2001. Bio-diversity in angiospermic (medicinal plants) wealth of Sriharikota Island, Andhra Pradesh. *Indian Journal of Environmental Protection*21 (9): 811-815.
- Singh, S. 2002. Report of the Shekhar Singh Commission, submitted to the Supreme Court.
- Sivaganesan, N. and Kumar, A. 1994. Status of feral elephants in the Andaman Islands, India. *SACON-Technical Report*, Coimbatore, India.
- Sivaganesan, N. and Kumar, A., 1993. Status of feral elephants in Andamans. In *A Week with Elephants: Proceedings of the International Seminar on the Conservation of Asian Elephant* (eds Daniel, J. C. and Datye, H. S.), Oxford University Press, Oxford, June.
- Sujay, Y.H., Sattagi H.N. and Patil, R.K.2010. Invasive alien insects and their impact on agroecosystem Karnataka *J. Agric. Sci.*, 23(1) : (26-34) 2010.
- Surendra, B., Muhammed, A. A., & Raju, Solomon AJ. 2013. Invasive Alien plant species assessment in urban ecosystem: a case study from Andhra University, Visakhapatnam, India. *International Research Journal of Environment Sciences*, 2(5), 79–86.

- UNDP. 2001. Conservation and Sustainable Use of the Gulf of Mannar Biosphere's Coastal Biodiversity. United Nations Development Programme, Global Environment Facility.
- Venkataraman, K., Rajkumar, R., Satyanarayana, C.H., Raghunathan, C. and Venkataraman, C. 2012. Marine Ecosystems and Marine Protected Areas of India. Kolkata: Zoological Survey of India. 296 pp.
- Whittaker, R.J., 1998: Island Biogeography: Ecology, Evolution, and Conservation, Oxford University Press, Oxford, 304 pp.
- Wikipedia 2017. [https://en.wikipedia.org/wiki/List\\_of\\_Nepenthes\\_species\\_by\\_distribution](https://en.wikipedia.org/wiki/List_of_Nepenthes_species_by_distribution). Accessed on 13/11/17.
- Wikipedia 2017a .[https://en.wikipedia.org/wiki/List\\_of\\_islands\\_of\\_India](https://en.wikipedia.org/wiki/List_of_islands_of_India). Accessed on 13/11/17.
- WWF.2009. Silent Invasion – The spread of marine invasive species via ships' ballast water. WWF International, Gland, 2009. ([www.wwf.de/fileadmin/fm-wwf/Study\\_Silent\\_Invasion.pdf](http://www.wwf.de/fileadmin/fm-wwf/Study_Silent_Invasion.pdf)). Accessed on 8/10/16.).
- Zacharia, P.U., Krishnakumar, P.K., Dineshbabu, A.P., Kaladharan, P. and Vijayakumaran, K. 2006. Discovery of fringing reefs off Karnataka coast. CMFRI Newsletter110: 1-2.
- Zacharia, P.U., Krishnakumar, P.K., Dineshbabu, A.P., Vijayakumaran, K., Rohit, P., Thomas, S., Sasikumar, G., Kaladharan, P., Durgekar, R.N. and Mohamed, K.S. 2008. Species assemblage in the coral reef ecosystem of Netrani Island off Karnataka, southwest coast of India. Journal of the Marine Biological Association of India 50(1): 87-97.
- Ziemer, R.R.1988. Carnivorous Plants in Micronesia. Carnivorous Plant Newsletter; (17); 70-73.



# ANNEXURE 1

## Species reported in major islands of Indian states

Name of the Island	Important species	Source
<b>West Bengal</b>		
Haliday Island	Star fish, King Crab Common Carp, Silver Carp, Butter Fish, electric rays, Estuarine Crocodile, Monitor Lizard, Green Turtle, King Cobra, Rat Snake, Russell's Viper, Dog-Faced Water Snake, Common Krait and Python. Spotted Deer, Wild Boar, Rhesus Macaque,	Venkataraman <i>et al</i> 2012
<b>Lothian Island</b>	Acanthus illicifolius and Avicennia alba, A. marina, Ceriops.decandra, E. agallocha and Heritiera fomes	Mukhopadhyaya <i>et al</i> 2001
Sagar Island	Great Knot (Calidris tenuirostris), Sanderling (Calidris alba), Pheasant-Tailed Jacana (Hydrophasianus chirurgus), Small Pratincole (Glareola lactea), Black-Headed Gull (Larus ridibundus), Great Crested Tern (Sterna bergii), White-Winged Tern (Chlidonias leucopterus), Oriental Honey Buzzard (Pernis ptilorhyncus), Booted Eagle (Hieraetus pennatus), Common Kestrel (Falco tinnunculus), Amur Falcon (Falco amurensis), Ashy-Crowned Sparrow Lark (Eremopterix grisea) and Richard's Pipit (Anthus richardi)	Pande <i>et al</i> .2013
<b>Odisha</b>		
Wheeler Island	Olive Ridley turtles; Black-Bellied Terns	Gopi and Pandav 2007; Pande <i>et al</i> .2013
<b>Andhra Pradesh</b>		
Hope Island	Olive Ridley Turtles	Rao 1985

Sriharikota Island	Plants includes Manilkara hexandra, Syzigium cumini, Albizzia amara, Albizzia lebbeck, Strychnos nux-vomica, Drypetes sepiaria, Ficus tsilea, Sapindus emarginatus, Tamarindus indica, Azadirachta indica, Pterospermum suberifolium, Borassus flabellifer, Memecylon umbellatum, Maba buxifolia, Garcinia spicata, Crataeva religiosa, Atlantia monophylla Cordia dichotoma, Gmelina arborea, Phoenix	Daniels <i>et al</i> 2007; Savithramma and Narayana 2001; Manakadan <i>et al</i> 2013
	sylvestris, Flacourtia indica, Glycosmis pentaphylla. Approximately 440 species of angiosperms, belonging to 115 families, and 212 medicinal plants have been identified from the island.  Twenty-eight species of mammal, 12 amphibian species, 34 species of reptile, 44 fish species, 51 species of butterfly and 125 species of bird (70 resident bird species, 33 winter migrant species has been reported	
<b>Tamil Nadu</b>		
Pamban Island	Smoke Angel Apolemichthys xanthurus, Midnight Angel Centropyge nox, Koran Angel Pomacanthus semicirculatus, Blue Ring Angel P. annularis and Emperor Angel P. imperator Olive Ridley Lepidochelys olivacea	Rajeshwari and Thangavel 2014; Kasinathan 1988

Gulf of Mannar Group of Islands	<p>Mangrove plants such as <i>Excoecaria agallocha</i>, <i>Avicennia marina</i>. and Marine algae (99), Sea grass (7), were reported.</p> <p>In the case of animals crustacean (79), sponge (108) mollusc (260) echinoderm (100) coral (99) and reported 11 species of sea snakes (<i>Hydrophis cyanocinctus</i>, <i>Hydrophis</i> (<i>Microcephalophis</i>) <i>gracilis</i>, <i>Hydrophis fasciatus fasciatus</i>, <i>Hydrophis lapemoides</i>, <i>Hydrophis ornatus ornatus</i>,</p> <p><i>Hydrophis spiralis</i>, <i>Lapemis curtus</i> and <i>Thallasophina viperina</i>) and three species of marine turtles Green Turtle <i>Chelonia mydas</i>, Olive Ridley Turtle <i>Lepidochelys olivaceae</i> and Logger head Turtle <i>Caretta caretta</i>(Nearly 180 birds reported in this group of Islands the important bird species includes Lesser Sandpiper, Little Stint, Red Knot, Eastern Knot, Crab Plover, Bar-Tailed Godwit, Broad-Billed Sandpiper, Dunlin, Long-Toed Stint, Red-Necked Phalarope, Little Tern, Stone Plover, Stone Curlew and Lesser Crested Stern. Greater Flamingoes. The endangered mammal Sea Cow <i>Dugong dugon</i> was also reported in this group of islands</p>	Rajagopalan 1996; UNDP 2001; Jeganathan <i>et al</i> 2006; Lobo 2006; Pande <i>et al</i> .2013;
<b>Gujarat</b>		
Gulf of Kachchh group of islands	<p>174 species of alga, 10 species of mangrove, and 35 species of echinoderm (including 10 species of sea cucumber and 6 species of star fishes) and 69 species of sponge, 102 species of coelentrate (including 68 species of coral), 357 species of mollusc, 115 species of arthropod (including 71 species of crab and 33 species of prawn), 365 species of fish, , 8 species of reptile 129 species of aquatic bird, 5 species of marine mammal,</p>	Dixit <i>et al</i> 2010
<b>Maharashtra</b>		
Murud-Janjira Island	50 species of angiosperms and <i>Ficus asperima</i> Roxb; <i>Ficus parasitica</i> Koen ex Willd. and <i>Ficus virens</i>	Pande <i>et al</i> .2013;

Padamdurg Island	Enicostemma littorale; Azadirachta indica L., Manilkara hexandra (Roxb); Indigofera cordifolia	Pande <i>et al.</i> 2013;
<b>Goa</b>		
Chorao Island	6 species of alga and other important mangroves species includes Rhizophora mucronata, Rhizophora apiculata, Avicennia officinalis, Avicennia alba, Avicennia marina, Bruguiera gymnorrhiza, Bruguiera cylindrica, Kandelia candel, Ceriops tagal, Sonneratia alba, Sonneratia caseolaris, Aegiceras corniculatum, Excoecaria agallocha and Acanthus ilicifolius In the case of animals 3 species of fish, 115 species of bird (59 terrestrial, 56 aquatic, 64 resident). Reptiles includes Indian Rock Python and mammals such as Smooth Indian Otter, Flying Fox and Jackal	Borges 2002; Nagi 2008; SAC 2012
Divar Island	2 algal species, Dicotomosiphon salinas and Enteromorpha flexuosa, and a single angiosperm, Halophila beckerri. and mangroves plants Avicennia marina A. officinalis, A. ilicifolius, S. caseolaris, Kandelia candel, Excoecaria agallocha and Sonneratia alba and One species of nematode, 23 species of polychaete, 15 species of crustacean and 9 species of mollusc and 93 species of bird have been recorded from the island.	Pande <i>et al.</i> 2013;
<b>Karnataka</b>		
Netrani Island	Phytoplankton (16), Zooplankton (25), Gastropods (48), Bivalves (15), Cephalopods (3), Crabs (17), Shrimps (2), Lobsters (4) Seaweeds (7), sponges (6), jellyfish (2), Ornamental shrimps/ camel shrimp (Rhynchocinetes durbanensis) Giant Clam (Tridacna maxima); Coral reefs (Porites sp., Favia favus, Pocillopora sp., Pocillopora verrucosa, Goniastrea pectinata, G. retiformes, Goniopora sp., Plasiastrea versipora, Coscinaraea monile, Turbinaria sp., Leptastrea sp. and Dendrophyllia sp) ; eels, Butterfly Fish, Trigger Fish and Parrot Fish; Wild goats. Recent studies reported that 69 fish species belonging to 39 genera, 19 families and 3 orders in Netrani.	Zacharia <i>et al</i> 2008; Pande <i>et al.</i> 2013; Dineshbabu and Zacharia 2007;

<b>Kerala</b>		
Cochin group of Islands (Vypeen, Vallarpadam, Bolghatty)	<p>Mangrove plants: <i>Avicennia marina</i>, <i>A. officinalis</i>, <i>Exoecaria agallocha</i>, <i>Clerodentron</i> spp., <i>Aegiceras corniculatum</i>, <i>Rhizophora appiculata</i> and <i>Acanthus ilicifolius</i></p> <p>6 endemic plant species (<i>Artocarpus hirsutus</i>, <i>Hardwickia binata</i>, <i>Lagerstroemia microcarpa</i>, <i>Phyllanthus rotundifolius</i>, <i>Terminalia paniculata</i>, <i>Vateria indica</i>) have also been documented from the Cochin Islands</p> <p>135 species of zooplankton, 150 species of fishes, 194 species of phytoplankton, 199 species of benthos</p> <p>4 species of amphibian</p> <p>6 species of mammal and 49 species of butterfly (many butterflies are endemic) 57 species of birds have also been recorded.</p>	ICMAM 2002; Azeez <i>et al</i> 2011

*Note : Please check the References in the main part*

## ANNEXURE 2

### Mangrove flora reported in Andaman

S. No	Plant Species
1	<i>Acanthus ebracteatus</i>
2	<i>Acanthus ilicifolius</i>
3	<i>Acanthus volubilis</i>
4	<i>Acrostichum aureum</i>
5	<i>Aegialitis rotundifolia</i>
6	<i>Aegiceras corniculatum</i>
7	<i>Avicennia alba</i>
8	<i>Avicennia marina</i>
9	<i>Avicennia officinalis</i>
10	<i>Bruguiera cylindrica</i>
11	<i>Bruguiera gymnorrhiza</i>
12	<i>Bruguiera parviflora</i>
13	<i>Bruguiera sexangula</i>
14	<i>Ceriops decandra</i>
15	<i>Ceriops tagal</i>
16	<i>Excoecaria agallocha</i>
17	<i>Heritiera littoralis</i>
18	<i>Kandelia candel</i>

S. No	Plant Species
19	<i>Kandelia rheedii</i>
20	<i>Lumnitzera littorea</i>
21	<i>Lumnitzera racimosa</i>
22	<i>Nypa fruticans</i>
23	<i>Phoenix paludosa</i>
24	<i>Rhizophora apiculata</i>
25	<i>Rhizophora lamarckii</i>
26	<i>Rhizophora mucronata</i>
27	<i>Rhizophora stylosa</i>
28	<i>Scyphiphora hydrophyllacea</i>
29	<i>Sonneratia alba</i>
30	<i>Sonneratia apetala</i>
31	<i>Sonneratia caseolaris</i>
32	<i>Sonneratia griffithii</i>
33	<i>Xylocarpus granatum</i>
34	<i>Xylocarpus mekongensis</i>
35	<i>Xylocarpus moluccensis</i>

## Mangrove associated flora recorded in Andaman

S. No	Species name
1	<i>Adenanthera pavon in</i>
2	<i>Aglaia cucullata</i>
3	<i>Aisandra butyracea</i>
4	<i>Ardisia solanacea</i>
5	<i>Atalantia monophylla</i>
6	<i>Barringtonia asiatica</i>
7	<i>Barringtonia racemosa</i>
8	<i>Boswellia serrata</i>
9	<i>Brownlowia lanceolata</i>
10	<i>Calophyllum innophyllum</i>
11	<i>Centotheca lappacea</i>
12	<i>Cerbera manghas</i>
13	<i>Chydenanthus excelsus</i>
14	<i>Clerodendrum inerme</i>
15	<i>Cocos nucifera</i>
16	<i>Cycas rumphii</i>
17	<i>Cynometra iripa</i>
18	<i>Cynometra ramiflora</i>
19	<i>Cyperus kyllinga</i>
20	<i>Dalbergia spinosa</i>
21	<i>Dendrolobium umbellatum</i>
22	<i>Derris heterophylla</i>
23	<i>Derris trifoliata</i>
24	<i>Ehretia acuminata</i>
25	<i>Euphorbia nerifolia</i>
26	<i>Ficus altissimae</i>
27	<i>Finlaysonia obovata</i>
28	<i>Fimbristylis littoralis</i>
29	<i>Glochidion calocarpum</i>
30	<i>Glycosmis mauritiana</i>
31	<i>Guettarda speciosa</i>

S. No	Species name
32	<i>Hernandia peltata</i>
33	<i>Hibiscus tiliaceus</i>
34	<i>Indigofera glandulosa</i>
35	<i>Indigofera zollingeriana</i>
36	<i>Ipomoea pes-caprae</i>
37	<i>Ischaemum muticum</i>
38	<i>Manilkara littoralis</i>
39	<i>M esserschmidia argentea</i>
40	<i>Mimusops species</i>
41	<i>Morinda citrifolia</i>
42	<i>Mucuna gigantean</i>
43	<i>Ochrosia oppositifolia</i>
44	<i>Olox imbricate</i>
45	<i>Ophiorrhiza mungos</i>
46	<i>Pandanus andamanensis</i>
47	<i>Pandanus leram</i>
48	<i>Pandanus odoratissimus</i>
49	<i>Pandanus tectorius</i>
50	<i>Pemphis acidula</i>
51	<i>Pongamia pinnata</i>
52	<i>Scaevola plumierii</i>
53	<i>Scaevola sericea</i>
54	<i>Scaevola taccada</i>
55	<i>Sophora tomentosa</i>
56	<i>Sporobolus virginicus</i>
57	<i>Syzygium samarangense</i>
58	<i>Tabernaemontana crispa</i>
59	<i>Thespesia populnea</i>
60	<i>Triphasia trifolia</i>
61	<i>Vitex diversifolia</i>
62	<i>Vitex trifoliata L.</i>

## Faunal Diversity of Andaman and Nicobar Islands

S.No	Faunal Group	Andaman & Nicobar Island	Endemic forms
1	Sponges	112	5
2	Corals	235	100
3	Earthworms	21	7
4	Leeches	10	--
5	Polychaetes	186	--
6	Arachnids	14	--
7	Gastrotricha	32	6
8	Chinorincha	4	2
9	Crustaceans	607	56
10	Spiders & Scorpions	94	28
11	Centipede	17	--
12	Millipedes	5	--
13	Insects	2256	485
14	Land Molluscs	110	75
15	Freshwater molluscs	51	12
16	Marine molluscs	1422	2
17	Siphonculates	25	--
18	Echinodermns	430	2
19	Fishes	1283	--
20	Amphibians	23	3
21	Reptiles	104	23
22	Aves	284	105
23	Mammals	62	33



## ANNEXURE 3

### Alien Flora species reported in Major Islands of India

S. No	Species	Name of the Island	Native region of the species
1	<i>Acacia farnesiana</i> (L.) Willd.	Andaman & Nicobar	Tropical South America
2	<i>Alternanthera ficoidea</i> (L.) Sam.	Andaman & Nicobar	Tropical America
3	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Andaman & Nicobar	Tropical America
4	<i>Alternanthera pungens</i> Kunth	Andaman & Nicobar	Tropical America
5	<i>Asclepias curassavica</i> L.	Andaman & Nicobar	Tropical America
6	<i>Blainvillea acmella</i> (L.) Philipson	Andaman & Nicobar	Tropical America
7	<i>Blumea balsamifera</i> (L.) DC.	Andaman & Nicobar	Tropical America
8	<i>Blumea eriantha</i> DC	Andaman & Nicobar	Tropical America
9	<i>Blumea lacera</i> (Burm.f.) DC.	Andaman & Nicobar	Tropical America
10	<i>Blumea lanceolaria</i> (Roxb.) Druce	Andaman & Nicobar	Tropical America
11	<i>Blumea mollis</i> (D. Don.) Merr.	Andaman & Nicobar	Tropical America
12	<i>Calotropis gigantea</i>	Andaman & Nicobar	Tropical America
13	<i>Cannabis sativa</i> L	Andaman & Nicobar	Tropical America
14	<i>Celosia argentea</i> L.	Andaman & Nicobar	Tropical America
15	<i>Chamaecrista absus</i> (L.) Irwin & Barneby	Andaman & Nicobar	Tropical America
16	<i>Chloris barbata</i> Sw.	Andaman & Nicobar	Tropical America
17	<i>Chromolaena odorata</i> (L.) King & Robinson	Andaman & Nicobar	Tropical America
18	<i>Chrozophora rottleri</i> (Geis.) Spreng.	Andaman & Nicobar	Tropical Africa
19	<i>Cleome gynandra</i> L.	Andaman & Nicobar	Tropical America
20	<i>Corchorus fascicularis</i> Lam.	Andaman & Nicobar	Tropical America
21	<i>Crassocephalum crepioides</i> (Benth.) Moore	Andaman & Nicobar	Tropical America

S. No	Species	Name of the Island	Native region of the species
22	<i>Dactyloctenium aegyptium</i> (L.) Beauv.	Andaman & Nicobar	Tropical America
23	<i>Datura innoxia</i> Miller	Andaman & Nicobar	Tropical America
24	<i>Digera muricata</i> (L.) Mart. Beitr.	Andaman & Nicobar	South West Asia
25	<i>Eichhornia crassipes</i> (C. Martius) Solms-Loub.	Andaman & Nicobar	Tropical America
26	<i>Euphorbia thymifolia</i> L.	Andaman & Nicobar	Tropical America
27	<i>Evolvulus nummularius</i> (L.) L.	Andaman & Nicobar	Tropical America
28	<i>Grangea maderaspatana</i> (L.) Poir.	Andaman & Nicobar	Tropical America
29	<i>Hyptis brevipes</i> Poit.	Andaman & Nicobar	Tropical America
30	<i>Hyptis capitata</i> Jacq.	Andaman & Nicobar	Tropical America
31	<i>Impatiens balsamina</i> L.	Andaman & Nicobar	Tropical America
32	<i>Imperata cylindrica</i> (L.) Raensch.	Andaman & Nicobar	Tropical America
33	<i>Ipomoea aquatica</i> Forsskal	Andaman & Nicobar	Tropical America
34	<i>Ipomoea carnea</i> Jacq. ssp. <i> fistulosa</i> (Choisy) D. Austin	Andaman & Nicobar	Tropical America
35	<i>Ipomoea obscura</i> (L.) Ker.-Gawl.	Andaman & Nicobar	Tropical America
36	<i>Ipomoea quamoclit</i>	Andaman & Nicobar	Tropical America
37	<i>Ludwigia perennis</i> L.	Andaman & Nicobar	Tropical America
38	<i>Melochia corchorifolia</i> L.	Andaman & Nicobar	Tropical America
39	<i>Mimosa invisa</i> Mart.ex Colla	Andaman & Nicobar	Tropical America
40	<i>Nicotiana plumbaginifolia</i> Viv.	Andaman & Nicobar	Tropical America
41	<i>Ocimum canum</i> Sims	Andaman & Nicobar	Tropical America
42	<i>Oxalis corniculata</i> L.	Andaman & Nicobar	Europe
43	<i>Parthenium hysterophorus</i> L.	Andaman & Nicobar	Tropical America
44	<i>Pennisetum purpureum</i> Schum.	Andaman & Nicobar	Tropical America
45	<i>Phyllanthus maderaspatensis</i> L	Andaman & Nicobar	Tropical America
46	<i>Saccharum spontaneum</i> L.	Andaman & Nicobar	Tropical America

<b>S. No</b>	<b>Species</b>	<b>Name of the Island</b>	<b>Native region of the species</b>
47	<i>Senna alata</i> (L.) Roxb.	Andaman & Nicobar	West Indies
48	<i>Senna obtusifolia</i> (L.) Irwin and Barneby	Andaman & Nicobar	Tropical America
49	<i>Senna uniflora</i> (Mill.) H.S. Irwin & Barneby	Andaman & Nicobar	Tropical America
50	<i>Solanum americanum</i> Miller	Andaman & Nicobar	Tropical America
51	<i>Solanum anguivi</i> Lam.	Andaman & Nicobar	Tropical America
52	<i>Solanum ferox</i> L.	Andaman & Nicobar	Tropical America
53	<i>Solanum sisymbriifolium</i> Lam.	Andaman & Nicobar	Tropical America
54	<i>Spermacoce hispida</i> L.	Andaman & Nicobar	Tropical America
55	<i>Spermacoce pusilla</i> Wallich	Andaman & Nicobar	Tropical America
56	<i>Spilanthes radicans</i> Jacq.	Andaman & Nicobar	Tropical America
57	<i>Stachytarpheta urticaefolia</i> (Salisb.) Sims	Andaman & Nicobar	Tropical America
58	<i>Tithonia rotundifolia</i> (Mill.) Blake	Andaman & Nicobar	Tropical America
59	<i>Triumfetta rhomboidea</i> Jacq	Andaman & Nicobar	Tropical America
60	<i>Turnera ulmifolia</i> L.	Andaman & Nicobar	Tropical America
61	<i>Urena lobata</i>	Andaman & Nicobar	Tropical America
62	<i>Wedelia biflora</i> (L.) DC.	Andaman & Nicobar	Tropical America

## References

- Ali, R. 2010. Invasives and their impact on Andaman Biodiversity. Recent Trends in Biodiversity of the Andaman and Nicobar Islands. pp 511-517. Zoological Survey of India, Kolkata.
- Hajra, P. K., Rao, P. S. N., & Mudgal, V. 1999. Flora of Andaman & Nicobar Islands. Volume 1. Botanical Survey of India. Kolkata.
- Reddy, C.S. & Roy, P.S. 2011. Plant Diversity of Lakshadweep Islands. National Remote Sensing Centre, Hyderabad & Bishen Singh Mahendra Pal Singh, Dehra Dun. pp 1-166. ISBN 978-81-211-0784-6.
- Reddy, C.S. 2008. Catalogue of invasive alien flora of India. Life Science Journal, 5(2): 84-89.
- Reddy, C.S. 2013. Flora of North Andaman Islands, India. Biodiversity in India (Ed. Pullaiah, T. & Reddy, K.J.). Regency Publications. New Delhi. Vol.6. pp: 111-208. ISBN 978-81-89233.
- Sharma, T. V. R. S., Jayakumar, V., Purthi, N., & Ganeshiah, K. (2013). Alien flora into the fragile ecosystem of Andaman and Nicobar islands: a major concern. Journal of the Andaman Science Association Vol, 18(1), 25-31.

## ANNEXURE 4

### Alien animal species reported in major islands of India

S. No	Species name	Common Name
<b>Insects</b>		
1	<i>Citripestiseutraperha</i>	Mango borer
<b>Ants</b>		
1	<i>Anoplolepisgracilipes</i>	Yellow crazy ant
2	<i>Paratrechinalongicornis</i>	Long legged crazy ant
3	<i>Monomoriumpharaonic</i>	Pharaoh ant
4	<i>Pheidolemegacephala</i>	Big headed ants
5	<i>Solenopsisgeminata</i>	Fire ants
6	<i>Tetramoriumbucarinatedum</i>	Guinea ant
7	<i>Tetramoriumpacificum</i>	
8	<i>Tetramoriumsimillimum</i>	Similar groove-headed ant
<b>Cnidaria</b>		
1	<i>Carijoariisei</i>	Snowflake coral
<b>Mollusca</b>		
1	<i>Achatina fulica</i>	Giant African Snail
2	<i>Euglandina rosea</i>	Cannibal snail
<b>Amphibian</b>		
1	<i>Hoplobatrachus tigerinus</i>	Indian bullfrog
<b>Fishes</b>		
1	<i>Oreochromis mossambicus</i>	Mozambique tilapia
<b>Reptiles</b>		
1	<i>Lissemys punctata</i>	Flap shell Turtle
2	<i>Calotes versicolor</i>	Garden lizard
<b>Recent survey (2013) confirm the occurrence of the birds in Andaman</b>		
1	<i>Acridotheres tristis</i>	Common Myna
2	<i>Columba livia</i>	Blue Rock Pigeon
3	<i>Corvus splendens</i>	House Crow
4	<i>Francolinuspondicerianus</i>	Grey Partridge

5	<i>Passer domesticus</i>	House Sparrow
6	<i>Pavo cristatus</i>	Peafowl
<b>Recently not reported in Andaman but once reported</b>		
1	<i>Acridotheres tristis</i>	Jungle Myna
2	<i>Passer montanus</i>	Eurasian Tree Sparrow
3	<i>Amandava formosa</i>	Red Avadavat
4	<i>Streptopeliasenegalensis</i>	Little Brown Dove
5	<i>Lonchuramalacca</i>	Black headed Munia
6	<i>Anaspoecilorhyncha</i>	Spot-billed Duck
7	<i>Coturnixcoturnix</i>	Common Quail
8	<i>Perdica asiatica</i>	Jungle Bush Quail
9	<i>Perdicaerythrorhyncha</i>	Painted Bush Quail
10	<i>Sarkidiornismelanotos</i>	Comb Duck
11	<i>Anastomusoscitans</i>	Open-billed Stork
12	<i>Francolinuspintadeanus</i>	Chinese Francolin
<b>Mammals</b>		
1	<i>Funambuluspennanti</i>	Five Striped Palm Squirrel
2	<i>Musmusculus</i>	Field Mouse
3	<i>Rattusnorvegicus</i>	Brown Rat, Norway Rat
4	<i>Rattusrattus</i>	Black Rat
5	<i>Canisfamiliaris</i>	Feral dogs
6	<i>Feliscatus</i>	Feral cats
7	<i>Capra hircus</i>	Goat
8	<i>Bostaurus</i>	Cow
9	<i>Elephasmaximus</i>	Asian Elephant
10	<i>Axis axis</i>	Chital/Spotted deer
11	<i>Muntiacus muntjak</i>	Indian muntjac
12	<i>Axis porcinus</i>	Indian Hog deer

# References

- Ali, R. 2004. The effect of introduced herbivores on vegetation in the Andaman Islands Current Science, 86(8); 1103-1112.
- Ali, R. 2006. Issues relating to invasives in the Andaman Islands. Journal of the Bombay Natural History Society, 103: 349-355.
- Bharti H, Guénard B, Bharti M, Economo EP (2016) An updated checklist of the ants of India with their specific distributions in Indian states (Hymenoptera, Formicidae). ZooKeys 551: 1–83. doi: 10.3897/zookeys.551.6767
- Mohanraj P., Veenakumari, K., and Bandyopadhyay, A. K., 1999. Perilous aliens. Central Agricultural. Research Institute, Port Blair.8-9pp
- Palavai, V and Davidar, P. 2009. A survey of freshwater fishes of Andaman Islands. JBNHS,106(1);11-14.
- Patro, S., Krishnan, P., Gopi, M. *et al.* 2015. Snowflake coral, *Carijoa riisei* from Grand Island, Goa: a case of invasion of an alien species or re-establishment of a native species?. Current Science, 109 (6); 1028-1030.
- Rajan, P., & Pramod, P., 2013. Introduced birds of the Andaman & Nicobar Islands, India. Indian BIRDS 8 (3): 71-72
- Sardar, N and Ghorai, N. 2017. Some invasive ants of India and their impact to environment. ENVIS News Letter; 23(2 )Pp2-4.
- Soumya1, B.R., Verghese, A *et al.*,2016. Need to strengthen quarantine between Andaman and Nicobar Islands and mainland India. Current Science 111(11); 1753-1756.

## ANNEXURE 5

### List of Marine Protected Areas in Islands of India

Sl.No	PA Name	State	NP/ WLS
1	Arial Island	Andaman & Nicobar	Sanctuary
2	Bamboo Island	Andaman & Nicobar	Sanctuary
3	Barren Island	Andaman & Nicobar	Sanctuary
4	Battimalv Island	Andaman & Nicobar	Sanctuary
5	Belle Island	Andaman & Nicobar	Sanctuary
6	Bennett Island	Andaman & Nicobar	Sanctuary
7	Bingham Island	Andaman & Nicobar	Sanctuary
8	Blister Island	Andaman & Nicobar	Sanctuary
9	Bluff Island	Andaman & Nicobar	Sanctuary
10	Bondoville Island	Andaman & Nicobar	Sanctuary
11	Brush Island	Andaman & Nicobar	Sanctuary
12	Buchanan Island	Andaman & Nicobar	Sanctuary
13	Campbell	Andaman & Nicobar	National Park
14	Chanel Island	Andaman & Nicobar	Sanctuary
15	Cinque Islands	Andaman & Nicobar	Sanctuary
16	Clyde Island	Andaman & Nicobar	Sanctuary
17	Cone Island	Andaman & Nicobar	Sanctuary
18	Curlew (B.P.) Island	Andaman & Nicobar	Sanctuary
19	Curlew Island	Andaman & Nicobar	Sanctuary
20	Defence Island	Andaman & Nicobar	Sanctuary
21	Dot Island	Andaman & Nicobar	Sanctuary
22	Dottrell Island	Andaman & Nicobar	Sanctuary
23	Duncan Island	Andaman & Nicobar	Sanctuary
24	East Island	Andaman & Nicobar	Sanctuary
25	East Of Inglis Island	Andaman & Nicobar	Sanctuary
26	Egg Island	Andaman & Nicobar	Sanctuary
27	Elat Island	Andaman & Nicobar	Sanctuary
28	Entrance Island	Andaman & Nicobar	Sanctuary
29	Galathea	Andaman & Nicobar	National Park
30	Gander Island	Andaman & Nicobar	Sanctuary
31	Girjan Island	Andaman & Nicobar	Sanctuary
32	Goose Island	Andaman & Nicobar	Sanctuary
33	Hump Island	Andaman & Nicobar	Sanctuary
34	Interview Island	Andaman & Nicobar	Sanctuary
35	James Island	Andaman & Nicobar	Sanctuary



Sl.No	PA Name	State	NP/ WLS
36	Jungle Island	Andaman & Nicobar	Sanctuary
37	Kyd Island	Andaman & Nicobar	Sanctuary
38	Landfall Island	Andaman & Nicobar	Sanctuary
39	Latouche Island	Andaman & Nicobar	Sanctuary
40	Lohabarrack	Andaman & Nicobar	Sanctuary
41	Mahatma Gandhi Marine	Andaman & Nicobar	National Park
42	Mangrove Island	Andaman & Nicobar	Sanctuary
43	Mask Island	Andaman & Nicobar	Sanctuary
44	Mayo Island	Andaman & Nicobar	Sanctuary
45	Megapode Island	Andaman & Nicobar	Sanctuary
46	Middle Button Island	Andaman & Nicobar	National Park
47	Montogemery Island	Andaman & Nicobar	Sanctuary
48	Mount Harriett	Andaman & Nicobar	National Park
49	Narcondam Island	Andaman & Nicobar	Sanctuary
50	North Brother Island	Andaman & Nicobar	Sanctuary
51	North Button Island	Andaman & Nicobar	National Park
52	North Island	Andaman & Nicobar	Sanctuary
53	North Reef Island	Andaman & Nicobar	Sanctuary
54	Oliver Island	Andaman & Nicobar	Sanctuary
55	Orchid Island	Andaman & Nicobar	Sanctuary
56	Ox Island	Andaman & Nicobar	Sanctuary
57	Oyster Island-I	Andaman & Nicobar	Sanctuary
58	Oyster Island-II	Andaman & Nicobar	Sanctuary
59	Paget Island	Andaman & Nicobar	Sanctuary
60	Parkinson Island	Andaman & Nicobar	Sanctuary
61	Passage Island	Andaman & Nicobar	Sanctuary
62	Patric Island	Andaman & Nicobar	Sanctuary
63	Peacock Island	Andaman & Nicobar	Sanctuary
64	Pitman Island	Andaman & Nicobar	Sanctuary
65	Point Island	Andaman & Nicobar	Sanctuary
66	Potanma Islands	Andaman & Nicobar	Sanctuary
67	Ranger Island	Andaman & Nicobar	Sanctuary
68	Rani Jhansi	Andaman & Nicobar	National Park
69	Reef Island	Andaman & Nicobar	Sanctuary
70	Roper Island	Andaman & Nicobar	Sanctuary
71	Ross Island	Andaman & Nicobar	Sanctuary
72	Rowe Island	Andaman & Nicobar	Sanctuary

Sl.No	PA Name	State	NP/ WLS
73	Saddle Peak	Andaman & Nicobar	National Park
74	Sandy Island	Andaman & Nicobar	Sanctuary
75	Sea Serpent Island	Andaman & Nicobar	Sanctuary
76	Shark Island	Andaman & Nicobar	Sanctuary
77	Shearme Island	Andaman & Nicobar	Sanctuary
78	Sir Hugh Rose Island	Andaman & Nicobar	Sanctuary
79	Sisters Island	Andaman & Nicobar	Sanctuary
80	Snake Island-I	Andaman & Nicobar	Sanctuary
81	Snake Island-II	Andaman & Nicobar	Sanctuary
82	South Brother Island	Andaman & Nicobar	Sanctuary
83	South Button Island	Andaman & Nicobar	National Park
84	South Reef Island	Andaman & Nicobar	Sanctuary
85	South Sentinel Island	Andaman & Nicobar	Sanctuary
86	Spike Island-I	Andaman & Nicobar	Sanctuary
87	Spike Island-II	Andaman & Nicobar	Sanctuary
88	Stoat Island	Andaman & Nicobar	Sanctuary
89	Surat Island	Andaman & Nicobar	Sanctuary
90	Swamp Island	Andaman & Nicobar	Sanctuary
91	Table (Delgarno) Island	Andaman & Nicobar	Sanctuary
92	Table (Excelsior) Island	Andaman & Nicobar	Sanctuary
93	Talabaicha Island	Andaman & Nicobar	Sanctuary
94	Temple Island	Andaman & Nicobar	Sanctuary
95	Tillongchang Island	Andaman & Nicobar	Sanctuary
96	Tree Island	Andaman & Nicobar	Sanctuary
97	Trilby Island	Andaman & Nicobar	Sanctuary
98	Tuft Island	Andaman & Nicobar	Sanctuary
99	Turtle Islands	Andaman & Nicobar	Sanctuary
100	Kwangtung Island	Andaman & Nicobar	Sanctuary
101	West Island	Andaman & Nicobar	Sanctuary
102	Wharf Island	Andaman & Nicobar	Sanctuary
103	White Cliff Island	Andaman & Nicobar	Sanctuary
104	Galathea Bay	Andaman & Nicobar	Sanctuary
105	Cuthbert Bay	Andaman & Nicobar	Sanctuary
106	Pitti	Lakshadweep	Sanctuary

**Source :** ENVIS Centre on Wildlife & Protected Areas ([http://wiienvs.nic.in/Database/MPA\\_8098.aspx](http://wiienvs.nic.in/Database/MPA_8098.aspx)). accessed on 23-10-2018







# About CEBPOL

Government of India in collaboration with the Norwegian Government has established "Centre for Biodiversity Policy and Law (CEBPOL)" at the National Biodiversity Authority (NBA), an autonomous and statutory body of the Ministry of Environment Forest and Climate Change towards strengthening of expertise in Biodiversity Policy and Law in India. This programme is executed by the NBA in collaboration with Norwegian Environment Agency through the Royal Norwegian Embassy, New Delhi, India.

The Centre aims to provide advice and support to the Government of India and Norway on Biodiversity Policy and Law related issues including complex negotiations on Access and Benefit Sharing and Traditional knowledge as well as governance issues relating to biodiversity at the National and International level. The Centre proposes to help NBA in the effective implementation of International agreements on conservation, sustainable use and the associated access and benefit sharing components of it.

CEBPOL is set up as a specialized Centre of Excellence in Biodiversity Policy and Law to network, organize and consolidate expertise on issues of Biodiversity Policy and Law in India and Norway. The Centre, located at NBA, would function as an independent think tank on Biodiversity Policy and Law. In addition, CEBPOL aims to contribute to the effective implementation of the Biological Diversity Act 2002 and Rules 2004.

Contact:

## The Secretary

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