Role of ENM, GeoCAT and Arc-GIS Software's in Conservation, Mapping and IUCN Assessments of Threatened Palms in Andaman & Nicobar Islands (ANI's), India

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Abstract

India represents about 97 species and 3 varieties of wild and semi-wild palm species in 21 genera (Baskaran *et al.,* 2019). Palm wealth is quite rich and unique in Andaman and Nicobar Island with 06 endemic species (Baskaran *et al.,* 2019). The arecaceous flora of the Islands comprises 49 species under 18 genera which include the palm species, *Bentinckia nicobarica* (Kurz) Becc*., Phoenix andamanensis* S. Barrow*, Phoenix paludosa* Roxb*., Pinanga manii* Becc*., Pinanga andamanensis* Becc. and *Rhopaloblaste augusta* (Kurz) H.E.Moore. However, these wild palms are being exploited by the local population for various uses in their daily life, thus they are threatened in the habitat. Therefore, present distribution of these species has been mapped with the help of Arc-GIS software and the IUCN Red List assessment has been carried out with the help of online GeoCAT software and Red List guidelines. ENM is a useful tool in outlining and understanding the distributions, an application to focus on diverse conservation issues, including suitable habitat and species range estimates, and may prove useful in a variety of applications to biodiversity conservation, especially in protected area prioritization and network design. In order to know the distribution and conservation status of the wild palms, Maxent Ecological Niche Modelling was used to predict the accurate distribution. The study revealed the high potential distribution of *Rhopaloblasta augusta* in Great Nicobar and Car Nicobar Islands; *Bentinckia nicobarica* was found in Nicobar group of Islands; *Phoenix andamanensis, Phoenix paludosa* and *Pinanga andamanensis* were found in North Andaman Islands; and *Pinanga manii* was found in both Andaman Islands and Great Nicobar Islands. The potential predicted distribution information of these palm species will be helpful in planning conservation areas encompassing its existing populations, discover new populations, identify top-priority survey sites, and to set priorities to restore its natural habitat for more effective conservation.

Keywords Maxent ENM, GeoCAT, IUCN, Assessment, Endemic, Palms, A&N Islands

Introduction

Andaman and Nicobar Islands (ANIs) is one of the rich and unique phytogeographical regions in terms of plant diversity with higher number of endemism (Singh & Murugan 2014, Singh *et al*. 2014, 2020 a, b, 2021a, b, Singh & Misra 2020). ANIs situated to the south-east of the mainland India in the Bay of Bengal between 6º45'–13º41'N and 92º12'–93º57'E consisting

of 572 islands, islets and rocks. Within a small geographical area of approximately 8249 sq. km, ANIs stretched over a length of about 912 km having a coastal line of 1962 km and maximum width of 57 km in the Bay of Bengal (Anonymous, 2012). Mythologically the name Andaman is presumed to be derived from 'Hanuman' who was known to Malays as 'Handuman'. These islands described as islands of the 'marigold sun', they were known throughout the country as 'Kalapani' because of there having been a penal settlement under British rule, a reputation fast shedding since Independence (Pandey & Diwakar, 2008). The Andaman group of islands are separated from Nicobar group of islands by the 10º Channel, situated at 10º N latitude. The boundary of this archipelago is demarcated by Landfall Island on the north, Great Nicobar Island on the south, Narcondam Island and Barren Island on the east and Interview Island and Sentinel Islands delimit the western boundary (Mathew, 2017).

ANIs possess a distinct identity, not only because of its geography, history and culture but also because of the unique and rich biodiversity of its natural ecosystems that constitute one of the biodiversity hotspots with a variety of ecosystems viz. tropical evergreen forests, wetlands, mangroves and coral reefs (Singh *et al*., 2014, 2021b). This archipelago sharing the close affinity with the flora of adjoining phyto-geographical regions viz., Eastern coast of South Asia, Madagascar, Sri Lanka, Burma, Thailand, Peninsular Malaysia, Sumatra and Java. Once considered as the islands of disaster and death, ANIs are geographically recognized as the part of Arakkan-Yoma mountain ranges of Myanmar to the Moluccas Islands of the Indonesia. As a result of continental drift these islands were get separated from the main continental land masses probably during Tertiary or Late Cretaceous period. Therefore, the origin of the flora and fauna of this archipelago can be considered as continental and through evolution over millions of years appearing in present form. The insular nature of this archipelago has made this area a treasure house of plants which is unique and richest in terms of biodiversity having a higher degree of endemism. The indigenous flora of these Islands sharing close affinities with flora of Myanmar, Malaysia, Sri Lanka, Sumatra, North-East India and Peninsular India. The plants occurring in Andaman group of Islands showing affinities towards plants of South-East Asia and mainland India and those occurring in Nicobar groups of islands towards the plants of Malaysia (Pandey & Diwakar, 2008).

It is also interesting to note that this island archipelago is the homeland for six aboriginal tribes of which four are of negrito origin, viz. Great Andamanese, Ongese, Jarawas and Sentineles – inhabited in Andaman group of islands and two are of mongoloid origin, viz. Nicobarese and Shompens - inhabited in Nicobar group of islands. 90% land area of Andaman group of islands is under reserved or protected forests of which 36% is 'Tribal reserve'. The highest point of Andaman Islands is the *Saddle Peak* (732 m) situated in the North Andaman. The entire Nicobar Island is considered as 'Tribal reserve' and is the place of the only Biosphere Reserve of this archipelago i.e. Great Nicobar Biosphere Reserve which includes almost 85% area of the Great Nicobar Island. The highest point of the Nicobar Islands is the *Mount Thullier* (670 m) is situated in the Great Nicobar Island. Out of the total 572 islands of ANIs only 37 islands (24 in Andaman Islands and 13 in Nicobar Islands) are having human settlements.

The monsoonal pattern of South-East Asia determines the climate of the islands. The wet seasons from May to September and October to December are mainly due to south-west monsoon and north-east monsoon respectively (Srivastava & Rao, 2001). The general

climatic condition of the islands is warm, humid and tropical coastal climate with no winter season and the annual temperature range of 24^{o}C- 31^{o}C. ANIs receive average annual rainfall from 2,800–3,650 mm. with a relatively dry season of January to April with scanty rainfall (<130 mm).

The ANIs situated between two major biodiversity hotspots viz. *Indo-Burma* (includes Andaman group of Islands) and *Sundaland* (includes Nicobar groups of Islands). Out of the 292 endemic angiosperm taxa approximately 11 % are endemic to these Islands and most of these endemic plants are rare and threatened with very narrow and restricted distribution. Around 60 endemic plant species of ANIs are known only by the type collections (only collected once) or type localities (Balakrishnan & Vasudeva Rao, 1983; Nayar, 1996; Singh *et al*., 2015; Karthigeyan, 2020). A total of 174 taxa of angiosperms are restricted to occurring only in Andaman group of Islands and 69 taxa occurring only in Nicobar group of Islands and a total of 49 taxa of angiosperms are widely distributed in both Andaman and Nicobar Islands (Karthigeyan, 2020). Trees are the dominant life-form types amongst the endemic angiosperms of the Andaman and Nicobar Islands with 95 taxa (33%) followed by shrubs with 85 taxa (29%), herbs with 65 taxa (22%) and climbers with 42 taxa (14%) (Singh *et al.,* 2019, Karthigeyan, 2020).

Palm Diversity: Palms are one of the important floristic resources which are distributed wild in the tropical rainforest ecosystem. The palms are known as "Prindces of Vegetative Kingdom" are belonging to the monocot group of plants. The palm family is economically important and also treated as one of the best ornamental plants for decoration and landscape beautification. The family Palmae comprises more than 200 genera and 3000 species. The maximum diversity of palm is in tropical Asia and tropical America. India represents about 97 species and 3 varieties of wild and semi-wild palm species in 21 genera (Baskaran *et al.,* 2019). Palm wealth is quite rich and unique in Andaman and Nicobar Island with 06 endemic species (Baskaran *et al.,* 2019). The arecaceous flora of the Islands comprises 49 species under 18 genera. The palm flora of Andaman group of Islands shows striking dissimilarities with that of Nicobar group of islands. Palms such as *Arenga westerhoutii, Arenga pinnata* (Kuntze) Merr*., Calamus basui* Renuka & Vijayak*., Calamus baratangensis* Renuka & Vijayak*., Calamus longisetus* Griff*., Calamus palustris* Griff*., Calamus viminalis* Willd*., Corypha macropoda, Daemonorops aurea, D. manii* Becc. & Hook.f*., D. rarispinosa* Renuka & Vijayak*., D. wrightmyoensis* Renuka &Vijayak*., Korthalsia rogersii* Becc*., Licuala spinosa* Wurmb*., Phoenix andamanensis* S. Barrow. and *Pinanga andamanensis* occur in Andaman group of Islands are absent in the Nicobar group of Islands. While *Bentinckia nicobarica* (Kurz) Becc*., Calamus dilaceratus* Becc*., Calamus nicobaricus* Becc. & Hook.f*., Calamus pseudorivalis* Becc*., Calamus semierectus* Renuka & Vijayak*., Calamus unifarius* Wendl. and *Rhopaloblaste augusta* (Kurz) H.E.Moore are confined to the Nicobar group of islands, but seldom found in the Andaman Islands. *Areca triandra* Roxb. ex.Buch.-Ham*., Calamus andamanicus* Kurz*, Caryota mitis* Lour*., Korthalsia laciniosa* (Griff.) Mart*., Licuala peltata* Roxb. ex Buch.-Ham*.,* and *Pinanga manii* are widely distributed in both the group of Islands. The endemic palms such as *Bentinckia nicobarica, Phoenix andamanensis, Phoenix paludosa, Pinanga manii, Pinanga andamanensis* and *Rhopaloblaste augusta* are threatened in their habitat for they are being exploited by the local population for various uses. Therefore, the present distribution status of these palms has been mapped using the Arc-GIS

software and the IUCN Red List assessment has been carried out with the help of online GeoCAT software and Red List guidelines.

Materials and methods

Input Data: Spatially unique points of six palm species were recorded during field surveys with GPS and from earlier reported localities. The points were further geo-rectified with the Survey of India topographic sheets and Google Earth (Google, Mountain View, CA, USA) to obtain accurate coordinates to be used in the modelling. The background environmental data is given in the form of nineteen bioclimatic and six topographic variables. The bioclimatic variables are from the Worldclim dataset developed by Hijmans et al. (2005) available at a resolution of 1 km^2 (http://www. worldclim.org). The variables of annual and monthly values of mean temperature, precipitation and seasonality were derived (Table 1). The topographic variables include elevation, slope, aspect, flow accumulation, flow direction and compound topographic index (a measure of tendency of water to pool). The topographic variables were derived from Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (http://topex.ucsd.edu/WWW html/ srtm30 plus.html) available at 30-meter resolution. All the geo-data processing was done with the software ArcGIS.

Geo-CAT (Geospatial Conservation Assessment Tool): Geo-CAT is an open source, browser-based tool that performs rapid geospatial analysis for Red List assessment. It is developed for utilising spatially referenced primary occurrence data, the analysis of two aspects of the geographic range of a taxon i.e. the extent of occurrence (EOO) and the area of occupancy (AOO). These metrics form part of the IUCN Red List categories and criteria and have often proved challenging to obtain in an accurate, consistent and repeatable way (Bachman *et al.,* 2015). Current and past distribution maps were prepared with the help of GPS coordinates of earlier reported localities and locations observed during present survey. Population data was used to assess IUCN threat category (IUCN, 2013). Online software GeoCAT (http://geocat.kew.org) was used to calculate AOO and EOO by keeping grid size 4×4 km.

Table 1 Bioclimatic and topographic variables used in modelling:

SN	Environmental variables	Type	Source
1	Bio_01 Annual Mean Temperature	Bioclimatic- Temperature	Worldclim
2	Bio_02 Mean Diurnal Range	Bioclimatic- Temperature	Worldclim
3	Bio_03 Isothermality	Bioclimatic- Temperature	Worldclim
4	Bio_04 Temperature seasonality	Bioclimatic- Temperature	Worldclim
5	Bio-05 Maximum Temperature of Warmest Month	Bioclimatic- Temperature	Worldclim
6	Bio_06 Minimum Temperature of Coldest Month	Bioclimatic- Temperature	Worldclim
7	Bio_07 Temperature Annual range	Bioclimatic- Temperature	Worldclim
8	Bio_08 Mean temperature of wettest quarter	Bioclimatic- Temperature	Worldclim
9	Bio_09 Mean temperature of driest quarter	Bioclimatic- Temperature	Worldclim
10	Bio-10 Mean temperature of warmest quarter	Bioclimatic- Temperature	Worldclim
11	Bio_11 Mean temperature of Coldest quarter	Bioclimatic- Temperature	Worldclim
12	Bio_12 Annual Precipitation	Bioclimatic- Rainfall	Worldclim
13	Bio_13 Precipitation of Wettest Month	Bioclimatic- Rainfall	Worldclim
14	Bio_14 Precipitation of Driest Month	Bioclimatic- Rainfall	Worldclim
15	Bio_15 Precipitation seasonality	Bioclimatic- Rainfall	Worldclim
16	Bio_16 Precipitation of wettest quarter	Bioclimatic- Rainfall	Worldclim
17	Bio_17 Precipitation of Driest quarter	Bioclimatic- Rainfall	Worldclim

18	Bio_18 Precipitation of Warmest quarter	Bioclimatic- Rainfall	Worldclim
19	Bio_19 Precipitation of Coldest quarter	Bioclimatic- Rainfall	Worldclim
20	Elevation	Topographic	SRTM
21	Slope	Topographic	SRTM
22	Aspect	Topographic	SRTM
23	CTI Compound Topographic Index	Topographic	SRTM
24	TRI Terrain Ruggedness Index	Topographic	SRTM

(Worldclim: http://www.worldclim.org), (SRTM, Shuttle Radar Topographic Mission; http://topex.ucsd.edu/WWW_html/srtm30_plus.html)

Ecological Niche Modelling: Maximum entropy (Maxent) modelling was chosen to predict the potential distribution of the endemic palm species in the ANI's. Maxent is a machine learning method which has its origin in the statistical mechanics (Franklin, 2009). It is a general-purpose method which makes predictions from incomplete information. The probability distribution of maximum entropy (closest to the uniform), subject to a set of constraints that represent the incomplete information about the target distribution (Phillips *et al.,* 2006; Peterson *et al.,* 2011). Maxent has shown to produce competitive results when compared with other general purpose modelling methods used in predicting the potential geographical distribution of a species (Elith *et al*., 2006; Wisz *et al.,* 2008). Maxent version 3.3.4e (http://www.cs.princeton.edu/~schapire/ maxent) was used to run the models. In the program, 500 iterations were run with a convergence threshold of 0.00001 and a maximum of 10,000 background points and algorithm parameters were set to auto features (Phillips & Dudik, 2008).

Only the random test percentage in the settings was turned to 20 orders to test the model robustness through the Area under Curve (AUC). In addition to that, an external test was done through a jackknife test. By leaving one occurrence point at a time and running the model, it was allowed to predict the excluded point and the accuracy was tested simple probability test. Maxent produces predictions in the form of real numbers between 0 and 100 representing the cumulative probability of occurrence. The cumulative output format is chosen and the values were imported into ArcGIS as integer grids for further analysis and comparison.

Result and discussion

The arecaceous flora of ANI's comprises 49 species of palms and rattans under 18 genera. Of which, *Bentinckia nicobarica, Phoenix andamanensis, Pinanga manii, Pinanga andamanensis* and *Rhopaloblaste augusta* are endemic palm species. Local distribution of these species is highly restricted in some pockets in the Islands. Further, they are being exploited by the local population for various purposes, thus the wild population of these species are under threat. Therefore, their distribution maps of present occurrence have been prepared (Fig. 1.1, 2.1, 3.1, 4.1, & 5.1) with the help of Arc-GIS software and the IUCN Red List assessment has been carried out with the help of online Geo-CAT software and Red List guidelines.

Conservation Assessment by IUCN criteria: Population data was used to assess IUCN threat category (IUCN, 2013). Online software GeoCAT (http://geocat.kew.org) was used to

calculate AOO and EOO by keeping grid size 4×4 km for the following five palms species of ANI's.

(A) Conservation Assessement of Bentinckia nicobarica (Kurz) Becc.: We used guidelines of IUCN red list criteria (IUCN, 2013). Due to non availablity of sufficient data or no study on this category, Criteria A has not followed. Detailed survey of areas of occurrence confirmed its rarity. Calculation of AOO with the help of our observations, locations and Geocat online software used for calculation of exact AOO resulted as 176 km^2 (Fig. 1.2, 1.3). In IUCN criteria B, AOO is more than 10 km^2 and less than 500 km^2 therefore, it is placed under **B_2** Endangered Category. During the present survey, we recollected the species from earilier reported three loaclities and in addition to seven new locations**.** The population of this species have been declined in previously reported five locations and fragmented population have been observed in seven new locations. On the basis of our observation of last 4 years, its natural population or mature individuals has been continously decreasing in number therefore, it is placed in **B_2b** under Endangered category**.** It's AOO and EOO are steadily reducing and its habitats also decline, so it is placed in **$B_2b_{(i, ii, iii)}$** under Endangered category**.** It's population size in a small pockets and continuous decline of the same, resulted in placing of this species in Category **C_{2a}** under Endangered category. Number of mature individuals in each subpopulation in the nature is less than 250 and the population is continuously shrinking, hence it should be placed in Category **$C_{2a(i)}$** under Endangered category. Due unavailabilty of sufficient data or lack of study on this category, Criteria D & Criteria E has not followed. Hence, its assessment using IUCN criteria best fitted it under the category Endangered [criteria - **$EN/B_2b_{(i,ii,iii)};C_{2a(i)}$**] (Purohit *et al.,* 2023).

(B) Conservation Assessement of Phoenix andamanensis S. Barrow: Due to unavailabilty of sufficient data or lack of study on this category, Criteria A has not followed. Calculation of EOO with the help of our observations, locations and Geocat online software used for calculation of exact EOO resulted as 374 km^2 (Fig. 2.2, 2.3). In IUCN criteria B, EOO is more than 100 km^2 and less than 5,000 km^2 therefore, it is placed under **B_1 Endangered** Category. Calculation of AOO with the help of our observations, locations and Geocat online software used for calculation of exact AOO resulted as 24 km^2 (Fig. 2.2). In IUCN criteria B, AOO is more than 10 km^2 and less than 500 km^2, therefore, it is placed under **B_2 Endangered** Category. Its reported from three locations in Andaman islands. In IUCN criteria B, number of locations is more than 01 and less than 05, therefore, it is palced under **B_{1+2}a Endangered Category**. But in most of the locations its population continuously declined and fragmented population have been observed. On the basis of our observation of last 4 years, its natural population or mature individuals are continously decreasing in number therefore, it is placed in **B_{1+2}ab** under Endangered category**.** It's EOO & AOO is steadily reducing and its populations decline, so it is placed in **$B_{1+2}ab_{(i,ii,iv)}$** under Endangered category**.** Due to non availability of sufficient data or not study on this category, Criteria C, Criteria D and Criteria E has not followed. Hence, its assessment using IUCN criteria best fitted it under the category Vulnerable [criteria - **$EN/B_{1+2}ab_{(i,ii,iv)}$**] (Purohit *et al.,* 2023).

(C) Conservation Assessement of Pinanga andamanensis Becc.: On the basis of published literature and observation during last four-year field exploration, population of this plant has

been observed to be declining i.e. approx. 70% decrease in the wild, therefore it is placed under A_1 Endangered Category. Its AOO is continue declining, resulted in placing of this species in Category **A_1c** under Endangered Category.

Detailed survey of areas of occurrence confirmed its rarity. Calculation of EOO has done with the help of our observations, locations and Geocat online software has been used for calculation of exact EOO resulted as 1,215 km^2 (Fig. 3.2, 3.3). In IUCN criteria B, EOO is more than 100 km^2 and less than 5,000 km^2 therefore, it is placed under **B_1** Endangered Category. Calculation of AOO has done with the help of our observations, locations and Geocat online software has been used for calculation of exact AOO which resulted as 24 km^2 (Fig. 3.2, 3.3). In IUCN criteria B, AOO is more than 10 km^2 and less than 500 km^2 therefore, it is placed under **B_2** Endangered Category. Its reported from four locations in Andaman islands but traced out in only one location and find one new locations**.**

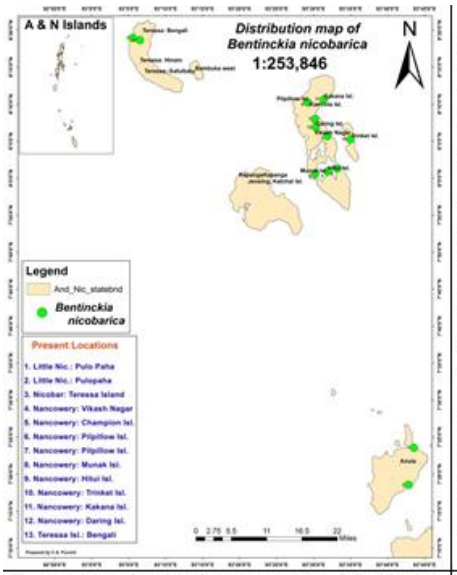

Fig. 1.1: Map showing the occurrence and distribution of *Bentinckia nicobarica* in ANI's

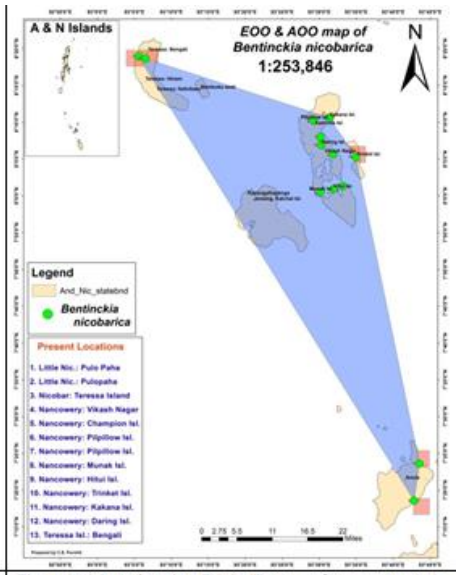

Fig. 1.3: Map showing EOO (Extent of occurrence) & AOO (Area of Occurrence) of *B. nicobarica* in ANI's

Fig. 1.2: Convex hull of occurrence points for analysis of EOO and AOO using GeoCat

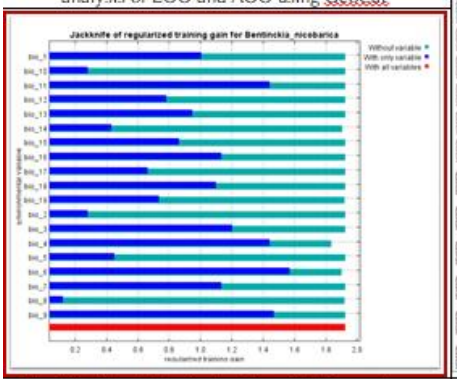

Fig. 1.6: The Jackknife test of variable importance for *B. nicobarica*.

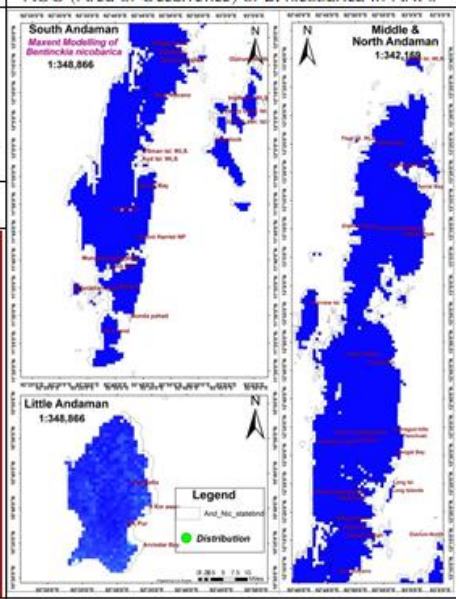

Fig. 1.5: Map showing potential distribution and Habitat suitability of *Bentinckia nicobarica* in Andaman Islands

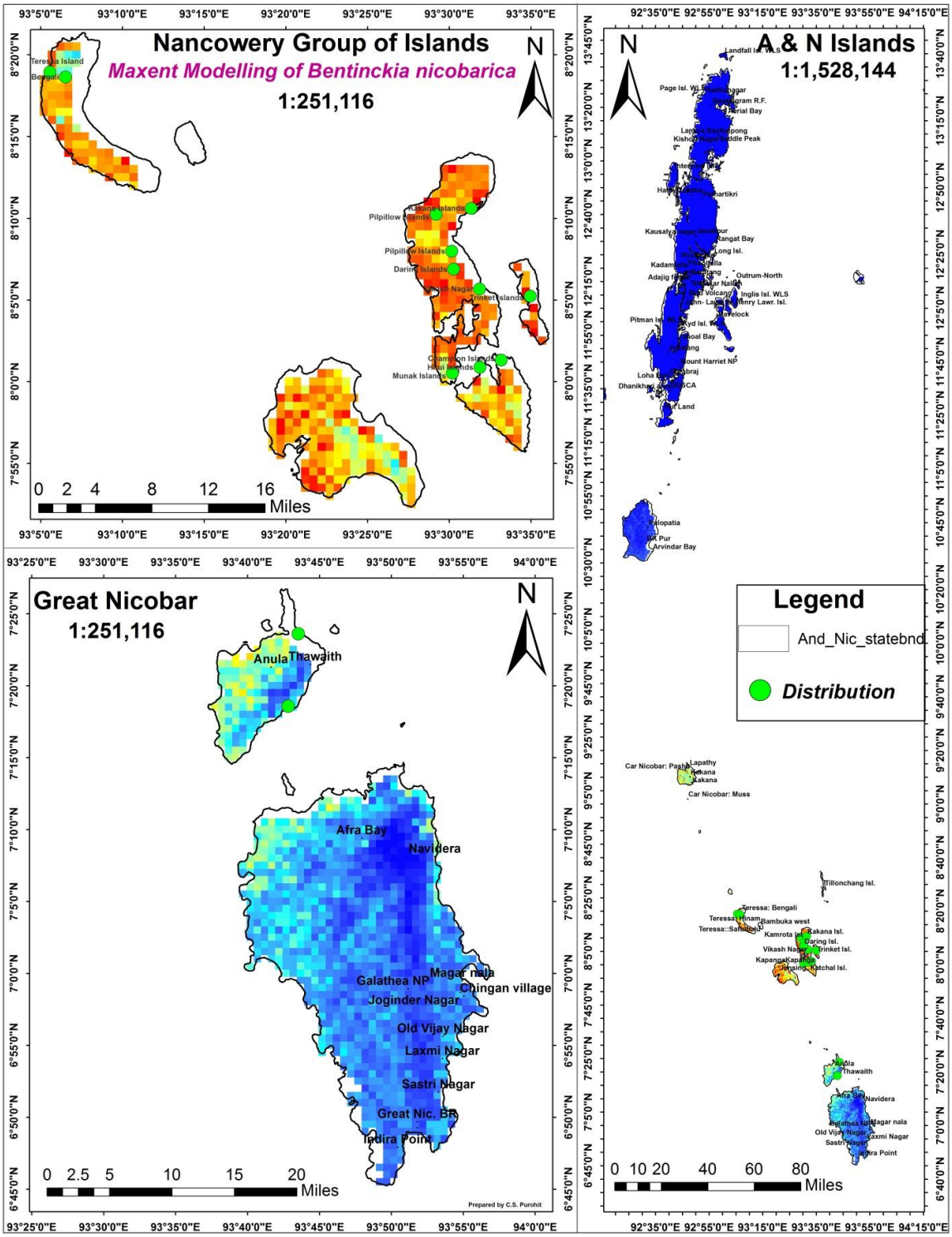

Fig. 1.4 Map shows potential distribution and Habitat suitability of Bentinckia nicobarica (Kurz) Becc. in ANI's.

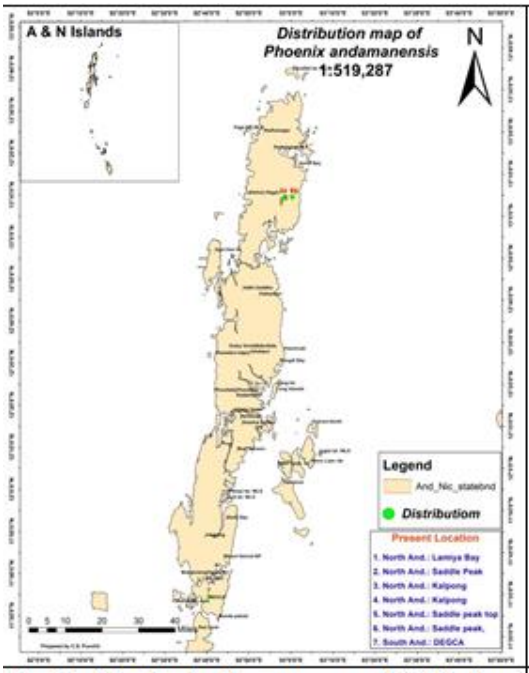

Fig. 2.1: Map showing the occurrence and distribution of *Phoenix andamanensis* S. Barrow in ANI's

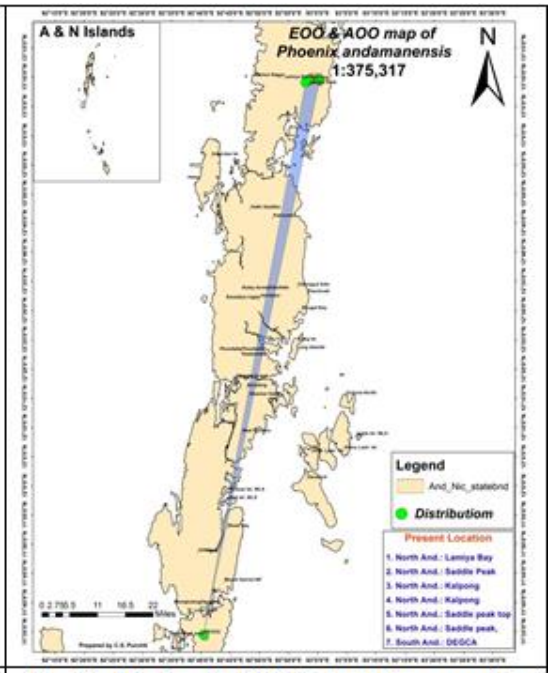

Fig. 2.3: Map showing EOO (Extent of occurrence) & AOO of *Phoenix andamanensis* in ANI's

Fig: 2.2: Convex hull of occurrence points for analysis of EOO and AOO using GeoCat

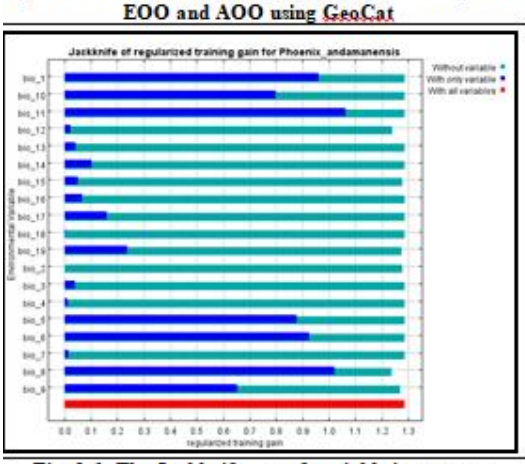

Fig. 2.6: The Jackknife test of variable importance for *Phoenix andamanensis*

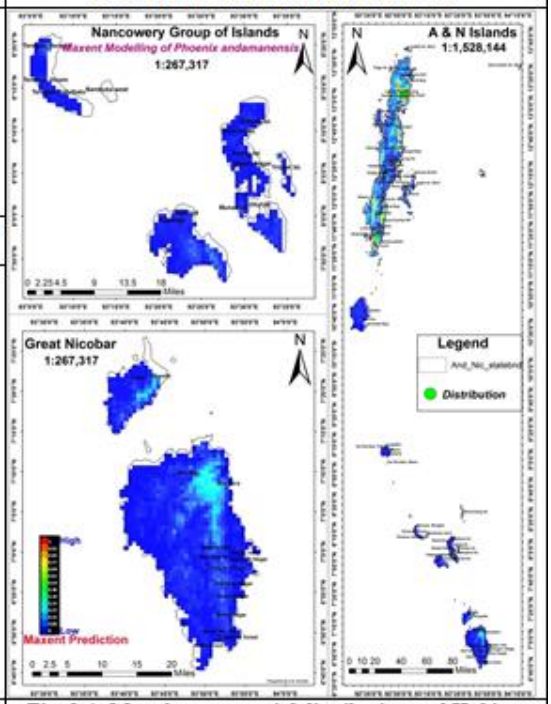

Fig. 2.4: Map shows potential distribution and Habitat suitability of *Phoenix andamanensis* in ANI's

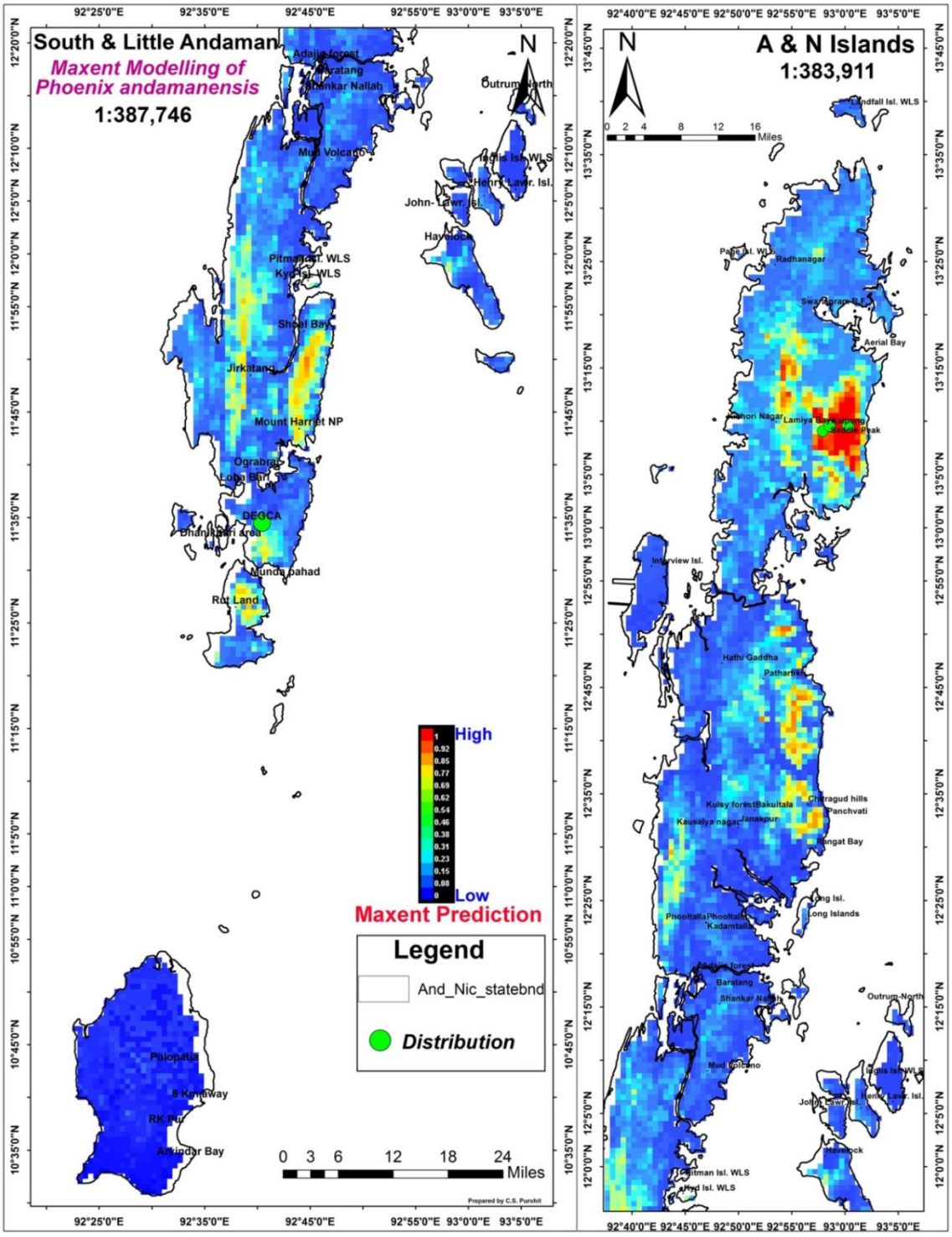

Fig. 2.5 Map showing potential distribution and Habitat suitability of Phoenix andamanensis S. Barrow in North, Middle, South and Little Andaman Islands.

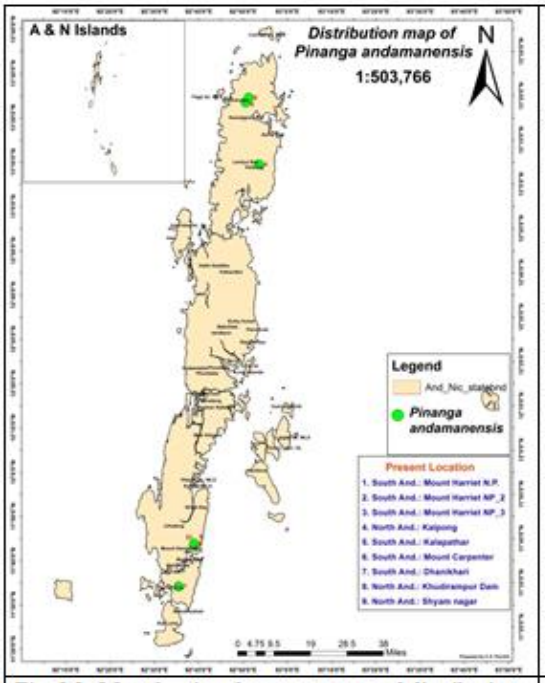

Fig. 3.1: Map showing the occurrence and distribution of *Pinanga andamanensis* Becc. in ANI's

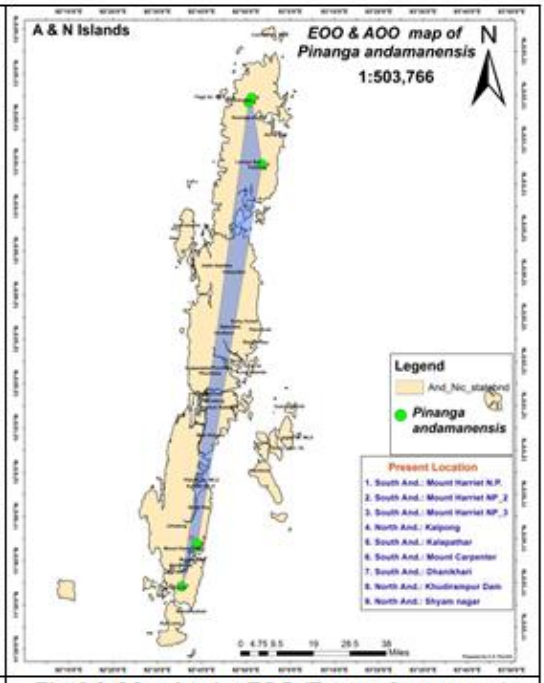

Fig. 3.3: Map showing EOO (Extent of occurrence) & AOO of *Pinanga andamanensis* in ANI's

Fig: 3.2: Convex hull of occurrence points for analysis of EOO and AOO using GeoCat

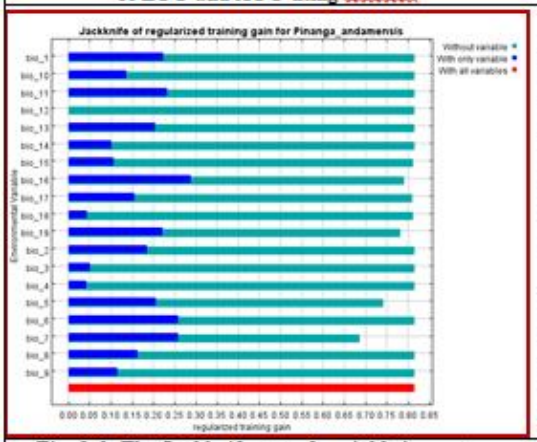

Fig. 3.6: The Jackknife test of variable importance for *Pinanga andamanensis*

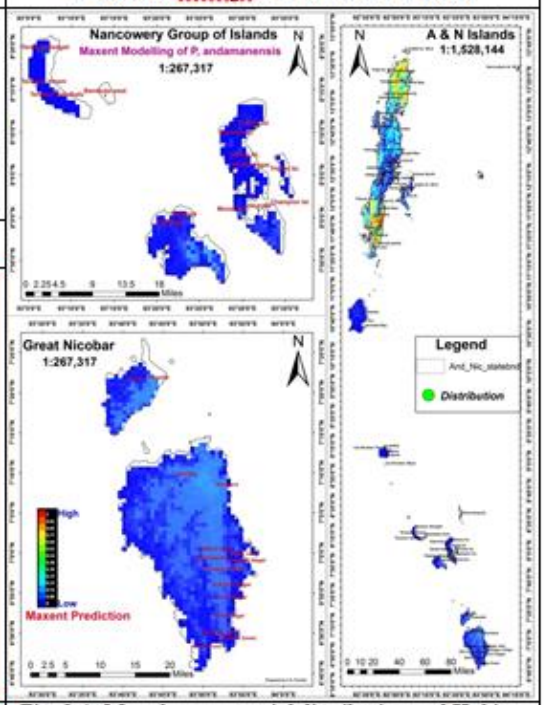

Fig. 3.4: Map shows potential distribution and Habitat suitability of *Pinanga andamanensis* in ANI's

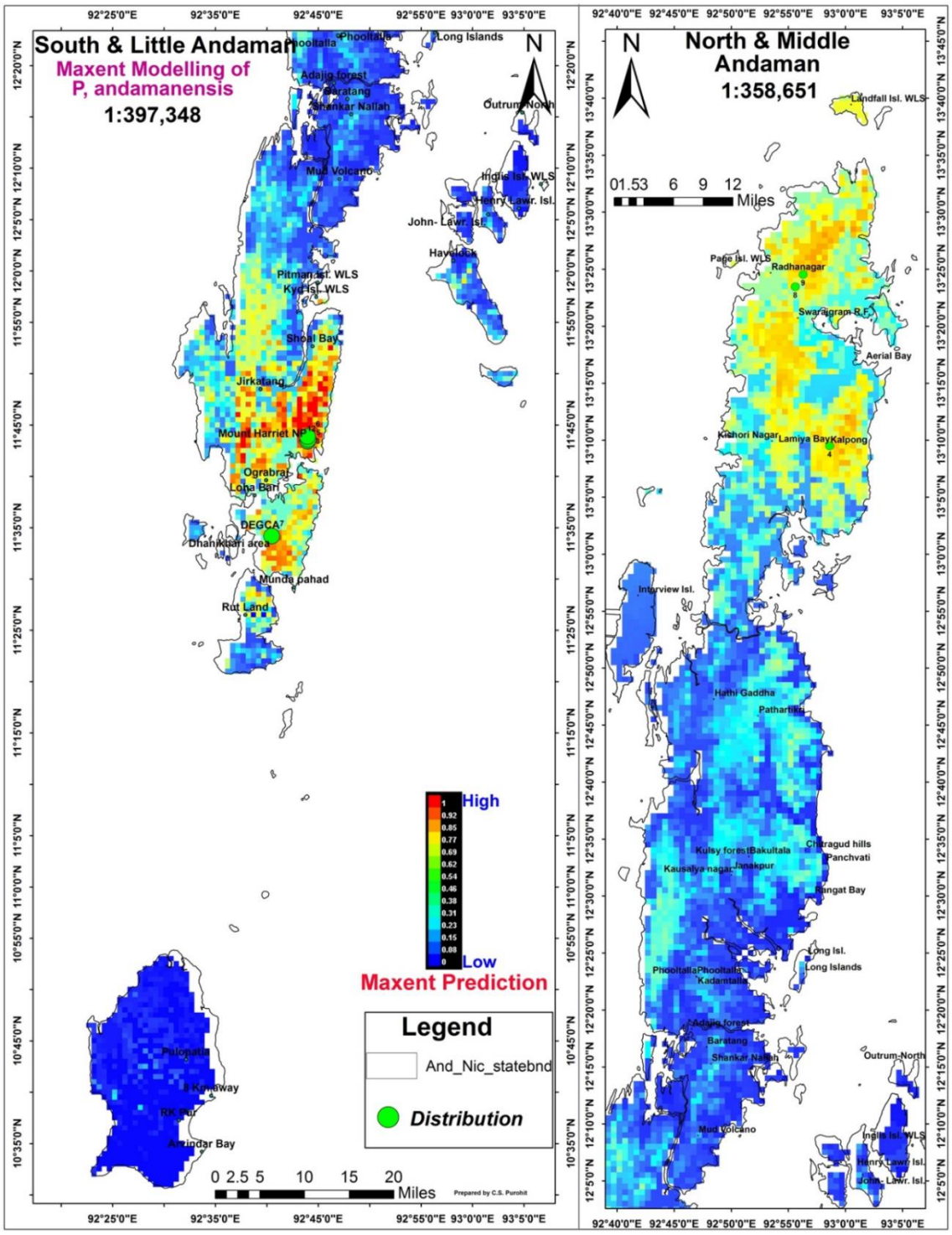

Fig. 3.5 Map showing potential distribution and Habitat suitability of Pinanga andamanensis Becc. in North, Middle, South and Little Andaman Islands.

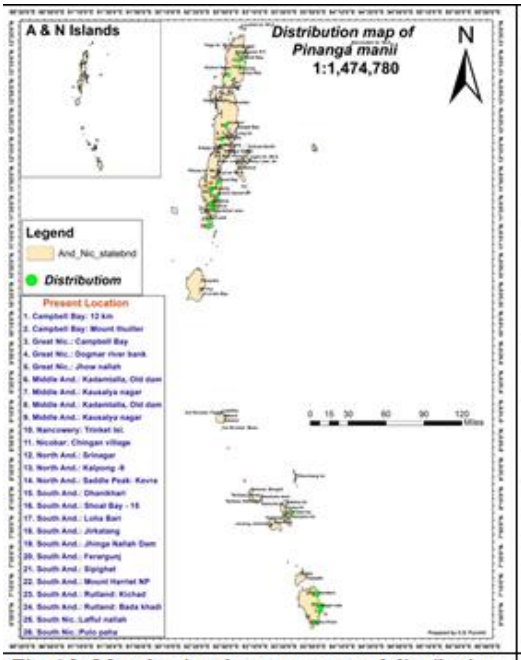

Fig. 4.1: Map showing the occurrence and distribution of *Pinanga manii* Becc. in ANI's

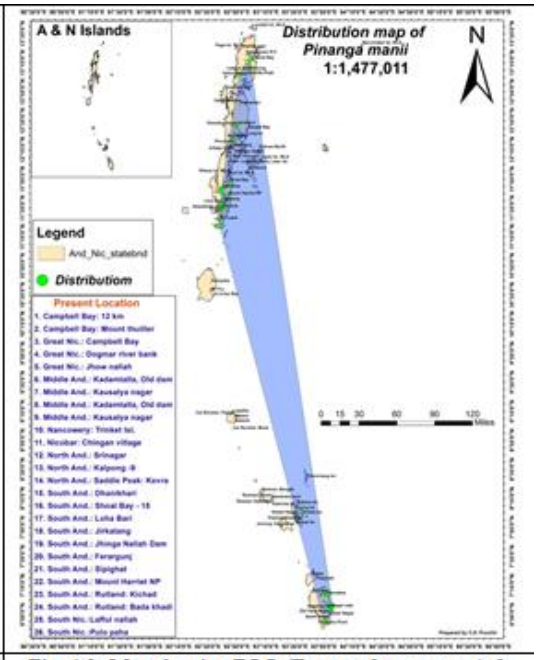

Fig. 4.3: Map showing EOO (Extent of occurrence) & AOO of *Pinanga manii* Becc. in ANI's

Fig: 4.2: Convex hull of occurrence points for analysis of EOO and AOO using GeoCat

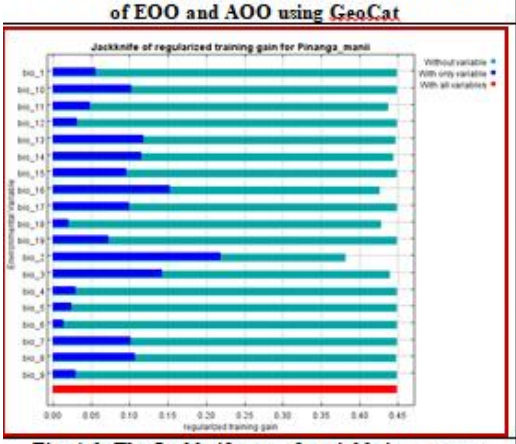

Fig. 4.6: The Jackknife test of variable importance for *Pinanga manii* Becc

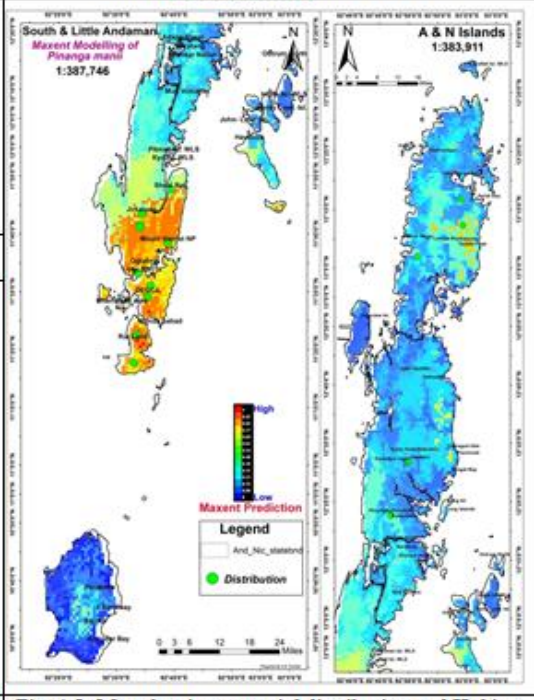

Fig. 4.5: Map showing potential distribution and Habitat suitability of *Pinanga manii* Becc. in ANI's

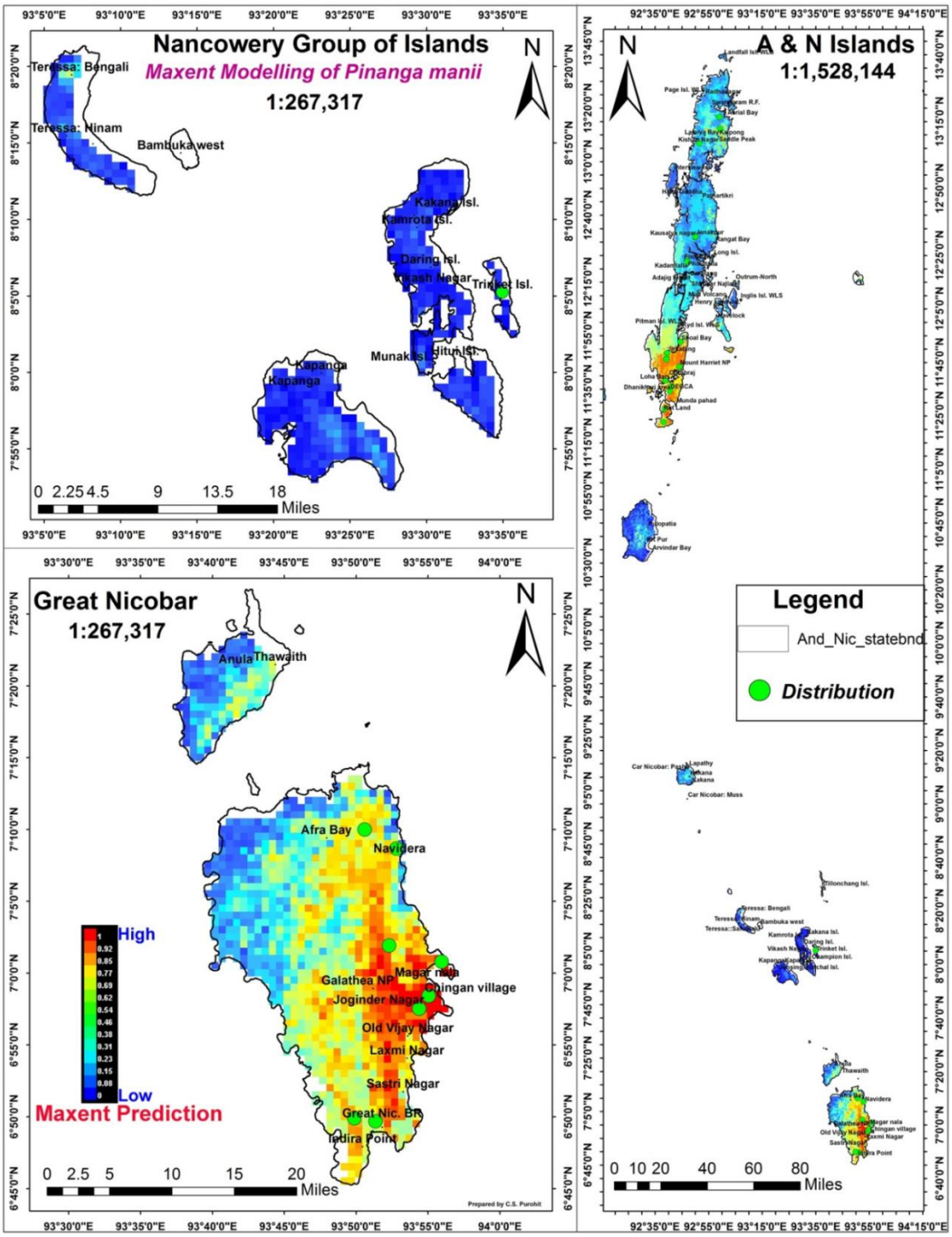

Fig. 4.4 Map shows potential distribution and Habitat suitability of Pinanga manii Becc. in ANI's.

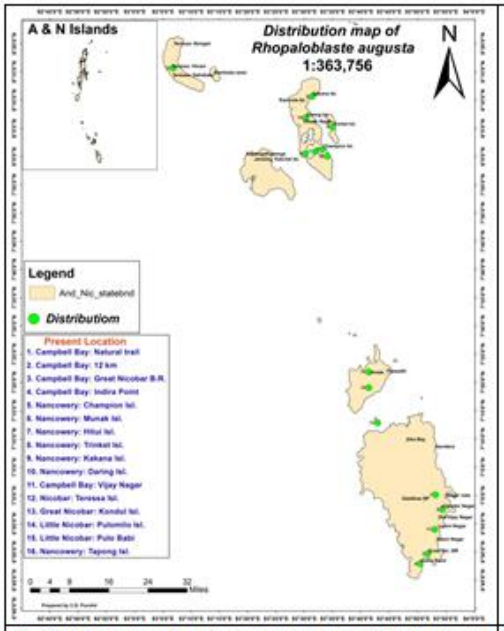

Fig. 5.1: Map showing the occurrence and distribution of *Rhopaloblaste augusta* in Andaman & Nicobar Islands

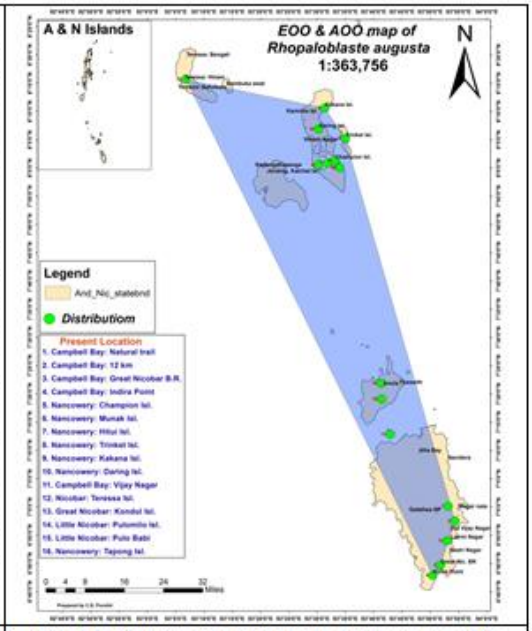

Fig. 5.3: Map showing EOO (Extent of occurrence) & AOO of *Rhopaloblaste augusta* in ANI's

Fig: 5.2: Convex hull of occurrence points for analysis of EOO and AOO using GeoCat

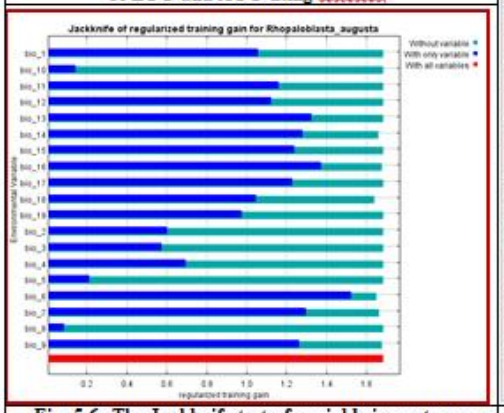

Fig. 5.6: The Jackknife test of variable importance for *Rhopaloblaste augusta*

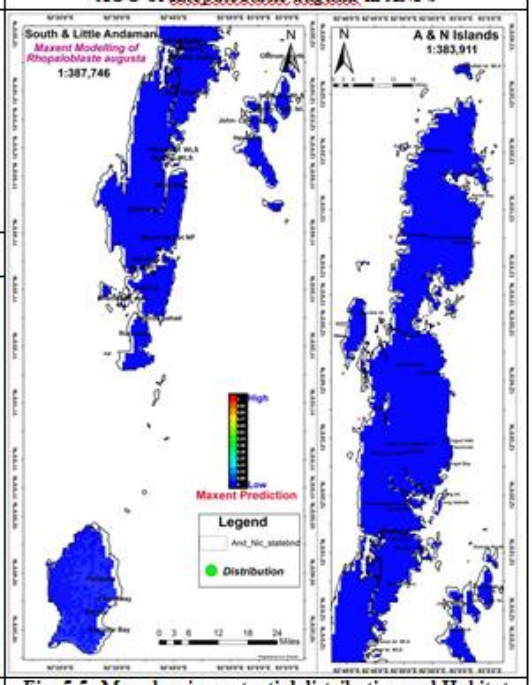

Fig. 5.5: Map showing potential distribution and Habitat suitability of *Rhopaloblaste augusta* in ANI's

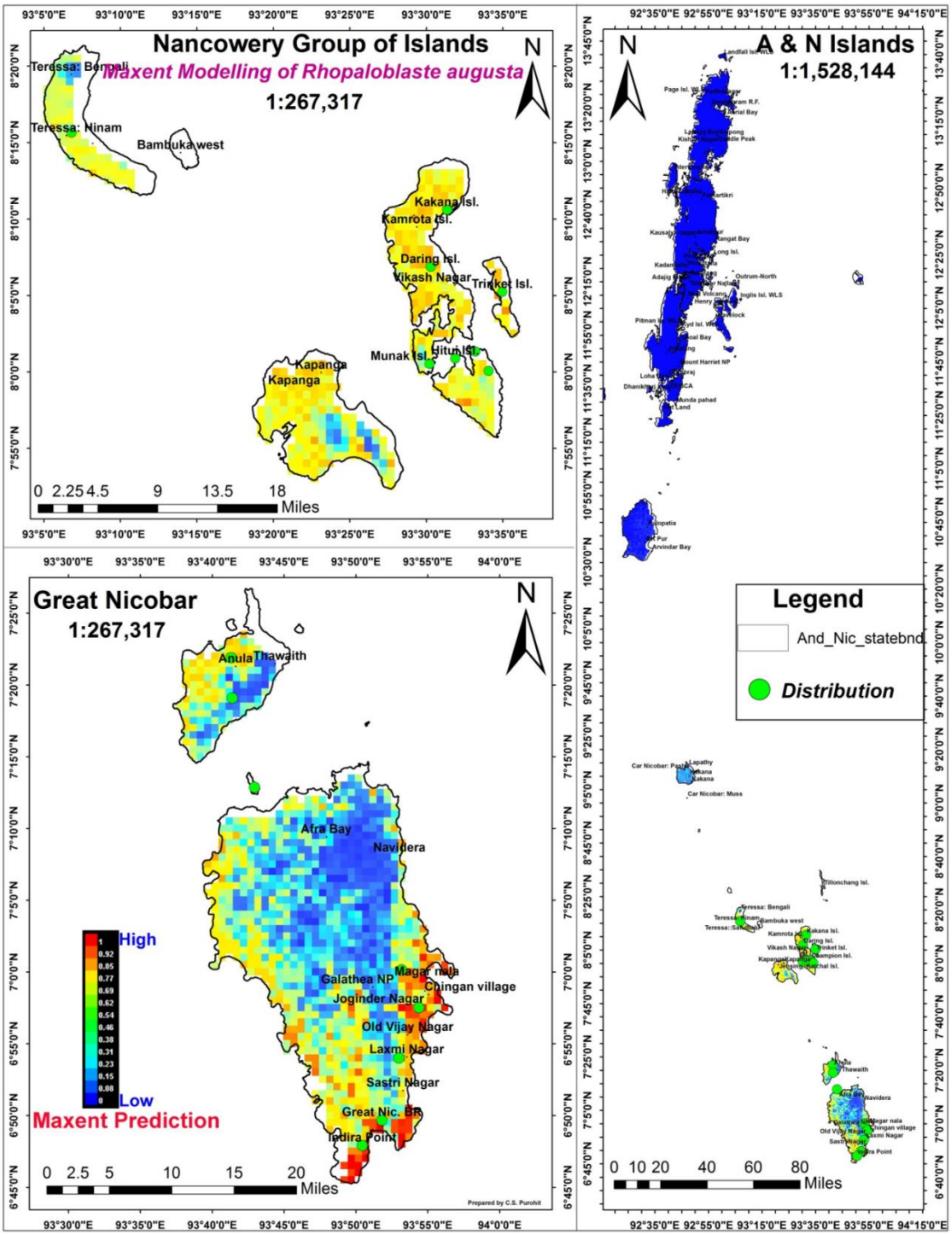

Fig. 5.4 Map shows potential distribution and Habitat suitability of Rhopaloblaste augusta (Kurz) H. E. Moore in ANI's.

The population of this plant has been declined in previously reported four locations and fragmented population have been observed in one new location. On the basis of our observation of last 4 years, its natural population or mature individuals are continously decreasing in number therefore, it is placed in **$B_{1+2}b$** under Endangered category**.** It's AOO and EOO are steadily reducing and its habitats is also declining, so it is placed in **$B_{1+2}b_{(i,ii,iii)}$** under Endangered category**.** It's population size in small pockets and continuous decline of the same, resulted in placing of this species in Category **C_2a** under Endangered category.

Number of mature individuals in each subpopulation in the nature is less than 250 and its continuous shrink is placing the species in Category **$C_2a_{(i)}$** under Endangered category. Due to unavailabilty of sufficient data or lack of study on this category, Criteria D & Criteria E have not followed. Hence, its assessment using IUCN criteria best fitted it under the category Endangered [criteria- **$EN/A_1c;B_{1+2}b_{(i,ii,iii)};C_2a_{(i)}$**] (Purohit *et al.,* 2023).

(D) Conservation Assessement of Pinanga manii Becc.: Due to unavailabilty of sufficient data or lack of study on this category, Criteria A has not followed. On the basis of published literature and observation during the last four-year field exploration, population of this plant continue declining. Geocat online software was used for calculation of exact AOO which resulted as 100 km^2 (Fig. 4.2, 4.3). In IUCN criteria B, AOO is more than 10 km^2 and less than 500 km^2 therefore, it is placed under **B_2** Endangered Category. It's reported from thirteen locations in Andaman & Nicobar islands but traced out in only ten location and found six new locations**.** The population of this species has been declined in previously reported three locations and fragmented population has been observed in six new locations. On the basis of our observation during last 4 years, its natural population or mature individuals are continously decreasing in number therefore, it is placed in **B_2b** under Endangered category**.** Its AOO and EOO are steadily reducing and its habitats also declining, so it is placed in **$B_2b_{(i,ii,iii)}$** under Endangered category**.** Due to unavailabilty of sufficient data or lack of study on this category, Criteria C, Criteria D & Criteria E have not followed. Hence, its assessment using IUCN criteria best fitted it under the category Endangered [criteria- **$EN/B_2b_{(i,ii,iii)}$**] (Purohit *et al.,* 2023).

(E) Conservation Assessement of Rhopaloblaste augusta (Kurz) H. E. Moore: On the basis of published literature and observation during last four-year field exploration, it was observed that the population of this species continue declining i.e. approx. 70% decrease, therefore, it is placed under A_1 Endangered Category. Its AOO continue declining, resulted in placing of this species in Category A_{1C} under Endangered Category. Detailed survey of areas of occurrence confirmed its rarity. Geocat online software was used for calculation of exact AOO resulted as 44 km^2 (Fig. 5.2, 5.3). In IUCN criteria B, AOO is more than 10 km^2 and less than 500 km^2 therefore, it is placed under **B_2** Endangered Category. As per published records, this species has been reported from two locations in Andaman islands, however we could not tarce it from the reported locations but found in eleven new locations in Nicobar Islands**.** The population of this species has been declined in previously reported four locations and fragmented population has been observed in eleven new locations. On the basis of our observation of last 4 years, its natural population or mature individuals are continously decreasing in number therefore, it is placed in **B_2b** under Endangered category**.** Its AOO and EOO are steadily reducing and its habitats are also declining, so it is placed in **$B_2b_{(i,\ ii,\ iii)}$** under Endangered category**.** It's population size in small pockets and continuous decline of the same, resulted in placing of this species in Category **C_{2a}** under Endangered category. Number of mature individuals in each subpopulation in the habitat is less than 250 and are in continuous shrink which places the species in Category **$C_{2a(i)}$** under Endangered category. Due to unavailabilty of sufficient data or lack of study on this category, Criteria D & Criteria E have not followed. Hence, its assessment using IUCN criteria best fitted it under the category Endangered [criteria - **$EN/\ A_{1C};B_2b_{(i,ii,iii)};C_2a_{(i)}$**] (Purohit *et al.,* 2023).

Few other reports on IUCN threat category assessment of different species from India are on: *Bentinckia nicobarica* (Johnson, 1998), *Mangifera nicobarica* (WCMC, 1998), *Drypetes andamanica* (WCMC, 1998), *Ceropegia bulbosa* var. *lushii* (Purohit *et al.*, 2018); *Aloe trinervis* (Kulloli *et al*., 2020), *Macaranga nicobarica* (Rivers, 2020), *Neoscortechinia nicobarica* (Barstow, 2021), *Euphorbia jodhpurensis* (Purohit & Kulloli, 2022), *Ammannia desertorum* (Kulloli & Purohit, 2022).

Ecological Niche Modelling: A jackknife test confirmed that the prediction is significantly better than at random (AUC) values were also higher (above 0.9) which implies that the model is accurate and justifies the construction of final niche model with all the available points for all five endemic palm species.

(A) Bentinckia nicobarica (Kurz) Becc.: The prediction was good because the final niche model includes all the thirteen occurrence points in the Nicobar Islands. The potential distribution is found to be more in the Nancowry group of Islands. Though there was no record of the species from any other islands in the Nicobar group, the species was predicted to be present in the rest of the islands. Output of the ecological niche modelling of *B. nicobarica* is shown in the Fig. 1.4 and Fig. 1.5. This is a representation of the Maxent model for *Bentinckia_nicobarica*. Warmer colours (Dark Red, Orange and Dark yellow colour) show areas with better predicted conditions and other colours (Dark blue, sky blue, green and yellowish green) show area with very low prediction. Fig. 1.4 shows that Katchal Island, Teressa Islands and Kamorta Islands are predicted as suitable (dark red and Orange colour in maps). There is a possibility of the presence of *B. nicobarica* in Katchal islands (places of Kapananga, Jhoola, Jansin, Mohean area), Car Nicobar Islands (Lapathy, Kakana, Muss, Malaca) and Nancowry group of Islands (Champion Isl., Hitui Isl., Kakana Isl., Trinket, Munak Isl., Pillpillow Isl.) (Fig. 1.4). It is predicted that probability of occurrence of *B. nicobarica* in the rest of the areas of Andaman and Nicobar Islands (In map of Fig. 1.5 shows dark blue colour in North, middle, South and Little Andaman) i.e. Andaman Islands is very low (Fig. 1.5). The northern most known occurrence limit of *B, nicobarica* is from the Car Nicobar Island. The reported central distribution range is in the Katchal and Kamorta Islands and the model has predicted suitable areas in the nearest islands such as Trinket, Nancowery, Teressa, Tillanchong and Chowra. Maxent model gives the estimations of relative contributions of the significant environmental variables influencing the distribution of the species in a given region. In Nancowry group of Islands, main populations were located in the Kamorta, Vikash Nagar, Kakana, Champion Island, Daring Island, Pilpillow Island, Trinket Island and Tapong (Purohit *et al.,* 2023).

Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. Of the 19 bioclimatic and six topographic variables, only four variables viz., Minimum temperature of coldest month, Mean temperature of driest month, Precipitation seasonality and precipitation in the wettest quarter of the year positively influence the distribution of this species in Nicobar Islands which are located in the tropical region with a very stable equatorial climate. This characteristic of higher precipitation in the warmest quarter, the annual mean temperature which is above 18°C and less temperature seasonality that might influences the biological

requirements of *B. nicobarica*. A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_6, which therefore appears to have the most useful information by itself (Fig. 1.6) (Purohit *et al.,* 2023).

(B) Phoenix andamanensis S. Barrow: The prediction was good because the final niche model includes all the twenty-six occurrence points in the ANI's. The potential distribution is found to be more in the North Andaman Islands. Of the seven reported localities of *P. andamanensis*, six were from North Andaman Islands and one location (ex-situ conservation) from South Andaman Islands. Though there were no records from whole Nicobar group of Islands, Little, South & Middle Andaman Islands, the species was predicted to be present in the rest of the islands. Output of the ecological niche modelling of *P. andamanensis* is shown in the Fig. 2.4 & 2.5. This is a representation of the Maxent model for *P. andamanensis*, warmer colours (Dark Red, Orange and Dark yellow colour) show areas with better predicted conditions and other colours (Dark blue, sky blue, green and yellowish green) show area with very low prediction. Fig. 2.4 & 2.5 shows that Mount Harriet, Saddle peak, Lamiya Bay, Kalpong, Ramnagar R.F. are predicted as highly suitable habitats (dark red and orange colour in maps). There is a possibility of the presence of *P. andamanensis* in North Andaman Islands (Saddle peak, Lamiya Bay, Bamboo nallah, Kalighat R.F., Manpur R.F., Mehandi tikri, Kalpong, Ramnagar R.F.), Middle Andaman Islands (Pathar tikri, Chitragud hills, Panchavati, Rangat Bay) and South Andaman Islands (Mount Harriet, Rutland, Shoal Bay, Ferargunj, Jirkatang) [Fig. 2.5]. It is predicted that probability of occurrence of *P. andamanensis* in the Nicobar group of Islands and Little, South and Middle Andaman Islands (In map of Fig. 2.4 & 2.5 shows dark blue colour in the Nicobar group of Islands and Little, South and Middle Andaman Islands) i.e. is very low (Fig. 2.5). In North Andaman Islands, main populations were located in the Kalpong and Saddle peak (Purohit *et al.,* 2023).

Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. Of the 19 bioclimatic and six topographic variables, only four variables viz., Mean temperature of wettest quarter, Mean temperature of driest quarter, Mean temperature of coldest quarter and Precipitation of driest quarter of the year positively influence the distribution of this species in Andaman Islands which are located in the tropical region with a very stable equatorial climate. This characteristic of Mean temperature of wettest quarter is 23.4°C, Mean temperature of driest quarter is 27.5°C, Mean temperature of coldest quarter is above 18°C and Precipitation of driest quarter is above 60 mm that might influences the biological requirements of *P. andamanensis*. A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_11, which therefore appears to have the most useful information by itself (Fig. 2.6) (Purohit *et al.,* 2023).

(C) *Pinanga andamanensis* Becc.: The prediction was good because the final niche model includes all the sixteen occurrence points in the Nicobar Islands. The potential distribution is found to be more in the South Andaman Islands. Of the nine reported localities of *P. andamanensis*, six were from South Andaman Islands and three from North Andaman Islands. Though there were no records from Nicobar group of Islands and Middle & Little

Andaman Islands, the species was predicted to be present in the rest of the islands. Output of the ecological niche modelling of *P. andamanensis* is shown in the Fig. 3.4 & 3.5. This is a representation of the Maxent model for *P. andamanensis*. Warmer colours (Dark Red, Orange and Dark yellow colour) show areas with better predicted conditions and other colours (Dark blue, sky blue, green and yellowish green) show area with very low prediction. Fig. 3.4 shows that Mount Harriet, Dhanikhari, Beechdera, Shyam nagar, Elezabeth Bay, Radhanagar, Saddle peak are predicted as suitable (dark red and Orange colour in maps). There is a possibility of the presence of *P. andamanensis* in South Andaman Islands (Mount Harriet, Dhanikhari, Flat Bay R.F., Shoal Bay, Munglutang, Manjeri R.F.) and North Andaman Islands (Beechdera, Shyam nagar, Elezabeth Bay, Radhanagar, Saddle peak, Lamiya Bay), [Fig. 3.5]. It is predicted that probability of occurrence of *P. andamanensis* in the ANI's (In map of Fig. 3.4 & 3.5 shows dark blue colour in Nicobar Islands and Middle, and Little Andaman) i.e. Nicobar Islands is very low (Fig. 3.4) and Middle & Little Andaman Islands is very low (Fig. 3.5). In South Andaman Islands, main populations were located in the Mount Harriet, Mount Carpenter, Kalapahar and Dhanikhari. In North Andaman Islands, main populations were located in the Kalpong, Khudirampur dam and Shyam nagar (Purohit *et al.,* 2023).

Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. Of the 19 bioclimatic and six topographic variables, only four variables viz., Maximum temperature of warmest month, annual range of temperature, Precipitation of driest quarter and Precipitation of coldest quarter of the year positively influence the distribution of this species in Nicobar Islands which are located in the tropical region with a very stable equatorial climate. This characteristic of average maximum temperature of warmest month is 30°C, annual range of temperature is 20°C to 37°C, Precipitation of driest quarter is above 2.5 mm/day and Precipitation of coldest quarter is 16.29 mm/day that might influences the biological requirements of *Pinanga andamanensis*. A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_16, which therefore appears to have the most useful information by itself (Fig. 3.6) (Purohit *et al.,* 2023).

(D) Pinanga manii Becc.: The prediction was good because the final niche model includes all the twenty-six occurrence points in the ANI's. The potential distribution is found to be more in the South Andaman and Great Nicobar Islands. Of the twenty-six reported localities of *P. manii*, ten were from South Andaman Islands six from Great Nicobar Islands, four from Middle Andaman Islands, three from North Andaman Islands, two from South Nicobar Islands and one from Nancowry group of Islands. Though there were no records from Little and North Nicobar Islands and Little Andaman Islands, the species was predicted to be present in the rest of the islands. Output of the ecological niche modelling of *Pinanga manii* Becc. is shown in the Fig. 4.4 & 4.5. This is a representation of the Maxent model for *P. manii*. Warmer colours (Dark Red, Orange and Dark yellow colour) show areas with better predicted conditions and other colours (Dark blue, sky blue, green and yellowish green) show area with very low prediction. Fig. 4.4 shows that Mount Harriet, Dhanikhari, Munda pahad, Rutland, Jirkatang, Galathea R.F., Joginder nagar, Nevidera, Afra Bay are predicted as suitable (dark red and Orange colour in maps). There is a possibility of the presence of *P. manii* in South Andaman Islands (Mount Harriet, Dhanikhari, Flat Bay R.F., Shoal Bay, Munglutang, Manjeri

R.F., Munda pahad, Rutland, Jirkatang), Great Nicobar Islands (Galathea R.F., Chingen village, Joginder nagar, Nevidera, Afra Bay, Vijay magar, Laxmi nagar, Sastri nagar, Indira point) and North Andaman Islands (Kalpong, Lamiya Bay, Saddle peak), [Fig. 4.5]. It is predicted that probability of occurrence of *P. manii* in the ANI's (In map of Fig. 4.4 & 4.5 shows dark blue colour in Nancowry group of Islands and North, Middle, and Little Andaman) i.e. Nancowry group of Islands is very low (Fig. 4.4) and North, Middle and Little Andaman Islands is very low (Fig. 4.5). In South Andaman Islands, main populations were located in the Rutland, Sipighat, Mount Harriet, Mount Carpenter, Ferargunj, Jhinga nallah, Jirkatang, Loha Bari, Shoal Bay, Dhanikhari. In North Andaman Islands, main populations were located in the Kalpong, Saddle peak, Srinagar), from Middle Andaman (Kadamtalla, Kasualya nagar. In Great Nicobar Islands main populations were located in the Campbell Bay, Mount Thuiller, 12 Km, Dogmar river bank, Jhow nallah, Chingan village. In South Nicobar main populations were located in the Lafful, Pulo paha and in Nancowery group of Islands at Trinket Island (Purohit *et al.,* 2023).

Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. Of the 19 bioclimatic and six topographic variables, only three variables viz., mean diurnal range, Precipitation of wettest quarter and Precipitation of driest quarter of the year positively influence the distribution of this species in Andaman and Nicobar Islands which are located in the tropical region with a very stable equatorial climate. This characteristic of mean diurnal range of temperature is 7.5°C, Precipitation of wettest quarter is above 90mm and Precipitation of driest quarter is above 60 mm that might influences the biological requirements of *Pinanga manii*. A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_2, which therefore appears to have the most useful information by itself (Fig. 4.6) (Purohit *et al.,* 2023).

(E) Rhopaloblaste augusta (Kurz) H. E. Moore: The prediction was good because the final niche model includes all the sixteen occurrence points in the Nicobar Islands. The potential distribution is found to be more in the Nancowry group of Islands. Of the sixteen reported localities of *R. augusta*, eight were from Nancowry group of Islands; six from Great Nicobar Islands and two from Little Nicobar Islands. Though there were no records from any other island in the Nicobar group, the species was predicted to be present in the rest of the islands. This indicates the possibility of wider scattered distribution of this species in all Islands. Output of the ecological niche modelling of *R. augusta* is shown in the fig. 5.4 & 5.5. This is a representation of the Maxent model for *R. augusta*. Warmer colours (Dark Red, Orange and Dark yellow colour) show areas with better predicted conditions and other colours (Dark blue, sky blue, green and yellowish green) show area with very low prediction. Fig. 5.4 shows that Great Nicobar Islands, Little Nicobar Islands, Katchal Islands and Kamorta Islands are predicted as suitable (dark red and Orange colour in maps). There is a possibility of the presence of *R. augusta* in Katchal islands (Kapannga), Little Nicobar (place of Anula, Jhoola), Great Nicobar Islands (Chingan village, Joginder nagar, Vijay nagar, Laxmi nagar, Galathea forest, Indira Point) and Nancowry group of Islands (Champion Isl., Hitui Isl., Kakana Isl., Trinket, Munak Isl.) (Fig. 5.4). It is predicted that probability of occurrence of *R. augusta* in the rest of the areas of ANI's (In map of Fig. 5.5 shows dark blue colour in North, middle,

South and Little Andaman) i.e. Andaman Islands is very low (Fig. 5.5). The northern most known occurrence limit of *R. augusta* is from the Teressa Islands. The reported central distribution range is in the Katchal and Kamorta Islands and the model has predicted suitable areas in the nearest islands such as Trinket, Kapanga, Teressa, Chingan village, Vijay nagar, Galathea forest and Campbell Bay. Maxent model gives the estimations of relative contributions of the significant environmental variables influencing the distribution of the species in a given region. In Great Nicobar Islands, main populations were located in the Natural trail, Govind Nagar, Vijay Nagar, Galathea forest and Indira point. In Nancowery group of Islands, main populations were located in the Champion Isl., Munak Isl., Hitui Isl., Trinket Isl., Kakana Isl., Daring Isl., Tarassa Isl. and Tapong Isl. There is a possibility of the presence of *R. augusta* in smaller islands like Pulomilo, Treis/Albatei, Trak/Mafuya and Menchal in Little Nicobar's shores. The islands situated between 8 - 9° north of equator like Teressa and Chowra, maxent model has predicted suitable conditions in all the three islands (Purohit *et al.,* 2023).

Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. Of the 19 bioclimatic and six topographic variables, only four variables viz., Precipitation of wettest quarter, Precipitation seasonality, Mean temperature of driest quarter and Temperature Annual range of the year positively influence the distribution of this species in Nicobar Islands which are located in the tropical region with a very stable equatorial climate. This characteristic of higher precipitation in the warmest quarter, the annual mean temperatures which is above 18°C and mean temperature of driest quarter is above 28°C that might influence the biological requirements of *R. augusta*. A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_6, which therefore appears to have the most useful information by itself (Fig. 5.6) (Purohit *et al.,* 2023).

Conclusion

All five palms' species i.e. *Bentinckia nicobarica*, *Phoenix andamanensis*, *Pinanga andamanensis*, *Pinanga manii*, *Rhopaloblaste augusta* are assessed as Endangered by using IUCN Red List Assessment categories and all palm species endemic to ANI's. In order to know the distribution and conservation status of these palms, Maxent ecological niche modelling was used to predict the accurate distributions of these palm species.

(A) Bentinckia nicobarica (Kurz) Becc.: A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_6, which therefore appears to have the most useful information by itself. The study revealed that high potential distribution of *B. nicobarica* was found in Nicobar group of Islands of the thirteen spatially unique points, nine were from Nancowry group of Islands, two from Teressa Islands and two from Little Nicobar Islands. For islands like Car Nicobar, Katchal, Trinket, Daring, Champion, Kakana and Nancowry, the model predicted significant influence of environmental variables in the distribution of species. The prediction of distribution ranges of *B. nicobarica* was good because the final niche model includes all the thirteen occurrence points in the Nicobar Islands. Based on current population data, it has placed under IUCN threat category **Endangered** globally but the criteria changed

(criteria- EN/$B_2b_{(i,ii,iii)}$;$C_{2a(i)}$) as reported assessed by Johnson (1998) on IUCN Red List (Purohit *et al.,* 2023)**.**

(B) Phoenix andamanensis S. Barrow: A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_11, which therefore appears to have the most useful information by itself. The study revealed that high potential distribution of *Phoenix andamanensis* was found in North Andaman Islands of the seven spatially unique points, six were from North Andaman Islands and one from South Andaman Islands. For islands like North Andaman Islands (Saddle peak, Lamiya Bay, Bamboo nallah, Kalighat R.F., Manpur R.F., Mehandi tikri, Kalpong, Ramnagar R.F.), Middle Andaman Islands (Pathar tikri, Chitragud hills, Panchavati, Rangat Bay) and South Andaman Islands (Mount Harriet, Rutland, Shoal Bay, Ferargunj, Jirkatang), the model predicted significant influence of environmental variables in the distribution of species. The prediction of distribution ranges of *Phoenix andamanensis* was good because the final niche model includes all the seven occurrence points in the Andaman Islands. It has been observed that some of the occurrence areas are now seriously threatened due to various biotic interferences. Based on current population data and calculate EOO & AOO with the help of online GeoCAT software, it has placed under IUCN threat category **Endangered** globally [criteria- **EN/$B_{1+2}ab_{(i,ii,iv)}$**] (Purohit *et al.,* 2023)**.**

(C) Pinanga andamanensis Becc.: A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_16, which therefore appears to have the most useful information by itself. The study revealed that high potential distribution of *Pinanga andamanensis* was found in Andaman Islands of the nine spatially unique points, six were from South Andaman Islands and three from North Andaman Islands. For places like Mount Harriet, Dhanikhari, Beechdera, Shyam nagar, Elezabeth Bay, Radhanagar, Saddle peak, the model predicted significant influence of environmental variables in the distribution of species. The prediction of distribution ranges of *Pinanga andamanensis* was good because the final niche model includes all the nine occurrence points in the Andaman Islands. It has been observed that some of the occurrence areas are now seriously threatened due to various biotic interferences. Based on current population data and calculate EOO & AOO with the help of online GeoCAT software, it has placed under IUCN threat category **Endangered** globally [criteria- **EN/A_1c;$B_{1+2}b_{(i,ii,iii)}$;$C_2a_{(i)}$**] (Purohit *et al.,* 2023)**.**

(D) Pinanga manii Becc.: A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_2, which therefore appears to have the most useful information by itself. The study revealed that high potential distribution of *Pinanga manii* was found in Andaman & Great Nicobar Islands of the twenty-six spatially unique points, ten were from South Andaman Islands six from Great Nicobar Islands, four from Middle Andaman Islands, three from North Andaman Islands, two from South Nicobar Islands and one from Nancowry group of Islands. For places like Mount Harriet, Dhanikhari, Flat Bay R.F., Shoal Bay, Munglutang, Manjeri R.F., Munda pahad, Rutland, Jirkatang, Galathea R.F., Chingen village, Joginder nagar, Nevidera, Afra Bay, Vijay magar, Laxmi nagar, Sastri nagar, Indira point, Kalpong, Lamiya Bay, Saddle

peak, the model predicted significant influence of environmental variables in the distribution of species. The prediction of distribution ranges of *Pinanga manii* was good because the final niche model includes all the twenty-six occurrence points in the Andaman & Great Nicobar Islands. It has been observed that some of the occurrence areas are now seriously threatened due to various biotic interferences. Based on current population data and calculate EOO & AOO with the help of online GeoCAT software, it has placed under IUCN threat category **Endangered** globally [criteria- **EN/$B_2b_{(i,ii,iii)}$**] (Purohit *et al.,* 2023)**.**

(E) Rhopaloblaste augusta (Kurz) H. E.: A jackknife test confirmed that the prediction is significantly better than at random and the environmental variable with highest gain when used in isolation is bio_6, which therefore appears to have the most useful information by itself. The study revealed that high potential distribution of *R. augusta* was found in Nicobar group of Islands of the sixteen spatially unique points, eight were from Nancowry group of Islands, six from Great Nicobar Islands and two from Little Nicobar Islands. For islands like Trinket, Kapanga, Teressa, Chingan village, Vijay nagar, Galathea forest, Indira point and Campbell Bay, the model predicted significant influence of environmental variables in the distribution of species. The prediction of distribution ranges of *R. augusta* was good because the final niche model includes all the sixteen occurrence points in the Nicobar Islands. Based on current population data, it has placed under IUCN threat category **Endangered** globally **(criteria- EN/A_1c;$B_2b_{(i,ii,iii)}$;$C_2a_{(i)}$).** In present assessment, its category and criteria both changed as reported assessed by Johnson (1998) on IUCN Red List as a VU/A_{1c} on IUCN Red List (Purohit *et al.,* 2023)**.**

From the conservation point of view, these palms species should be reintroduced into its depleted natural habitats. Aware and educate the local settlers and aborigines about the importance for conserving the biodiversity and to regulate the use of these natural resources in a sustainable manner. Scientists of Botanical Survey of India have succeeded in the *ex-situ* conservation of these species in the Palmatum of Dhanikhari Experimental Garden cum Arboretum (DEGCA), ANI's.

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