2017 FINAL REPORT

CONSERVATION PLANNING

Long-Term Conservation Planning for Some Endemic Plant Species in Egypt

CLP ID: F01315617

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Team Leader

Long-Term Conservation Planning for Some Endemic Plant Species in Egypt

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South Sinai, Egypt

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Karim A. Omar

SECTION I

Summary:

Silene leucophylla, Micromeria serbaliana, Ballota kaiseri, Euphorbia obovate, and *Hyoscyamus boveanus* are endemic plants to the St Catherine Protected Area (SCPA) in southern Sinai, Egypt. These species face many threats than may lead to its extinction in the future. The project objectives are to: 1. To assess the current conservation status of target species and to clearly identify conservation priorities, modeling and predicting the suitable habitat for better distribution and conservation effectiveness and suggest appropriate strategies for conservation, 2. Identify and rank threats, ecological and demographic features as well as clearly identify the socio-cultural environment interaction, and conflicts, 3. Setting strategies and management plans for the conservation of target species followed by ex situ conservation actions, 4. Raising awareness and capacity building among different stakeholders. From June 2017 to date the team succeseded to determain the geographical distribution, population characteristics, habitat and ecology, uses, threats, and conservation status based on IUCN Red List Categories and criteria. Acourding to the collected data the species qulified as Edengered species. With the help of local communites we identifed the major threats on the target species, root causes extracted and soulution sugessted. The team finalized the fieldwork activiteis and are working now in analysis and reporting stage.

Background:

Silene leucophylla, Micromeria serbaliana, Ballota kaiseri, Euphorbia obovate, and *Hyoscyamus boveanus* are endemic plants to the St Catherine Protected Area (SCPA) in southern Sinai, Egypt. The wild populations of *S. leucophylla* growing in SCPA are scattered over seven locations. The population size ranges between 1 and 12 individuals while its total count is only 50 individuals. *M. serbaliana* not recorded within the SCPA from year 1998. *Ballota kaiseri* is a very rare species distributed only within 3 locations with EOO about 6 km2. The population size of *Euphorbia obovate*, and *H. boveanus* deteriorated in the last 5 years as a result from extensive human activities and the absence of management plans to conserve such species. These species have a high medical and economic importance for the local community. These species are severely threatened by both natural (aridity of the area and climate change) and human factors (Over collection, scientific research, and over-grazing). All these factors are pushing them to the brink of extinction. Through a community based management approach we will assess the conservation status of this species to generate long-term conservation plans and actions through a multidisciplinary approach that integrates demography and ecology.

Project Members:

1. Karim abdelhai Omar **(PROJECT LEADER)**

Nationality:	Egyptian
Age as of December 31, 2017:	33
Email:	kariemomar@gmail.com
Highest level of education achieved:	Doctorate/Postdoc
Education levels:	Ph.D. in plant conservation (2013) entitle: Using GIS to detect the ecological and geographical status of Hypericum sinaicum in South Sinai, Egypt. M.Sc. in Plant ecology (2010) entitle: Ecogeographical study on Nepeta septemcrenata in South Sinai, Egypt
Work experience:	Minister Assistant on Nature Conservation Sector development. Environmental researcher at Nature Conservation Sector/ EEAA from 2010 to date. Medical Rep. from 2007 to 2009.
Team Role:	Team leader, Fieldwork, Mapping, data entry, analysis, IUCN Red Listing, and reporting
Relevant skills and experience you bring to the project:	IUCN Red List Global Assessor, leadership skills and a willingness, excellent organizational skills, field work experience, ability to communicate, data analysis and reporting, able to motivate others.
Skills and knowledge gained through this project:	strength my ability to communicate with big organizations like CLP, self-development with leadership ability, increase my ability to understand our conservation field, accessing, quality controlling, and statistically analyzing environmental data.
How many years of experience do you have working in the conservation sector (paid employment):	3-5 years

2. Ahmed Abdallah

Nationality:	Egyptian
Age as of December 31, 2017:	33
Email:	ahmed.tpa@gmail.com
Highest level of education achieved:	PhD
Education levels:	PhD. in plant ecology (2017) entitle: Anthropogenic effect on plant communites in Taba Protected Area, South Sinai, Egypt. B.Sc. (2006) in botany.
Work experience:	Botanist at Taba protected area from 2010 to date.
Team Role:	Field coordinator, soil analysis

Relevant skills and experience you bring to the project:	Good experience in communication with local community, fieldwork experience, adaptability, & flexibility, good organizer for environmental events, work confidently under pressure.
Skills and knowledge gained through this project:	It helped to improve my ability to deal with international conservation topics and how I can extract valuable information about threatened species from simple field data. Beside this, it supported the aim of teamwork that we miss here in Egypt, preparing scenarios of future environmental changes.
How many years of experience do you have working in the conservation sector (paid employment):	3-5 years

3. Gamal Mohamed Aboelftooh

Nationality:	Egyptian
Age as of December 31, 2017:	33
Email:	gamal2006_eg@yahoo.com
Highest level of education achieved:	Bachelor
Education levels:	Bachelor of Tourism Management 2006
Work experience:	Public awareness specialist in Southern Sinai protected areas from 2010 to date. English translator at many tourist sites in Cairo from 2007 to 2010.
Team Role:	Tourism and Public awareness
Relevant skills and experience you bring to the project:	English proficiency, oral communication skills, public awareness experience, awareness, and education for tourists visit the site, collaboration, & teamwork.
Skills and knowledge gained through this project:	Involvement in the cycle of conservation, Judgment negates my ability to move forward
How many years of experience do you have working in the conservation sector (paid employment):	3-5 years

4. Rasha Mohammed

Nationality:	Egyptian
Age as of December 31, 2017:	33
Email:	rkoraym@yahoo.com
Highest level of education achieved:	Bachelor
Education levels:	Bachelor of Arts and Education – Banha University - 2006
Work experience:	School teacher – educational activities specialist 2014- to date
Team Role:	educational activity coordinator – school children awareness activities – communication – data entry and analysis

Relevant skills and experience you bring to the project:	Ability to teach, creative thinking & problem solving skills, quality & carry through, ability to accept responsibility, communication with expert.
Skills and knowledge gained through this project:	Practical field methods, teamwork, collaboration, thought of scientific research, and engaged in work with international support
How many years of experience do you have working in the conservation sector (paid employment):	2-4 years

SECTION II: Overall Goal

Establishment and implement a Long term conservation program for 5 threatened endemic plant species in St. Catherine PA Conservation Regions through Community-based management approach depend on research, building capacities and participation

Project Purpose:

A strategic planned approach followed by conservation actions for the conservation of 5 threatened plant species in Egypt, based on a new understanding of their ecology, habitat requirements and the threats faced, is developed and agreed with local communities and other key stakeholders whose capacity to deliver it is enhanced.

Project Objectives:

1. To assess the current conservation status of target species and to clearly identify conservation priorities, modeling and predicting the suitable habitat for better distribution and conservation effectiveness and suggest appropriate strategies for conservation
2. Identify and rank threats, ecological and demographic features as well as clearly identify the socio-cultural environment interaction, and conflicts
3. Setting strategies and management plans for the conservation of target species followed by ex situ conservation actions
4. Raising awareness and capacity building among different stakeholders

Activities:

OBJECTIVE 1:

- Vegetation analysis
- Soil analysis (physical and chemical)
- Geographical and topographic analysis
- Eco-geographical analysis for all data collected during the field study (geographic, ecological, and climatic)
- Population characteristics
- Habitat characteristics (mapping, status, distribution, trend etc.)
- Mapping the distribution, hotspots, threats, conflicts, and interactions of the target ecological communities
- Zoning, ranking, and predicting the suitable habitat for growth of target species within the boundary of PA.
- Determine and mapping the areas for hands off.
- Extract the gaps point in observation of the target species and extract its root causes.

- Determine the effect of environmental factors on the distribution of the target species in order to use it as first step for conservation by rehabilitation or restoration.
- Predict the potential distribution of the target species using a series of modelling software's

OBJECTIVE 2:

- Demographic study
- Morphological study
- Mapping the distribution pattern and networking between the target species
- Hold orientation seminar on in-situ conservation, threat analysis, and threat reduction assessment methodology for the locals & PA staff to clarify the mission's objective and methodology.
- Meetings and interviews with locals and other relevant stakeholders to extract information about the threats, its timeline curve, find its root causes and suggest possible solutions.
- Field visits to record the on-ground threats with the help of local guide.
- Utilize the Threat Reduction Assessment tool and calculate the predicted TRA index.
- Mapping and ranking the recorded sites affected by these threats.
- prepare suitable threat management plan for each target species
- Collect and map the data about local communities' trips, distribution, size, influence, activities, economy, interactions, conflicts, land use, traffic patterns, demographics, employment etc.
- Record, map, and rank the culture and historical sites, roads, building, infrastructure, dams, etc. inside and close to the target areas.
- Extract the areas of resource use by local communities and rank it based on the type of resource, level of use, threats, etc.

OBJECTIVE 3:

- Review and update the existing management plan of St. Catherin PA
- Determine the gaps in the existing management plan and setting priorities and solutions for eliminating such gaps
- For each species we will make adaptive management plan for conservation (ranking species areas based on density and threats, areas of handoff, activities, recommendations, action plans for conservation, etc.)
- Workshops and meeting with stakeholders to approve these management plans
- Ex situ conservation through seed collection and storage

OBJECTIVE 4:

- Gap analysis to determine and extract the needed training for St. Catherin PA staff, community grads.

- A series of training courses (desk and fieldwork) in the field of conservation practices, threat analysis, fieldwork methodologies, GIS, data collection and cleaning.
- training for post and undergraduate students (botanists) in the field of conservation of threatened plants, data collection and analysis
- School visits (trips, stories, and drawing activities)
- Meetings with relevant stakeholders (local community, plant collectors, and SCPA decision makers, etc.) to discuss and set a suitable plan for future entire conservation program for the target species (in situ and ex situ).
- Conducting a series of seminars in the different related agencies (universities, scientific centers, etc.)
- Number of scientific articles will be published within this work.
- Finally, we will convene validation workshop whereby the key stakeholder's representatives will meet, discuss, evaluate and validate the information presented in the final project report.

Changes to original project plan:

We didn't make any changes to the original project plans. Only minor modifications had done in the area of threat analysis "detailed information and extra mapping were add to improve effectiveness of this objective". Number of meeting, workshops, and field training were doubled to improve the data accuracy and benefits to the maximum. All project objectives have been achieved without any problems. As expected, resulting from political instability in Egypt especially in Sinai "Target area" only the educational outreach faced some minor obstacles in the form of scale and publicity range. In order to solve this we made our educational activities (workshops, training, and meetings) in small scale and divided in two times. Very soon educational activities (drawing, stories, and trips) for school students will be done with the help of local community by the same way and every think will be as planned previously.

METHODOLOGY:

Data Collection:

- The present study was carried out in the period from June 2017 to date.
- Data used for analysis in this study were collected from the fieldwork survey (2017 - 2018), target PA reports, and previous literatures to minimize the gaps in analysis process to the maximum.
- To fit to the IUCN Red List Assessment requirements we need to study and discuss the Geographic Range, Population Characteristics, Habitat and Ecology, Threats, Uses and trade, and conservation actions for the target species.

IUCN Red List Assessment:

1- Geographic Range:

To determine the Geographic Range of this species we collected sufficient data about the following:

- Distribution of *target species* within the target PA during the field survey was record. A GPS fix was recorded in decimal degrees and datum WGS84 using Garmin 12 XL receiver. The fix was recorded to the fifth decimal digit. Arc View GIS 10.3 was used to plot the study sites.
- Number of locations where the target species occurs, Extent of Occurrence (EOO), Area of Occupancy (AOO), and its decline trend were recorded and measured according to IUCN guidelines, 2014. For more clarification,
- Extent of Occurrence measured by drawing a polygon PAs through the distribution points from outside. GIS then determined the area of this polygon in km^2.
- Area of Occupancy also measured though GIS; the distribution map was converted to grids each one cover 2 km^2, each occupied cell was then extracted and the total size were collected and presented in the form of km^2.
- Recorded GPS points for each location were imported into GIS 10.3 software as excel sheet, then it add on TIN map then from 3D analyst tool TIN surface was chosen to extract the topographic features (Elevation, aspect, and slope) of this species.

2- Population Characteristics

To understand the population characteristics of this species we collected sufficient data about the following:

- Number of species populations and subpopulations, number of total individuals were recorded within field visits, number of mature individuals, population structure and dynamics were determined according to IUCN (2014). Population trend, fluctuations, fragmentation, and decline trend were recorded and measured according to IUCN guidelines (2014) using historical data about population size, number of individuals, occurrences from former studies.

3- Habitats and Ecology:

To determine the Habitats and Ecology of this species we collect sufficient data about the following:

- Preferable habitat and microhabitat of the target species and its decline trend within the field survey, according to IUCN Habitats Classification Scheme were recorded (IUCN 2014).
- Life form and species correlation were recorded according to field observation.
- Climatic features (Max. Temp., Min. Temp., and Perception) were extracted from BIOCLIM data using DIVA-GIS.
- Soil properties (Physical and chemical) were extracted from several studies held in the area.
- Vegetation characteristics of target species like density, cover, and associated species within each site were recorded.
- Plant species in each given quadrant has been tentatively recorded in the field and put in tabulated form, giving the authentication of their identification with the help of the local floristic workers (Boulos, 1999; 2000; 2002 and 2003 & Fayed and Shaltout, 2004). More than 500 circles with diameter 25 and 50 m were established to cover all vegetation aspects.

4- Threats:

Using the IUCN threats classification scheme, version 3.1 and based on fieldwork observation and previous work, we used a systematic sampling approach to capture local environmental gradients, placing more than 500 circles with 25 and 50 m diameters at equal distances apart to cover most area of targets which containing the hottest spots for vegetation inside target PA. Within each circle, we record any sign that may be a threat to the plant community. Each threat was evaluated as follows:

- **Climate change & severe weather:** Based on historical data we record any sign about Habitat shifting & alteration, Droughts, Temperature extremes, Storms & flooding, etc.
- **Pollution:** Record the presence and degree of Domestic & urban waste water, Industrial & military effluents, Agricultural & forestry effluents, Garbage & solid waste, Air-borne pollutants.
- **Natural system modifications:** Record the presence and effect degree of Fire & fire suppression, Dams & water management/use.
- **Biological resource use: Over collection:** At each circle we recorded any sign of plant collection for the purposes of trade as medicinal plants, fuel or any economic value. Also assessment through meetings and interviews with the relevant stakeholders (collectors, traders and eco guides) will cover the medicinal plants rich sites within target PA and identify the hot spots. **Collection for Scientific Research:** We recorded all sites and target species of scientific interest by universities, research centers and scientific scholarships within target PA by reviewing reports and notifications from EIA (Environmental Impact Assessment) created by target PA staff.
- **Tourist Intrusions and recreation areas:** At each site we recorded any tourism activity (paths, camping, rest points and wastes) and ranked each point by density level (How much area it cover) (Very low 20%, Low 40%, Medium 60%, High 80% and Very high >80%).

- **Overgrazing:** Level of grazing was measured by dung abundance and ranked each point by density level (How much area it cover) (Very low 20%, Low 40%, Medium 60%, High 80% and Very high >80%).)
- **Feral Donkeys:** Using the methods of El-Alqamy, (2002); Hatab, (2009) and Omar *et al.,* (2012), numbers of dung (droppings) of donkeys were counted at each circle to frequency of animal presence.
- **Residential & commercial development:** *Urbanization, Settlement, and Agriculture Expansion:* In this factor we used several approaches. First, using satellite images available in Google Earth 6.0.1.2032 (beta) with build date 2017, we record settlements, agriculture areas, roads and gardens and characterized them according to boundaries and density. Second, they carried out field assessment to detect any expansion (buildings, dams, wells and roads).
- **Energy production & mining:** We record the presence and degree of these activities within the rich areas of the target PA.

✓**Underlying threat root causes, barriers and solutions.**

For each threat, we assigned the root causes, barriers, area, intensity, urgency, total ranking and categorical threat level. The above terms will describe as follows: **Root causes:** These are the underlying factors, usually social, economic, political, institutional, or cultural in nature, which enable or otherwise contribute to the occurrence and/or persistence of direct threats (IUCN definition). There is typically a chain of underlying causes behind any given direct threat. **Barriers:** These are constraints (institutional, legal, technical, knowledge), which limit effective conservation of MPs. **A = Area:** Approximate proportion of the overall area of a site likely to be affected by a threat under current circumstances (i.e. given the continuation of the existing situation). *Since there are 8 direct threats, the highest ranked threat for "Area" receives a score of 8, and the lowest ranked threat receives a score of 1 **I = Intensity:** refers to the impact of the threat within a micro-site. Will the threat completely destroy the habitat in a small locality, or will it only cause minor changes (i.e. given the continuation of the existing situation). Since there are 8 direct threats, the highest ranked threat for "Intensity" receives a score of 8, and the lowest ranked threat receives a score of 1 . **U = Urgency:** The importance of taking immediate action to counter the threat. Since there are 8 direct threats, the highest ranked threat for "Urgency" receives a score of 8, and the lowest ranked threat receives a score of 1. **TR = Total Ranking:** Sum of Area + Intensity + Urgency.

5- Conservation actions & requirements:

- Timing, scope, severity, and impact score for each threat were determined according to IUCN Threats Classification Scheme (IUCN, 2014).
- In this part, we collect any information about former, ongoing, and future activities to protect *target species* in-place or outside-place. Conservation actions that will take place on land or that needed in the near future will also recorded. Researches needed according to IUCN Scheme were recommending (IUCN 2014).

Ecological Niche Modeling

1. Environmental variables

We considered twenty three environmental variables as potential predictors of the *Target species* habitat distribution. These variables were chosen based on their biological relevance to plant species distributions and other habitat modeling studies (For example, Kumar et al., 2006; Guisan et al., 2007a, b; Pearson et al., 2007; Murienne et al., 2009). Nineteen bioclimatic variables (Nix, 1986), biologically more meaningful to define eco-physiological tolerances of a species, were obtained from WorldClim dataset (Hijmans et al., 2005; http://www.worldclim.org/bioclim.htm). Altitude (Digital Elevation Model; DEM) data were also obtained from the WorldClim website; 1 km spatial resolution. The DEM data were used to generate slope and aspect (both in degrees) using (ESRI) Environmental Systems Research Institute's ARC GIS version 9.2 and 'Sufrace Analysis' function. All environmental variables were resampled to 1 km spatial resolution. Maxent's predictions are 'cumulative values', representing, as a percentage, the probability value for the current analysis pixel and all other pixels with equal or lower probability values. The algorithm is implemented in a stand-alone, freely available application. In this study we considered each environmental variable (linear features) and its square (quadratic features). Because Maxent utilize pseudo-absence.

3. Modeling procedure

We used a novel modeling method called maximum entropy distribution or Maxent which has been found to perform best among many different modeling methods (Elith et al., 2006; Ortega-Huerta and Peterson, 2008), and may remain effective despite small sample sizes (Hernandez et al., 2006; Pearson et al., 2007; Papes and Gaubert, 2007; Wisz et al., 2008; Benito et al., 2009). Maxent is a maximum entropy based machine learning program that estimates the probability distribution for a species' occurrence based on environmental constraints (Phillips et al., 2006).

It requires only species presence data (not absence) and environmental variable (continuous or categorical) layers for the study area. We used the freely available Maxent software, version 3.1 (http://www.cs.princeton.edu/~schapire/maxent/), which generates an estimate of probability of presence of the species that varies from 0 to 1, where 0 being the lowest and 1 the highest probability. The 91 occurrence records and 10 environmental predictors were used in Maxent to model potential habitat distribution for *Target species*. Testing or validation is required to assess the predictive performance of the model. Ideally an independent data set should be used for testing the model performance, however, in many cases this will not be available, a situation particular prevalent for threatened and endangered species. Therefore, the most commonly used approach is to partition the data randomly into 'training' and 'test' sets, thus creating quasi-independent data for model testing (Fielding and Bell, 1997).

However, this approach may not work with a small number of samples because the 'training' and 'test' datasets will be very small. Therefore, we explicitly followed Pearson et al. (2007) and used a jackknife procedure, in which model performance is assessed based on its ability to predict the single locality that is excluded from the 'training' dataset. Number of different predictions was thus made with one of the occurrence

records excluded in each prediction and the final potential habitat map was generated using all records. We used the *P* value program provided by Pearson et al. (2007) to test the significance of the model. The jackknife validation test required the use of a threshold to define 'suitable' and 'unsuitable' areas. We used two different thresholds, the 'lowest presence threshold' (LPT, equal to the lowest probability at the species presence locations), and a fixed threshold of 0.10; for more details see Pearson et al. (2007).

Note:

▪ Bio 1	Annual Mean Temperature
▪ Bio 2	Mean Monthly Temperature Range
▪ Bio 3	Isothermality (2/7) (* 100)
▪ Bio 4	Temperature Seasonality (STD * 100)
▪ Bio 5	Max Temperature of Warmest Month
▪ Bio 6	Min Temperature of Coldest Month
▪ Bio 7	Temperature Annual Range
▪ Bio 8	Mean Temperature of Wettest Quarter
▪ Bio 9	Mean Temperature of Driest Quarter
▪ Bio 10	Mean Temperature of Warmest Quarter
▪ Bio 11	Mean Temperature of Coldest Quarter
▪ Bio 12	Annual Precipitation
▪ Bio 13	Precipitation of Wettest Month
▪ Bio 14	Precipitation of Driest Month
▪ Bio 15	Precipitation Seasonality (CV)
▪ Bio 16	Precipitation of Wettest Quarter
▪ Bio 17	Precipitation of Driest Quarter
▪ Bio 18	Precipitation of Warmest Quarter
▪ Bio 19	Precipitation of Coldest Quarter

RESULTS

Part I
Ecological, Conservation and Threat Assessment

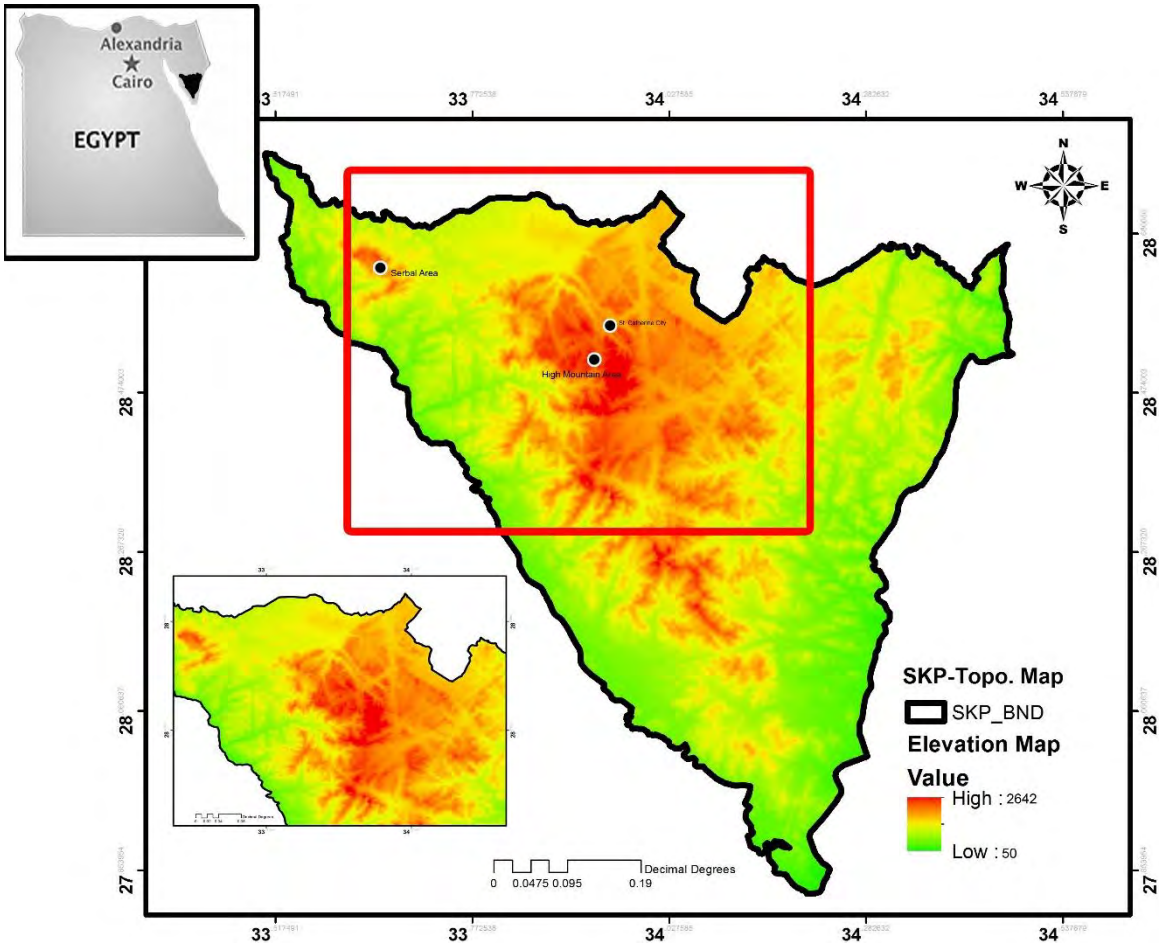
ST. CATHERINE PROTECTED AREA:

Prime Ministerial Decree No. 613 established St. Catherine as a Natural Protectorate in 1988 under Law 102/1983 and also established an Executive Council, headed by the Governor of South Sinai, to manage the Protectorate. In 1996, Prime Ministerial Decree No. 904 formally declared the St. Catherine Protected Area (Map 1); full protected-area status was given to approximately 4,350km^2 of largely mountainous terrain in South Sinai. The area includes the highest peaks in Egypt and contains a unique assemblage of natural resources, notably high altitude ecosystems with surprisingly diverse fauna and flora and with a significant proportion of endemic species[1].

Protectorate's Values[1]:

- The Protectorate includes the world renowned Monastery of St. Catherine and Mt. Sinai, where Moses is said to have received the Ten Commandments; these places were listed as a cultural World Heritage Site in 2002.
- The protected area contains a unique landscape of high scenic quality, with diverse associated habitats, flora and fauna along with unique or traditional land-use patterns and social organisations as evidenced in historical human settlements, local customs, livelihoods, and religious beliefs.
- As much of the area is inaccessible to motor vehicles the major part of the Protectorate remains in a largely natural state.
- The Protectorate is included in the BirdLife International, *Directory of Important Bird Areas in Egypt*.
- A 641km^2 core area of the Protectorate has been listed as a World Heritage Status on "Cultural Criteria" and it will be further listed as an Associative Cultural Landscape under "Natural Criteria."
- The protected area provides opportunities for public enjoyment through recreation and tourism within its normal lifestyle and economic activities.
- The SCPA contains a wide range of micro-habitats and landscapes that are a consequence of varying microclimatic conditions, a wide range of altitudes, and variable topography.
- Recently, the Protectorate define as one of 20 Important Plant Areas (IPA) in Egypt by IUCN (Radford *et al.* 2011).
- The St. Catherine Protected Area is an area of great biological interest; it has been recognized by IUCN, as one of the most important regions for flora diversity in the Middle East. It contains 472 plant species and about 23% of Egypt's endemic flora and a very high proportion of Egypt's endemic fauna, including butterflies.
- It is currently recognized as one of the central regions for flora diversity in the Middle East by the IUCN the World Conservation Union and Worldwide Fund for Nature (IUCN, 1994).

[1] (SCPA Management Plan 2003)



Map 1. St. Catherine Protected Area; Elevation Map and zoom in the area of study

Data collection and analysis:

A total of five endemic plant species (*Silene leucophylla, Micromeria serbaliana, Ballota kaiseri, Euphorbia obovate,* and *Hyoscyamus boveanus*) were chosen for this study based on their distribution range, availability of historical data, accessibility, the current status and threats degree. Conservation status assessments were done for those species based on IUCN Red List Categories and Criteria.

For each species, geographical range, population characteristics, habitat and ecology, threats, conservation actions were determined and presented in the form of Maps, Tables and charts to facilitate the decision making to the maximum. The needed data for this assessment were collected from 2017-2018 field work, reports, published articles in the same area of the study.

The team are working now in analysis and reporting stage, in the following part we will present some results that have been done until now:

Euphorbia obovate Decne. EUPHORBIACEAE

Figure 1. *Euphorbia obovata* Decne.

TAXONOMY

Table 1: Taxonomic notes on *Euphorbia obovata* Decne

Taxonomic Notes	Justification
Full Name	*Euphorbia obovata*
Level	Species
Parent	*Euphorbia*
Taxonomic Authority	Decne.
Status	Accepted
Taxonomy	PLANTAE-TRACHEOPHYTA-MAGNOLIOPSIDA-EUPHORBIALES-EUPHORBIACEAE-*Euphorbia-obovata*
Hybrid	No
Invasive	No
Feral	No
Synonyms	*Euphorbia prolifera* Ehrenb. ex Boiss.
Common Names	* Lopeina (Arabic)
Taxonomic Sources	Missouri Botanical Garden. 2015. Tropicos.org. St. Louis Available at: http://www.tropicos.org/.

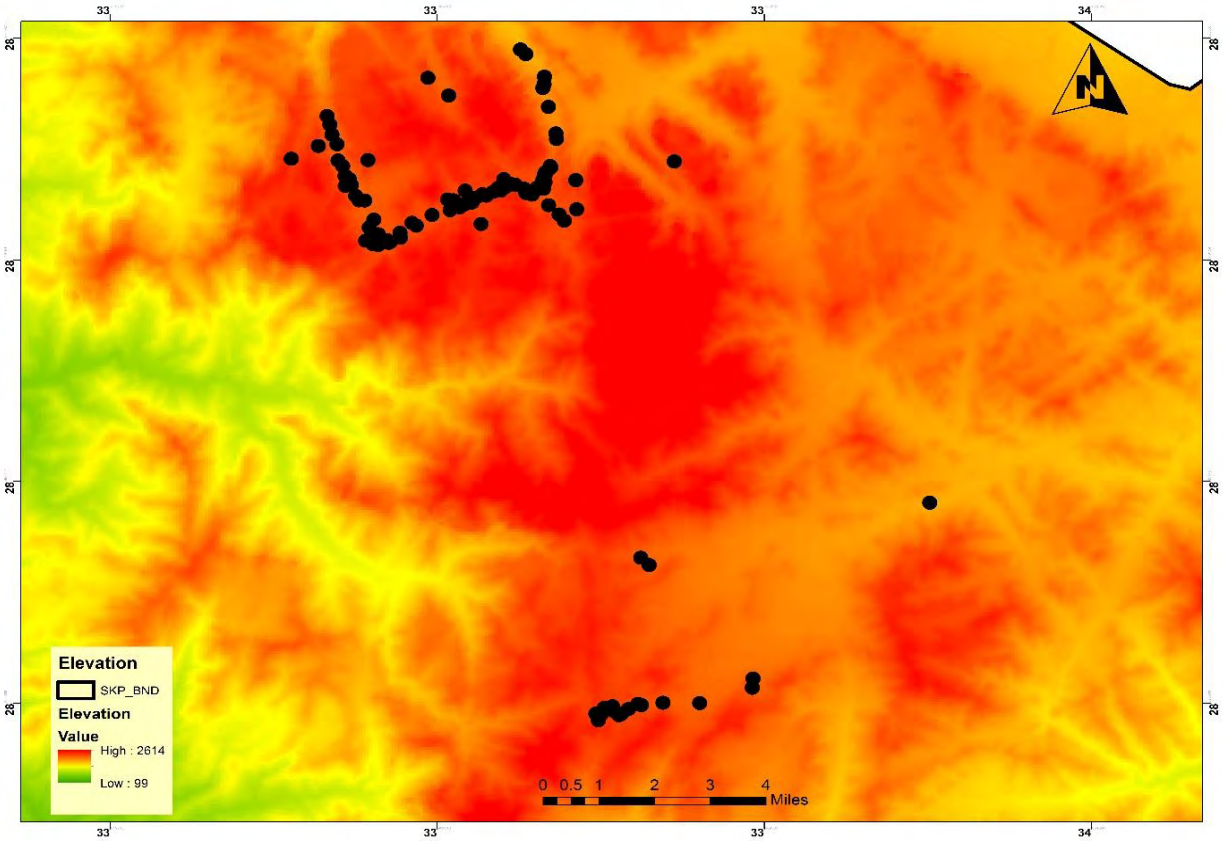
GEOGRAPHIC RANGE:

Euphorbia obovata is a plant species endemic to the St. Catherine Protected Area (SCPA) in southern Sinai, Egypt, with a narrow altitudinal range between 1,400 and 2,050 m asl (Map 2). Its extent of occurrence (EOO) is c. 179 km^2, and its area of occupancy (AOO) is 68 km^2 (Table 2, Map 3). This species is clearly distributed in two locations (High

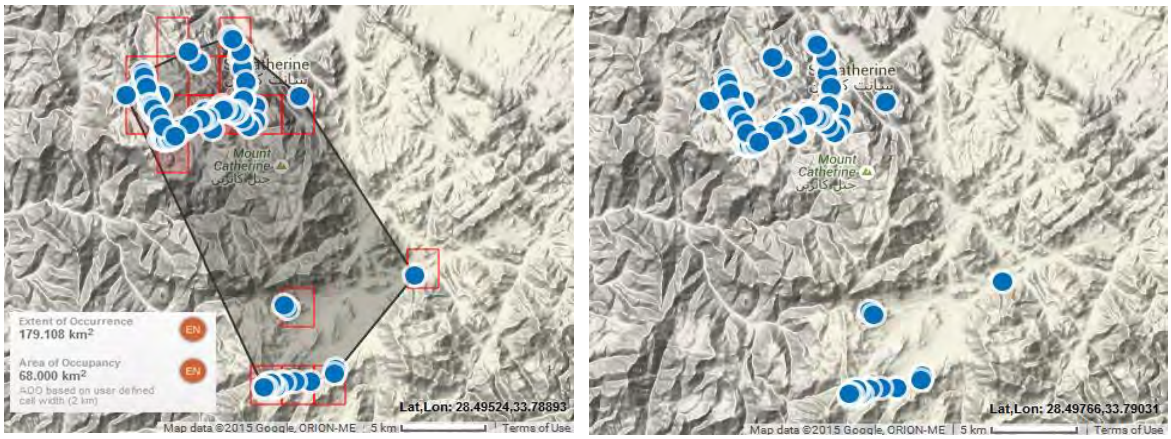
Mountains Area and Wadi Al Rhaba Area). Wadi Gebal (Farsh Elromana, Erheibet Nada, Wadi Tenya), Wadi Al Rahaba and Wadi Zwateina are the most important places for this species within the area of SCPA.

Table 2: Geographical distribution range of *Euphorbia obovata* inside St. Catherine Protected Area

Geographical Aspects	Justification
EOO	179 km^2
AOO	68 km^2
Elevation Lower Limit (in meters above sea level)	1400
Elevation Upper Limit (in meters above sea level)	2050
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic



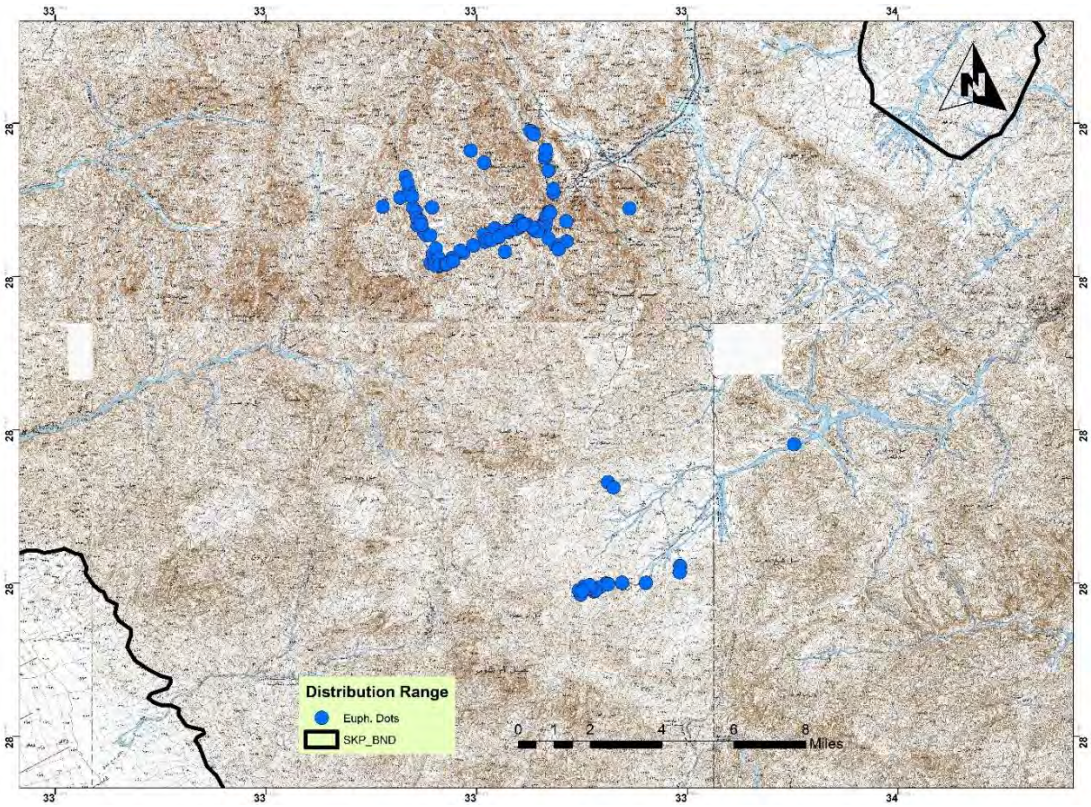
Map 2. Elevation map of *Euphorbia obovata* inside St. Catherine Protected Area



Map 3. Geographical Range map of *Euphorbia obovata* inside St. Catherine Protected Area

POPULATION INFORMATION:

Most of the *Euphorbia obovata* subpopulations are small; with individual plants occurring sporadically in space in little groups where the soil is gravelly and rocky (Map 4). The number of mature plants has been observed to decline slightly as a result of unmanaged human activities and habitat destruction. The total global population size estimate ranges from 2,500 to 4,000 mature individuals (Table 3). There are clearly separate subpopulations and the number of mature individuals range from 10 to 600 in each subpopulation. During the last 10 years these subpopulations have been observed to have slight changes in the total number of individuals, cover and density, due to drought and habitat destruction from unmanaged human activity.

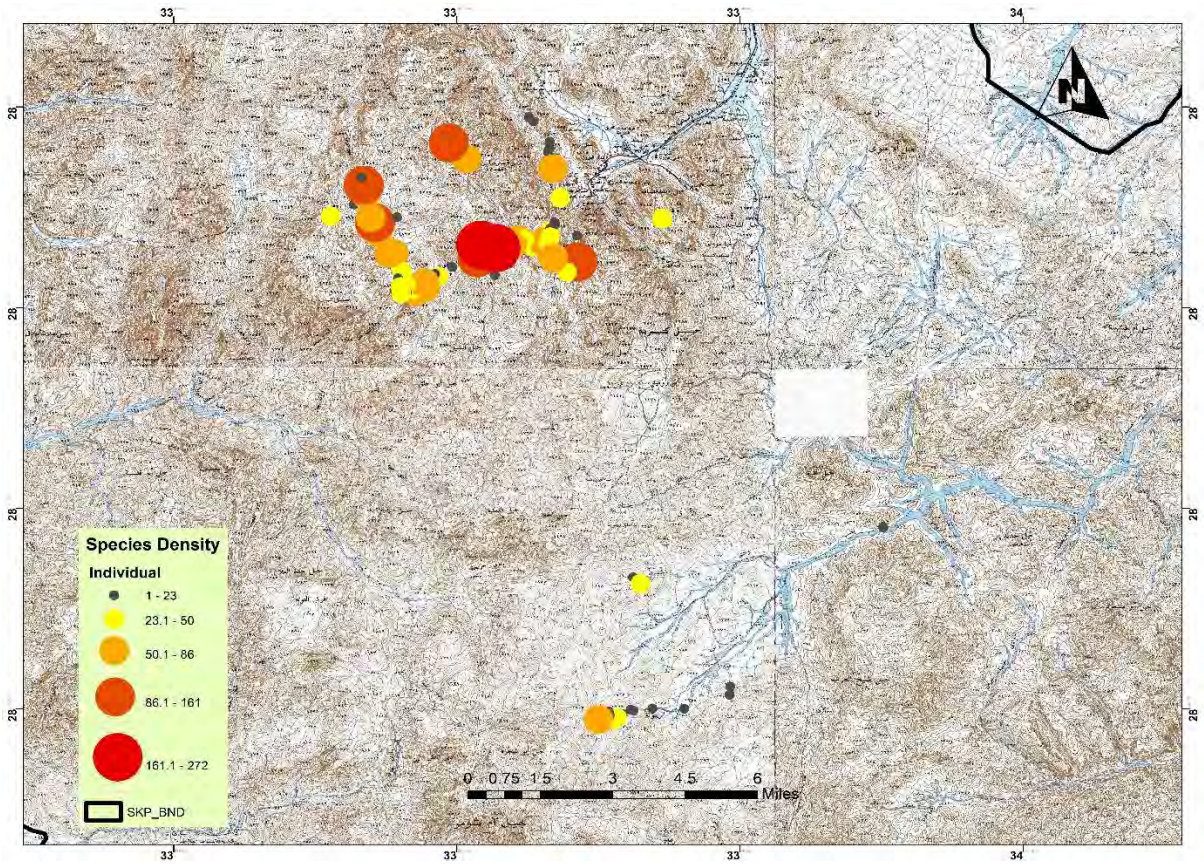


Map 4. Population structure of *Euphorbia obovata* inside St. Catherine Protected Area

Table 3: Some facts about population characteristics of *Euphorbia obovata*

Population Information	Justification
Locations	2 locations- High Mountains Area and Wadi Al Rhaba Area
Current Population Trend	Decreasing
Number of mature individuals	2500-4000 - Estimated
Severely fragmented?	Yes - Specific microhabitat and Mountains makes as barriers between different very small subpopulations.
Continuing decline in mature individuals?	Yes - Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	600 - Estimated

The population is considered severely fragmented as the requirement for a specific microhabitat and the mountains cause barriers between the very small subpopulations. The plant is distributed within two restricted areas: High Mountains Area and Wadi Al Rahba Area (Moursy 2010), and the effects of one threat will be felt by the two areas separately: thus the population is effectively in two clear locations. Wadi Gebal (Farsh Elromana, Erheibet Nada, Wadi Tenya), Wadi Al Rahaba and Wadi Zwateina are the most areas for density of this species (Map 5). Regarding to the frequency, it was found that Farsh Elromana, El-Zwitein, Abu Walee, W. Al Rahaba and Erheibet Nada are the highest areas for frequancy of this species (Figure 2).



Map 5. Density of *Euphorbia obovata* inside St. Catherine Protected Area

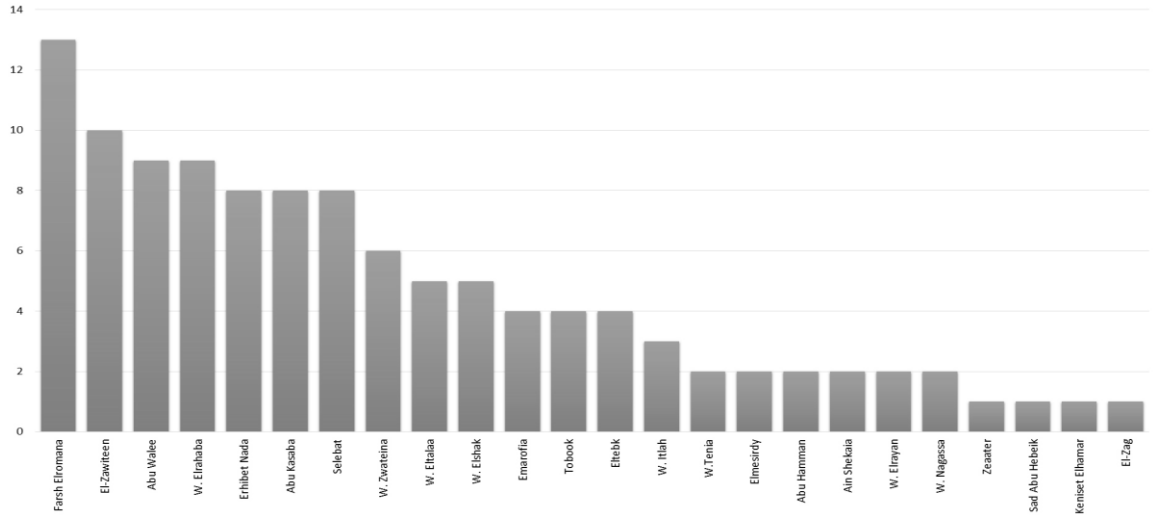
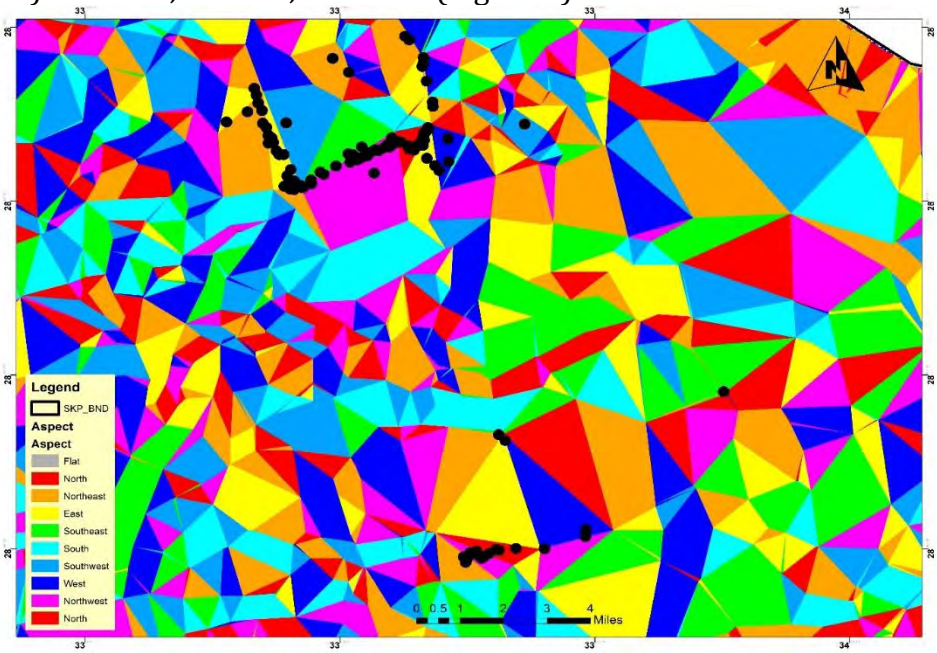


Figure 2. Frequency of *Euphorbia obovata* among different sites in St. Catherine Protected Area

HABITATS AND ECOLOGY:

Euphorbia obovata is a short-lived glabrous perennial of 10-35 cm. The stems are procumbent. It has cauline leaves 0.6-1.1 × 0.4-0.8 cm, which are obovate to suborbicular, subsessile, entire, obtuse, with involucres of 1-2 mm and campanulate. There are four glands, which are lunate with two horns. It has a glabrous capsule of c. 3 mm diameter. Seeds are 3 × 2 mm and smooth, with few spaced shallow pits. It has yellow caruncle of 0.5 mm diameter on short stalks (Boulos 2000). It has been observed that flowers appear in late spring and reproduction is by seed in late summer.

It is restricted to montane wadis with granite rocky ground of mountain areas (Table 4), mostly in wadi beds and gorges with steep slopes of up to 90° on Northwest- (29%), North- (21%), West- (14%) and Northeast-facing slopes (14%) (Map 6). It was found that the optimum elevation ranges for the growth of this species (based on species distribution) is from 1,600 to 2,000 m asl (Figure 3).



Map 6. Slope Aspect map of *Euphorbia obovata* inside St. Catherine Protected Area

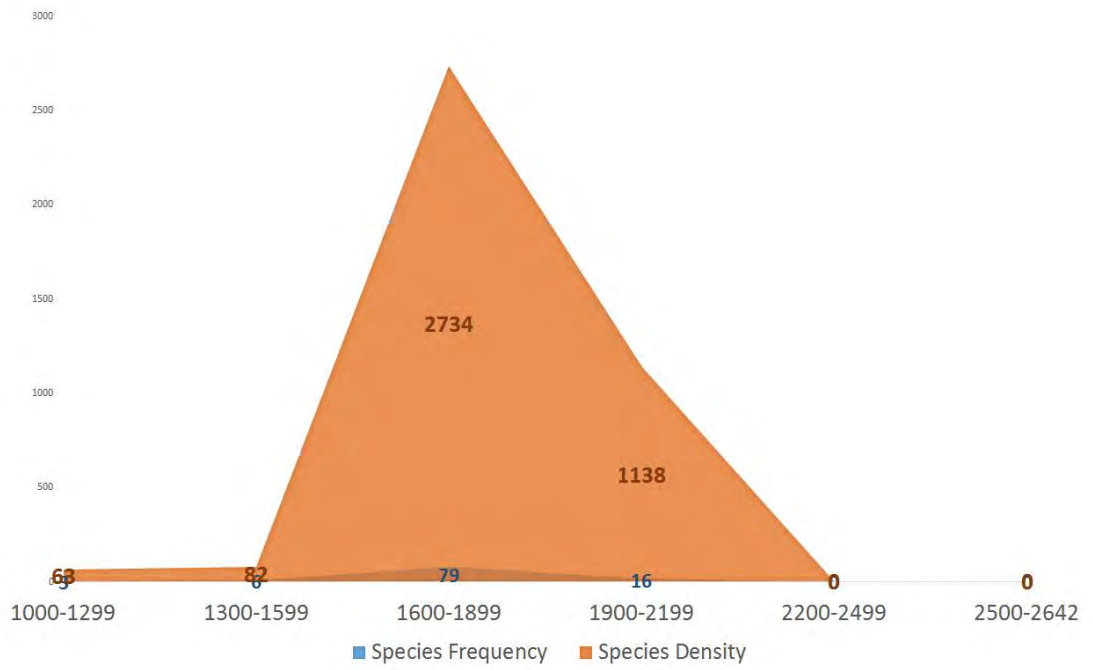


Figure 3. Relation between elevation and *Euphorbia obovata* density and frequency

The cold winter climate (minimum temperature can reach -10°C) and cool summers (maximum temperature of c. 29°C) of the high elevations of Mt. St. Catherine are the coolest on the peninsula (Omar *et al.* 2013). The arid climate has a mean annual rainfall of about 37.5 mm (between 1971-2015), some in the form of snow, but there is great inter-annual variation with up to 300 mm in any one year, usually between October and May. Relative humidity is low, ranging from 10-35% (data for 2005-2015), and potential evaporation rates are very high, in excess of 20 mm/day during August.

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that soils of South Sinai are desert soils (Aridisols), in agreement with Kamh *et al.* (1989), Balba (1995), Moustafa and Zayed (1996), Omar *et al.*(2013),and Moursy (2010) that soils of the *E. obovata* distribution area are gravelly in wadis and plains, rocky at mountains in the surface, sandy to loamy sand in texture, alkaline and non-saline to slightly saline. It's characterized by low content of essential nutrients and cation exchange capacity (CEC).

It has been recorded that the most associated species for *E. obovata* are *Achillea fragrantissima* and *Serphedium herba-alba.*

Table 4: Habitat of *Euphorbia obovata* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6	Rocky areas (eg. inland cliffs, mountain peaks)	(Not Specified)	Suitable	Yes
8.2	Desert -> Desert - Temperate	(Not Specified)	Suitable	Yes

Continuing decline in area, extent and/or quality of habitat? Yes – Observed
System: Terrestrial

TRADE AND USE:

General Use and Trade Information: Species not utilized

THREATS:

The vegetation within this species distribution area has been subjected to disturbance through human activities including "over grazing, overcutting, uprooting" (Mosallam 2007, Khafagi *et al.* 2012). Due to climate change, the wild population of this species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (2% loss observed). Water is being relocated in some localities from elevated wadis which are rich in water to supply to low wadis. This activity leads to consumption of water from wells and results in habitat deterioration and declines in population size (Table 5).

It has been observed that ants (species and origin unknown) collect the seeds, perhaps causing a reduction in the reproductive rate. It's possible that feral donkeys in the distribution of this species could cause destruction of the population through trampling.

In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (dams and unmanaged human construction). All these factors are pushing *E. obovata* to the brink of extinction.

Table 5: Threats on *Euphorbia obovata* based on IUCN Threats Classification Scheme

Code	Threat	Timing	Scope	Severity	Impact Score
6.1.	Human intrusions & disturbance -> Recreational activities	Ongoing	Minority (<50%)	Causing/Could cause fluctuations	Low Impact: 5
6.3.	Human intrusions & disturbance -> Work & other activities	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
7.2.5.	Natural system modifications -> Dams & water management/use -> Abstraction of ground water (domestic use)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
8.1.2.	Invasive and other problematic species, genes & diseases -> Invasive non-native/alien species/diseases -> Equus asinus	Ongoing	Unknown	Unknown	Unknown
8.4.1.	Invasive and other problematic species, genes & diseases -> Problematic species/disease of unknown origin -> Unspecified species	Ongoing	Unknown	Unknown	Unknown
11.2.	Climate change & severe weather -> Droughts	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.3.	Climate change & severe weather -> Temperature extremes	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.4.	Climate change & severe weather -> Storms & flooding	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9

CONSERVATION ACTIONS:

The entire global distribution of *E. obovata* is inside the St. Catherine Protected Area (SCPA). On average 20 checks are made every year to keep a watch on the current situation for the plant and its habitat, and to record any detrimental activities (Table 6). No individuals are protected by enclosures inside SCPA. Funded by UNEP, the Medicinal Plants Conservation Project tried to conserve some important species, *E. obovata* among them, using cultivation inside greenhouses, as well as storing its seeds for future use. Education and awareness activities are implemented by SCPA Management and supporting projects.

Table 6: Conservation Actions In-Place for *Euphorbia obovata* inside the St. Catherine Protected Area

No.	Conservation Actions In-Place	Justification
1	Occur in at least one PA	Yes
2	Percentage of population protected by PA (0-100)	91-100%
3	In-situ Conservation	Partly Yes
4	Ex-situ Conservation	Yes – inactivated
5	Monitoring	Partly Yes

A fruitful work was done on this species by Moursy (2010), aiming to determine features of the optimum range of this species among different eco-geographical variables to guide future conservation actions. Two sites are recommended for future *in situ* conservation by enclosures (Keniset Elhamar and Wadi Itlah). Much more is needed, however (Tables 7, 8).

Table 7: Important Conservation Actions Needed for *Euphorbia obovata*

Code	Conservation Actions	Specific Conservation Actions
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
2.3.	Land/water management	Habitat & natural process restoration
3.1.3.	Species management	Species management -> Limiting population growth
3.2.	Species management	Species recovery
3.4.1.	Species management	Ex-situ conservation -> Captive breeding/artificial propagation
3.4.2.	Species management	Ex-situ conservation -> Genome resource bank
4.2.	Education & awareness	Training
4.3.	Education & awareness	Awareness & communications
5.1.2.	Law & policy	Legislation -> National level
5.4.1.	Law & policy	Compliance and enforcement -> International level

Table 8: Important Research Needed for *Euphorbia obovata*

Code	Research Needed	Specification
1.2.	Research	Population size, distribution & trends
1.3.	Research	Life history & ecology
1.4.	Research	Harvest, use & livelihoods
1.5.	Research	Threats
2.1.	Conservation Planning	Species Action/Recovery Plan
2.2.	Conservation Planning	Area-based Management Plan
3.1.	Monitoring	Population trends
3.4.	Monitoring	Habitat trends

IUCN RED LIST ASSESSMENT RATIONALE:

Euphorbia obovata qualifies as Endangered because it is endemic to a tiny area in Egypt, with an extent of occurrence (EOO) of 178 km^2 and an area of occupancy (AOO) of 68 km^2. It occurs in the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations (based on climate change as the most serious plausible threat). There is a continuing decline in habitat quality for this species, with evidence of decline in the number of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

Micromeria serbaliana Danin & Hedge **LAMIACEAE**

Figure 4. *Micromeria serbaliana* Danin & Hedge

TAXONOMY

Table 9: Taxonomic notes on *Micromeria serbaliana* Danin & Hedge

Taxonomic Notes	Justification
Full Name	*Micromeria serbaliana*
Level	Species
Parent	*Micromeria*
Taxonomic Authority	Danin & Hedge
Status	Accepted
Taxonomy	PLANTAE-TRACHEOPHYTA-MAGNOLIOPSIDA- LAMIALES - LAMIACEAE -*Micromeria-serbaliana*
Hybrid	No
Invasive	No

Feral	No
Synonyms	*Satureja serbaliana* (Danin & Hedge) Greuter & Burdet
Taxonomic Sources	Govaerts R. (ed). For a full list of reviewers see: http://apps.kew.org/wcsp/compilersReviewers.do (2018). WCSP: World Checklist of Selected Plant Families (version Aug 2017). In: Roskov Y., Abucay L., Orrell T., Nicolson D., Bailly N., Kirk P.M., Bourgoin T., DeWalt R.E., Decock W., De Wever A., Nieukerken E. van, Zarucchi J., Penev L., eds. (2018). Species 2000 & ITIS Catalogue of Life, 26th February 2018. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.

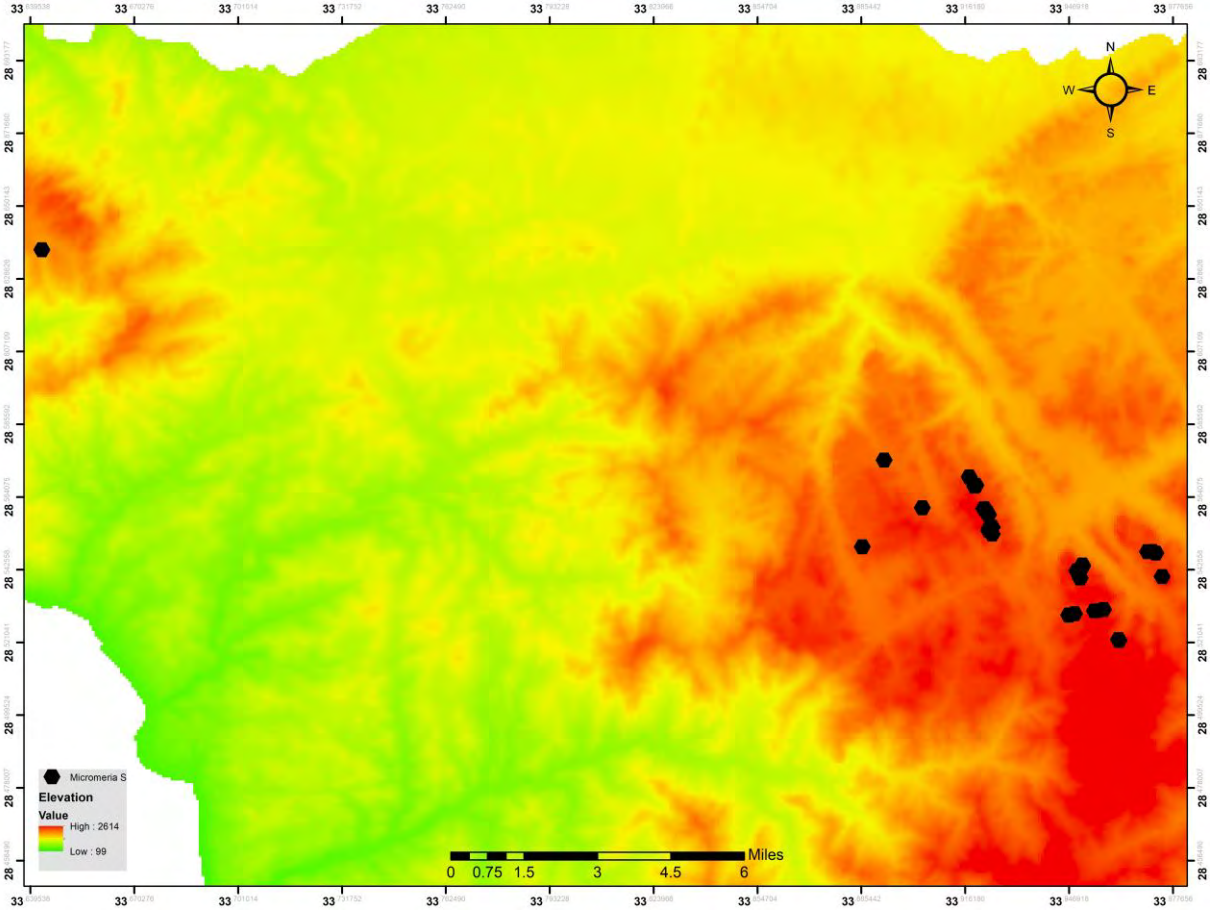
GEOGRAPHIC RANGE:

Micromeria serbaliana is a plant species endemic to the St. Catherine Protected Area (SCPA) in southern Sinai, Egypt, with a narrow altitudinal range between 1,750 and 2,200 m asl (Map 8). Its extent of occurrence (EOO) is c. 65.8 km², and its area of occupancy (AOO) is 44 km² (Table 10, Map 7). This species is clearly distributed in two locations (High Mountains Area and Serbal Mountain). Abu Mahshore, Shak Musa, Abu Hamman, and Elgabal Elahmar are the most important places for this species within the area of SCPA.

Table 10: Geographical distribution range of *Micromeria serbaliana* inside St. Catherine Protected Area

Geographical Aspects	Justification
EOO	65.8 km²
AOO	44 km²
Elevation Lower Limit (in meters above sea level)	1750
Elevation Upper Limit (in meters above sea level)	2200
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic

Map 7. Geographical Range map of *Micromeria serbaliana* inside St. Catherine Protected Area



Map 8. Elevation map of *Micromeria serbaliana* inside St. Catherine Protected Area

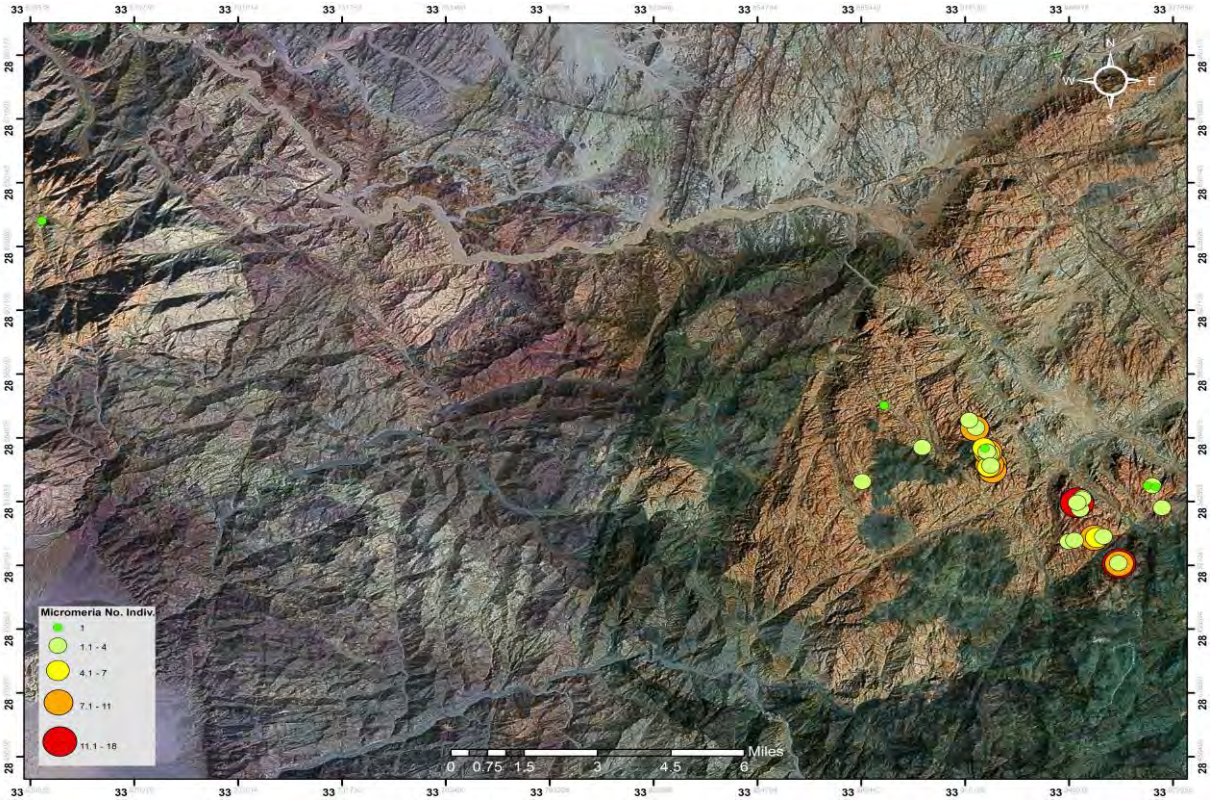
POPULATION INFORMATION:

Most of the *Micromeria serbaliana* subpopulations are very small, with individual plants occurring sporadically in space in little groups where the soil is gravelly and rocky. The number of mature plants has been observed to decline slightly as a result of unmanaged human activities and habitat destruction. The total global population size estimate ranges from 500 to 1,000 mature individuals (Table 11). There are clearly separate subpopulations and the number of mature individuals range from 1 to 50 in each subpopulation. During the last 10 years these subpopulations have been observed to have slight changes in the total number of individuals, cover and density, due to drought and habitat destruction from unmanaged human activity.

Table 11: Some facts about population characteristics of *Micromeria serbaliana*

Population Information	Justification
Locations	2 locations- High Mountains Area and Serbal Mountain
Current Population Trend	Decreasing
Number of mature individuals	500-1000 - Estimated
Severely fragmented?	Yes - Specific microhabitat and Mountains makes as barriers between different very small subpopulations.
Continuing decline in mature individuals?	Yes - Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	50 - Estimated

The population is considered severely fragmented as the requirement for a specific microhabitat and the mountains cause barriers between the very small subpopulations. The plant is distributed within two restricted areas: High Mountains Area and Serbal Mountain, and the effects of one threat will be felt by the two areas separately: thus the population is effectively in two clear locations. Abu Mahshore, Shak Musa, Abu Hamman, and Elgabal Elahmar are the most areas for density of this species (Map 9). Regarding to species cover%, it was found that Abu Mahshore, El qalp, Abu Hamman, and Elgabal Elahmar are the highest areas for species cover of this species (Figure 5).



Map 9. Density of *Micromeria serbaliana* inside St. Catherine Protected Area

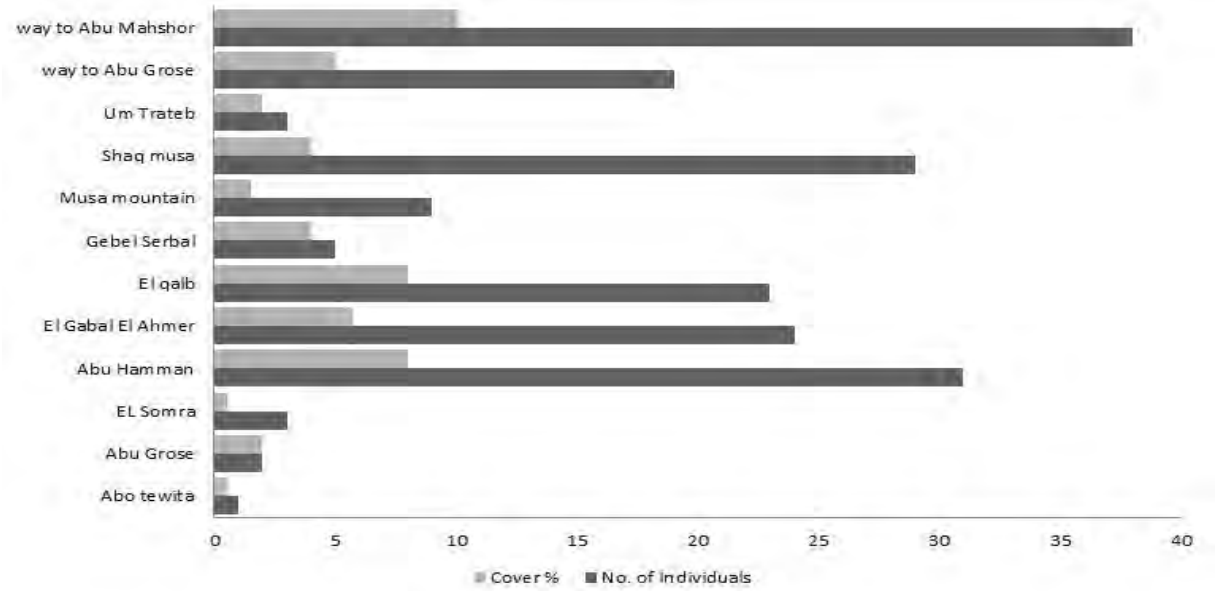
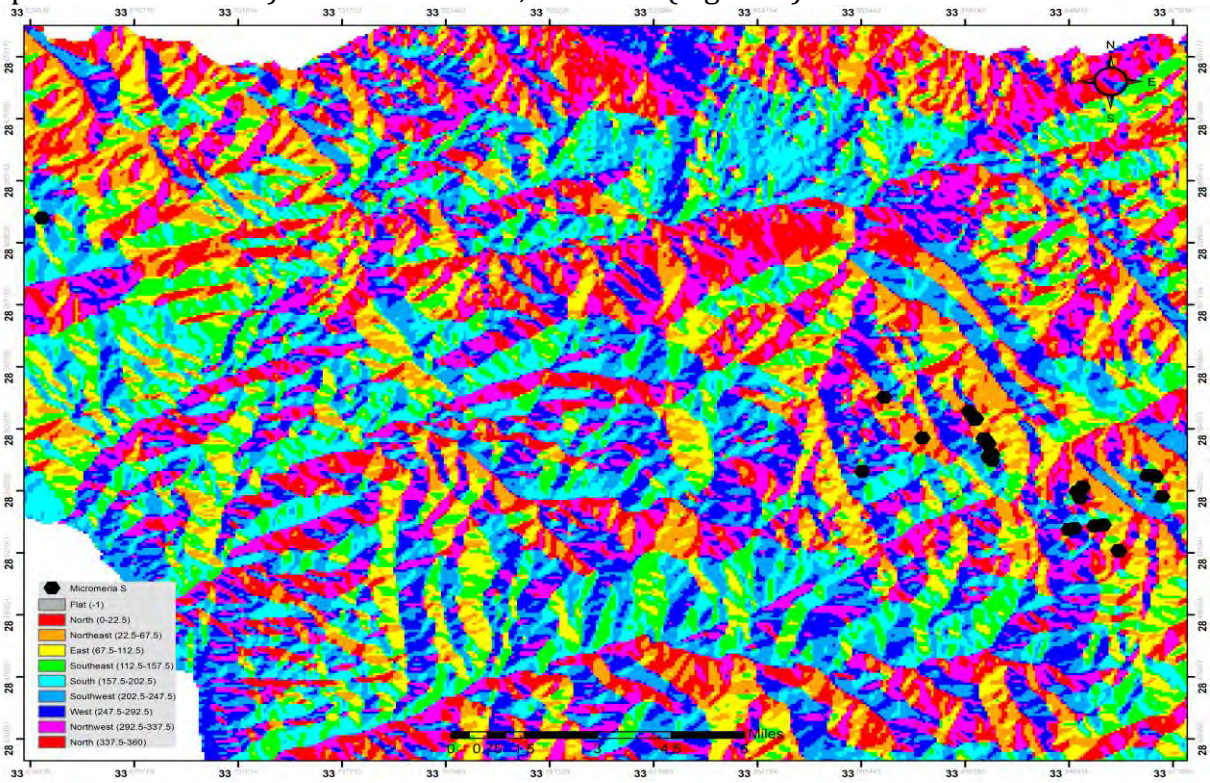


Figure 5. Frequency of *Micromeria serbaliana* among different sites in St. Catherine Protected Area

HABITATS AND ECOLOGY:

Micromeria serbaliana is perennial herb, it has been observed that flowers appear in late spring and reproduction is by seed in late summer. It is restricted to montane slopes with granite rocky ground of mountain areas (Table 12), mostly in slopes and gorges with steep slopes (Figure 6) of up to 90° on Northwest- (38%), North- (22%), Northwest- (16%) and Southeast and East facing slopes (8%) (Map 10, Figure 7). It was found that the optimum elevation ranges for the growth of this species (based on species distribution) is from 2000 to 2,150 m asl (Figure 8).



Map 10. Slope Aspect map of *Micromeria serbaliana* inside St. Catherine Protected Area

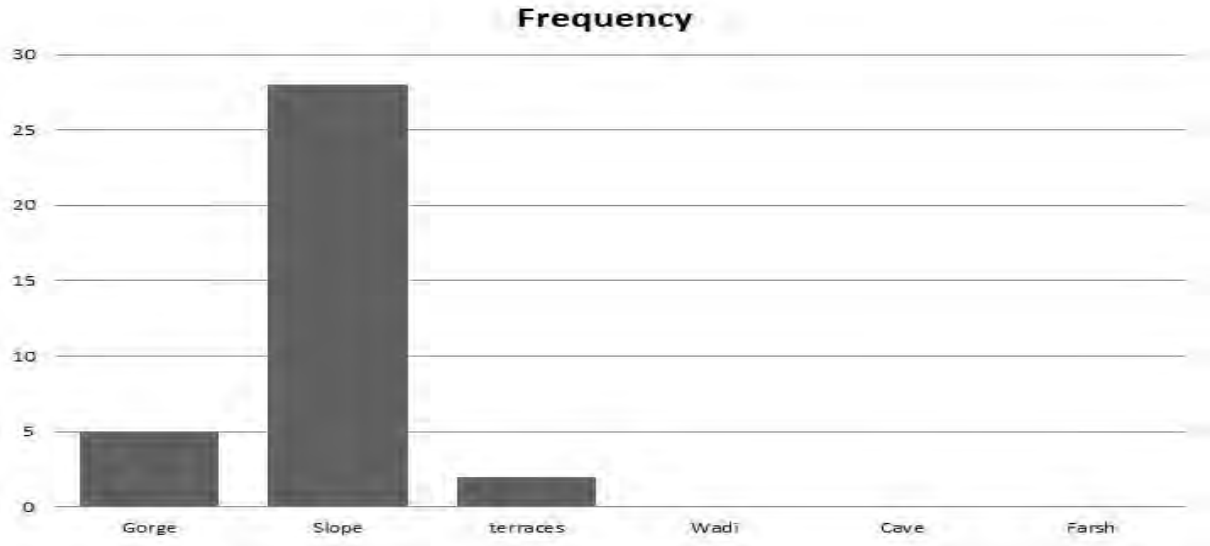


Figure 6 : Frequency of *Micromeria serbaliana* among different micro-habitat in St. Catherine Protected Area

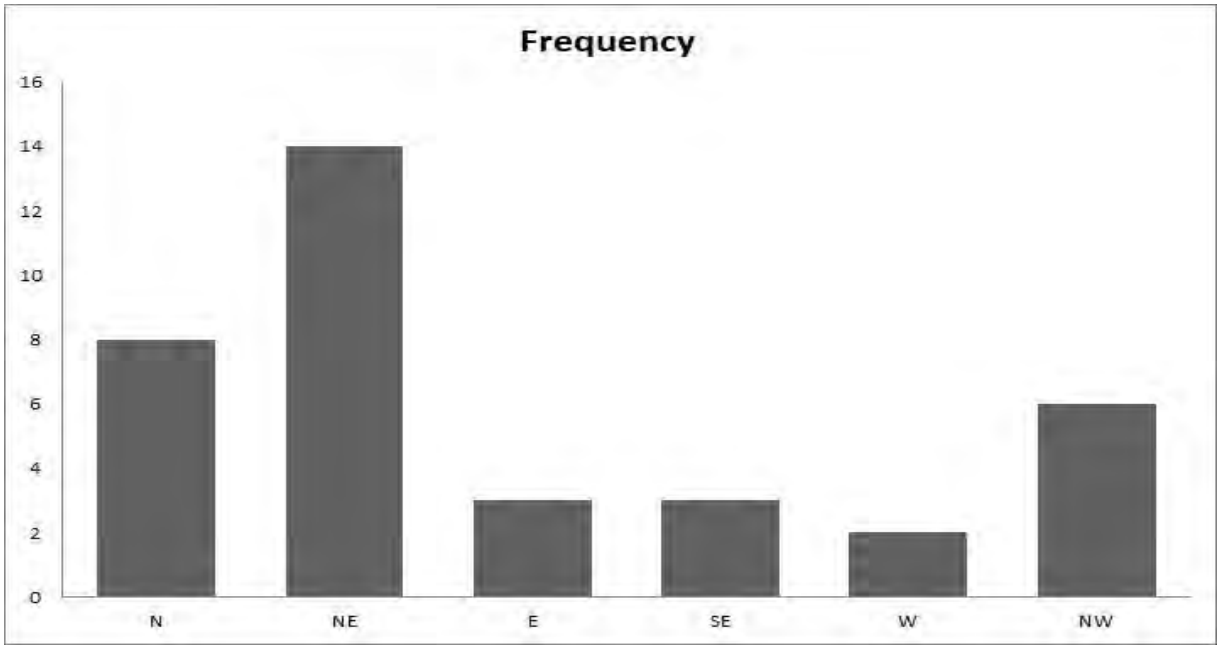


Figure 7 : Frequency of *Micromeria serbaliana* among different Slope Aspect in St. Catherine Protected Area

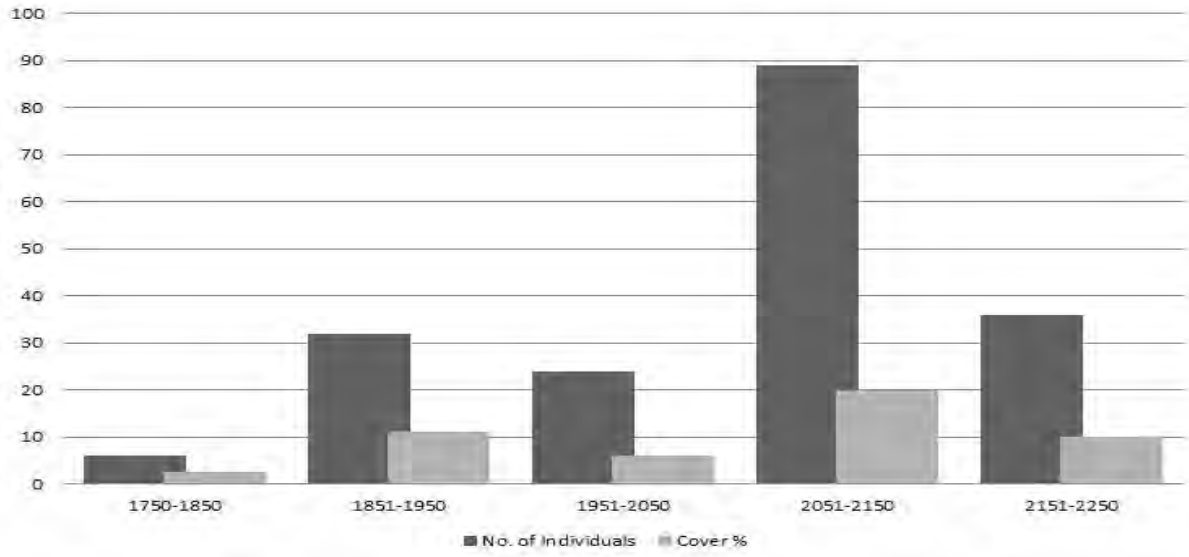


Figure 8. Relation between elevation and *Micromeria serbaliana* density and cover%

The cold winter climate (minimum temperature can reach -10°C) and cool summers (maximum temperature of c. 29°C) of the high elevations of Mt. St. Catherine are the coolest on the peninsula (Omar *et al.* 2013). The arid climate has a mean annual rainfall of about 37.5 mm (between 1971-2015), some in the form of snow, but there is great inter-annual variation with up to 300 mm in any one year, usually between October and May. Relative humidity is low, ranging from 10-35% (data for 2005-2015), and potential evaporation rates are very high, in excess of 20 mm/day during August.

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that soils of South Sinai are desert soils (Aridisols), in agreement with Kamh *et al.* (1989), Balba (1995), Moustafa and Zayed (1996), and Omar *et al.* (2013) that soils of the *Micromeria serbaliana* distribution area are gravelly in wadis and plains, rocky at

mountains in the surface, sandy to loamy sand in texture, alkaline and non-saline to slightly saline. It's characterized by low content of essential nutrients and cation exchange capacity (CEC).

It has been recorded that the most associated species for *Micromeria serbaliana* are *Achillea fragrantissima* and *Serphedium herba-alba.*

Table 12: Habitat of *Micromeria serbaliana* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6	Rocky areas (eg. inland cliffs, mountain peaks)	(Not Specified)	Suitable	Yes
8.2	Desert -> Desert - Temperate	(Not Specified)	Suitable	Yes

Continuing decline in area, extent and/or quality of habitat? Yes – Observed
System: Terrestrial

TRADE AND USE:

General Use and Trade Information: Economic use for grazing

THREATS:

The vegetation within this species distribution area has been subjected to disturbance through human activities including "over grazing, overcutting, uprooting" (Mosallam 2007, Khafagi *et al.* 2012). Due to climate change, the wild population of this species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (2% loss observed). Overgrazing is one of the most threats affect the distribution of this species. Water is being relocated in some localities from elevated wadis which are rich in water to supply to low wadis. This activity leads to consumption of water from wells and results in habitat deterioration and declines in population size (Table 13).

In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (dams and unmanaged human construction). All these factors are pushing *Micromeria serbaliana* to the brink of extinction.

Table 13: Threats on *Micromeria serbaliana* based on IUCN Threats Classification Scheme

Code	Threat	Timing	Scope	Severity	Impact Score
2.3.1.	Agriculture & aquaculture -> Livestock farming & ranching -> Nomadic grazing	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
6.1.	Human intrusions & disturbance -> Recreational activities	Ongoing	Minority (<50%)	Causing/Could cause fluctuations	Low Impact: 5
6.3.	Human intrusions & disturbance -> Work & other activities	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5

7.2.5.	Natural system modifications -> Dams & water management/use -> Abstraction of ground water (domestic use)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
8.1.2.	Invasive and other problematic species, genes & diseases -> Invasive non-native/alien species/diseases -> Equus asinus	Ongoing	Unknown	Unknown	Unknown
8.4.1.	Invasive and other problematic species, genes & diseases -> Problematic species/disease of unknown origin -> Unspecified species	Ongoing	Unknown	Unknown	Unknown
11.2.	Climate change & severe weather -> Droughts	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.3.	Climate change & severe weather -> Temperature extremes	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.4.	Climate change & severe weather -> Storms & flooding	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9

CONSERVATION ACTIONS:

The entire global distribution of *Micromeria serbaliana* is inside the St. Catherine Protected Area (SCPA). On average 20 checks are made every year to keep a watch on the current situation for the plant and its habitat, and to record any detrimental activities (Table 14). No individuals are protected by enclosures inside SCPA.

Table 14: Conservation Actions In-Place for *Micromeria serbaliana* inside the St. Catherine Protected Area

No.	Conservation Actions In-Place	Justification
1	Occur in at least one PA	Yes
2	Percentage of population protected by PA (0-100)	91-100%
3	In-situ Conservation	No
4	Ex-situ Conservation	No
5	Monitoring	Partly Yes

The species not recorded from 1998, it's the first record from this data. The team record information about the geographical distribution, population characteristics, threats, and habitat. Much more is needed, however (Tables 15, 16).

Table 15: Important Conservation Actions Needed for *Micromeria serbaliana*

Code	Conservation Actions	Specific Conservation Actions
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
2.3.	Land/water management	Habitat & natural process restoration
3.1.3.	Species management	Species management -> Limiting population growth
3.2.	Species management	Species recovery
3.4.1.	Species management	Ex-situ conservation -> Captive breeding/artificial propagation

3.4.2.	Species management	Ex-situ conservation -> Genome resource bank
4.2.	Education & awareness	Training
4.3.	Education & awareness	Awareness & communications
5.1.2.	Law & policy	Legislation -> National level
5.4.1.	Law & policy	Compliance and enforcement -> International level

Table 16: Important Research Needed for *Micromeria serbaliana*

Code	Research Needed	Specification
1.2.	Research	Population size, distribution & trends
1.3.	Research	Life history & ecology
1.4.	Research	Harvest, use & livelihoods
1.5.	Research	Threats
2.1.	Conservation Planning	Species Action/Recovery Plan
2.2.	Conservation Planning	Area-based Management Plan
3.1.	Monitoring	Population trends
3.4.	Monitoring	Habitat trends

IUCN RED LIST ASSESSMENT RATIONALE:

Micromeria serbaliana qualifies as Endangered because it is endemic to a tiny area in Egypt, with an extent of occurrence (EOO) of 65.8 km^2 and an area of occupancy (AOO) of 44 km^2. It occurs in the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations (based on climate change as the most serious plausible threat). There is a continuing decline in habitat quality for this species, with evidence of decline in the number of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

Hyoscyamus boveanus (Dun.) Aschers. & Schweinf. SOLANACEAE

Figure 9. *Hyoscyamus boveanus* (Dun.) Aschers. & Schweinf.

TAXONOMY

Table 17: Taxonomic notes on *Hyoscyamus boveanus* (Dun.) Aschers. & Schweinf.

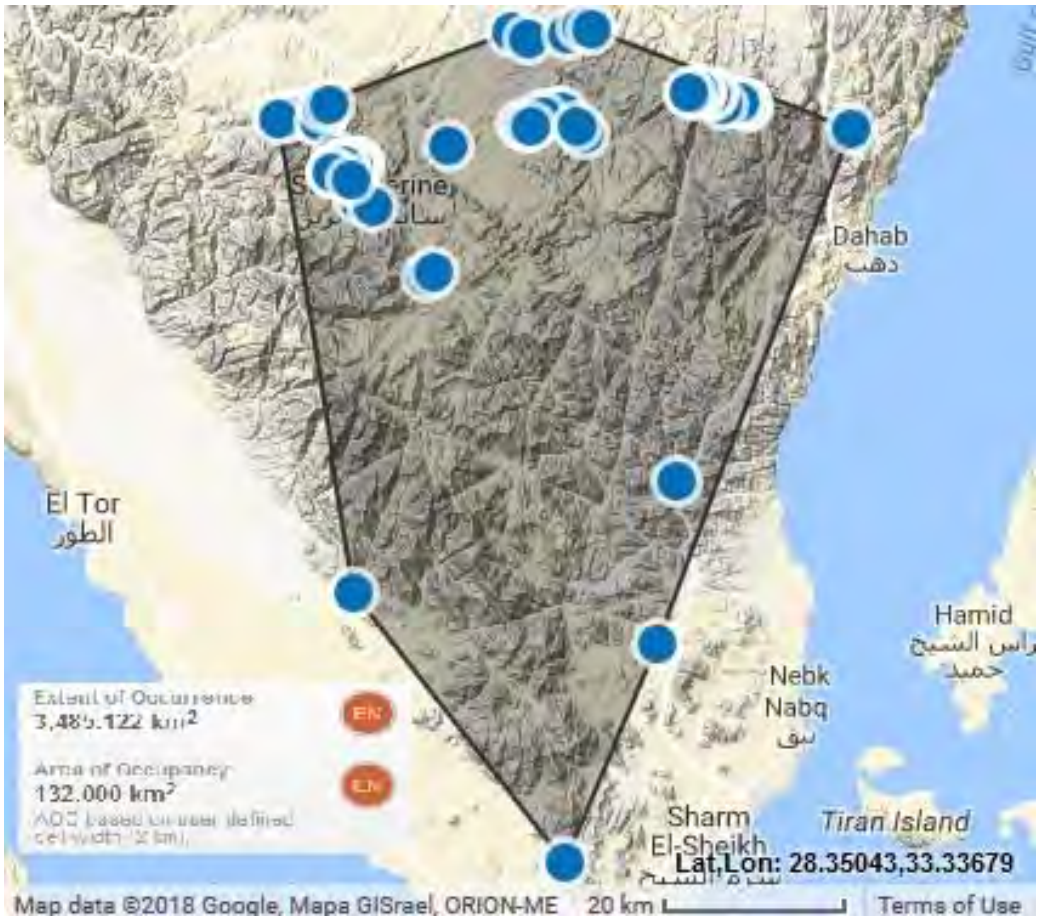
Taxonomic Notes	Justification
Full Name	*Hyoscyamus boveanus* (Dun.) Aschers. & Schweinf.
Level	Species
Parent	*Hyoscyamus*
Taxonomic Authority	(Dun.) Aschers. & Schweinf.
Status	Accepted
Taxonomy	PLANTAE-TRACHEOPHYTA-MAGNOLIOPSIDA- SOLANALES-SOLANACEAE- *Hyoscyamus boveanus*
Hybrid	No
Invasive	No
Feral	No
Synonyms	*Scopolia boveana* Dun.
Taxonomic Sources	Hassler M. (2018). World Plants: Synonymic Checklists of the Vascular Plants of the World (version Apr 2018). In: Roskov Y., Abucay L., Orrell T., Nicolson D., Bailly N., Kirk P.M., Bourgoin T., DeWalt R.E., Decock W., De Wever A., Nieukerken E. van, Zarucchi J., Penev L., eds. (2018). Species 2000 & ITIS Catalogue of Life, 30th June 2018. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.

GEOGRAPHIC RANGE:

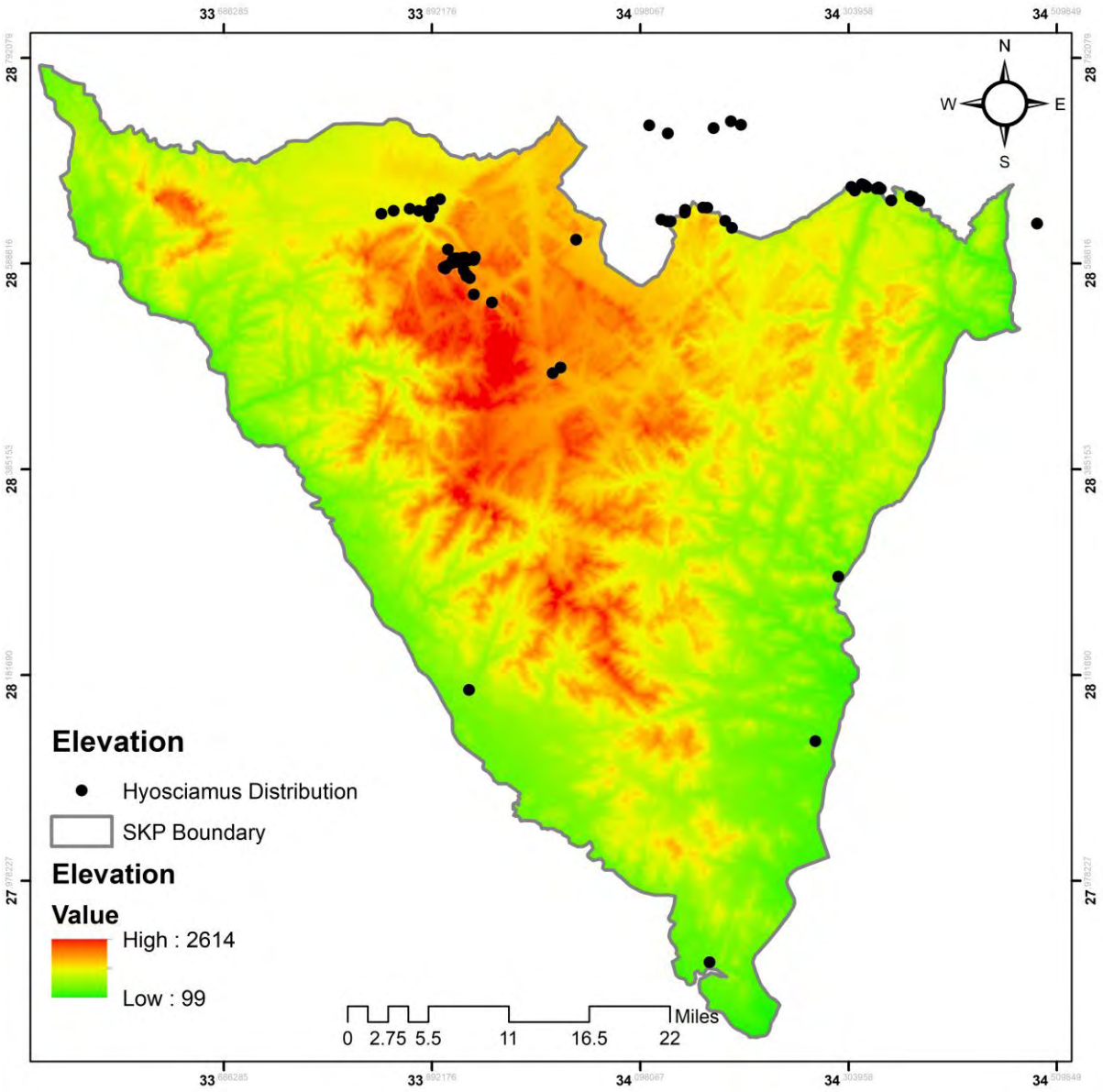
Hyoscyamus boveanus is a plant species endemic to Egypt, with altitudinal range between 250 and 1800 m asl (Map 12). Its extent of occurrence (EOO) is c. 3485 km^2, and its area of occupancy (AOO) is 132 km^2 (Table 18, Map 11). This species is clearly distributed in two locations (North and South St. Catherine PA). Wadi Zaghraa, Wadi Soaal, Shag Telah, and Wadi Itlah are the most important places for this species within the area of SCPA.

Table 18: Geographical distribution range of *Hyoscyamus boveanus* inside St. Catherine Protected Area

Geographical Aspects	Justification
EOO	3485 km^2
AOO	132 km^2
Elevation Lower Limit (in meters above sea level)	250
Elevation Upper Limit (in meters above sea level)	1800
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic



Map 11. Geographical Range map of *Hyoscyamus boveanus* inside St. Catherine Protected Area



Map 12. Elevation map of *Hyoscyamus boveanus* inside St. Catherine Protected Area

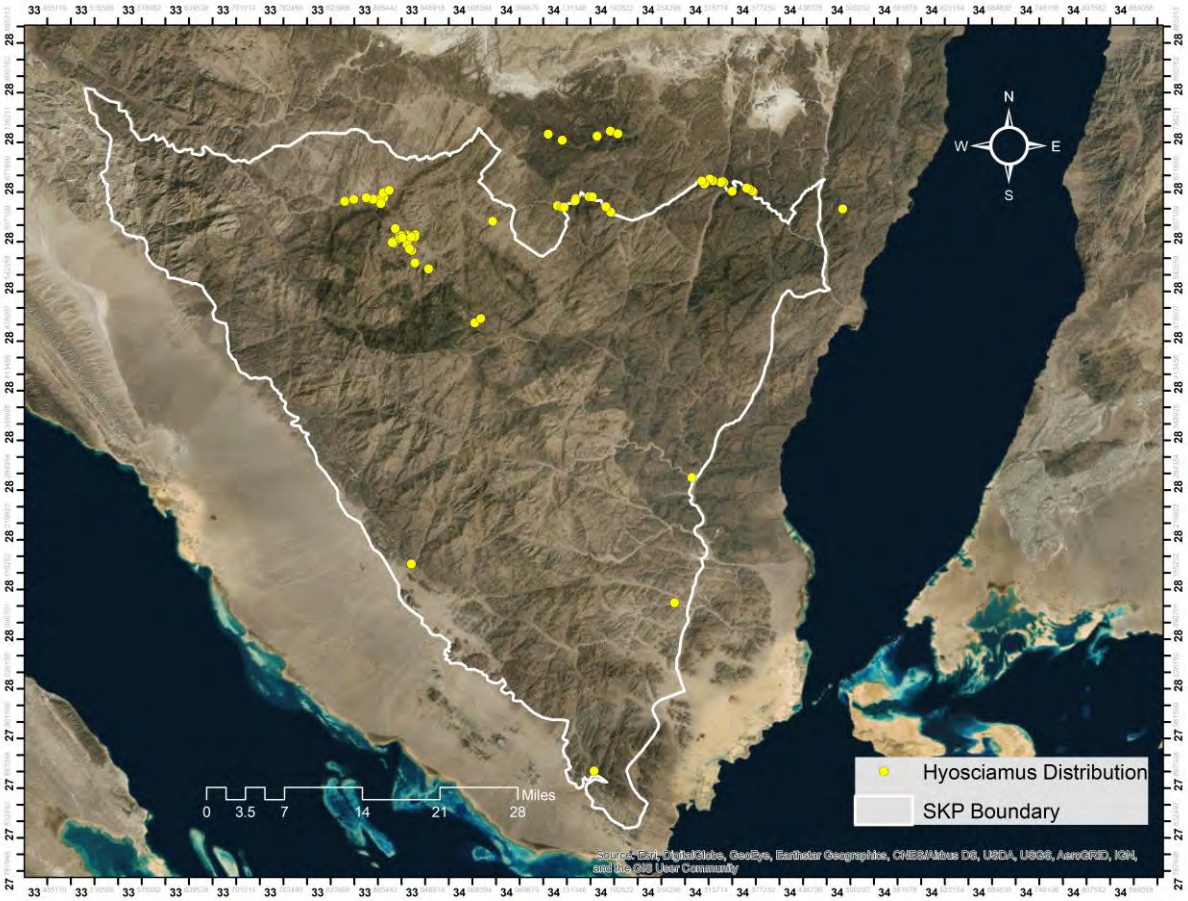
POPULATION INFORMATION:

Most of the *Hyoscyamus boveanus* subpopulations are very small, with individual plants occurring sporadically in space in little groups where the soil is sandy to fine gravelly. The number of mature plants has been observed to decline slightly as a result of drought, water consumption as well as unmanaged human activities and habitat destruction. The total global population size estimate ranges from 3000 to 5000 mature individuals (Table 19). There are clearly separate subpopulations and the number of mature individuals range from 1 to 100 in each subpopulation. During the last 10 years these subpopulations have been observed to have slight changes in the total number of individuals, cover and density, due to drought and habitat destruction from unmanaged human activity.

Table 19: Some facts about population characteristics of *Hyoscyamus boveanus*

Population Information	Justification
Locations	2 locations- North and South St. Catherine PA
Current Population Trend	Decreasing
Number of mature individuals	3000-5000 – Estimated
Severely fragmented?	Yes - Specific microhabitat and Mountains makes as barriers between different very small subpopulations.
Continuing decline in mature individuals?	Yes – Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	100 – Estimated

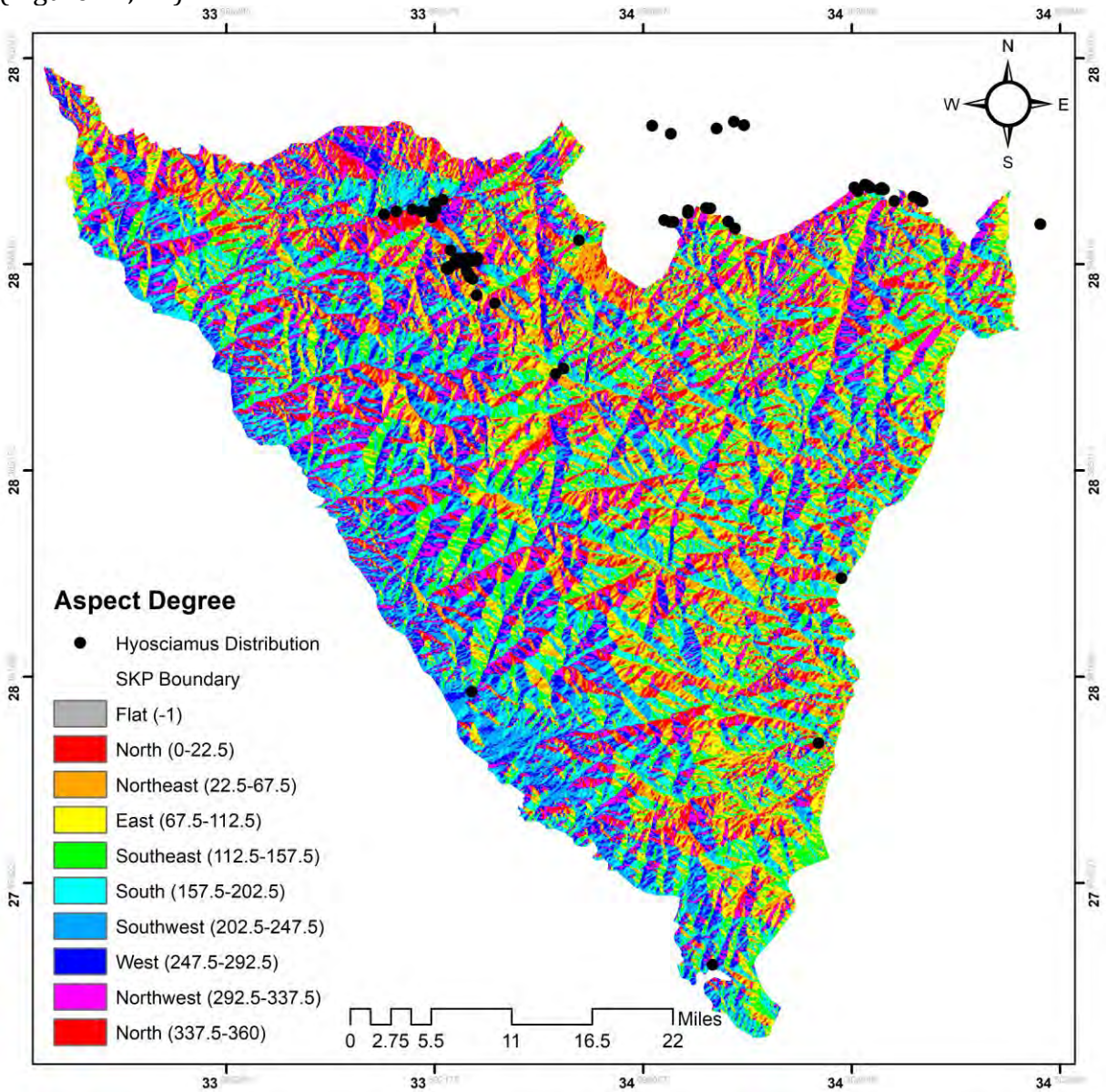
The population is considered severely fragmented as the requirement for a specific microhabitat and the mountains cause barriers between the very small subpopulations. The plant is distributed within two restricted areas and the effects of one threat will be felt by the two areas separately: thus the population is effectively in two clear locations. Zaghraa, and Wadi Soaal are the highest areas for species No. of individuals and cover of this species.



Map 13. Distribution of *Hyoscyamus boveanus* inside St. Catherine Protected Area

HABITATS AND ECOLOGY:

Hyoscyamus boveanus is a rare perennial herb. The whole plant including the inflorescence is spreadingly hairy. The flowers are white with purple blotches and stripes, filaments and anthers have cream colour (Täckholm 1974). It has been observed that flowers appear in late spring and reproduction is by seed in late summer. It is restricted to montane wadis with Sandy soil of mountain areas (Table 20), mostly in Wadi bed (60%) gorges (18%) terraces (15%) with steep slopes (Figure 10) of up to 90° on Northwest, North, Northwest. It was found that the optimum elevation ranges for the growth of this species (based on species distribution) is from 1300 to 1650 m asl (Figure 11, 12).



Map 14. Slope Aspect map of *Hyoscyamus boveanus* inside St. Catherine Protected Area

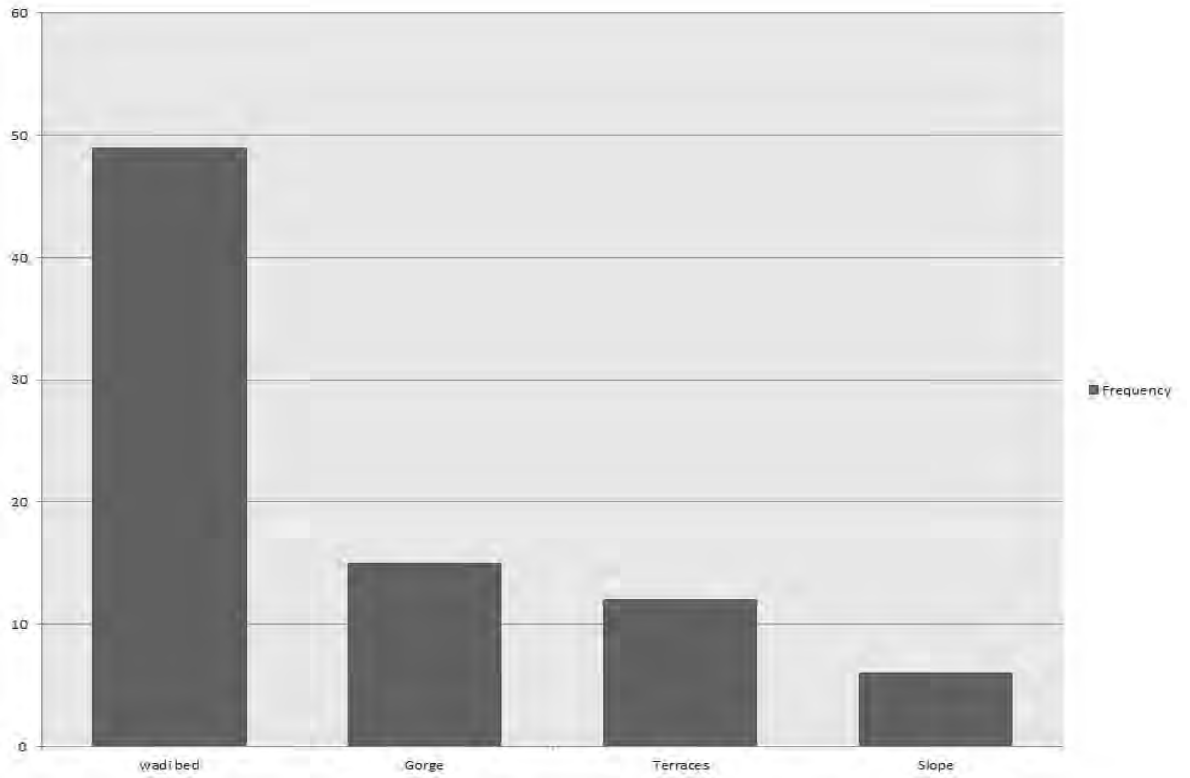


Figure 10 : Frequency of *Hyoscyamus boveanus* among different micro-habitat in St. Catherine Protected Area

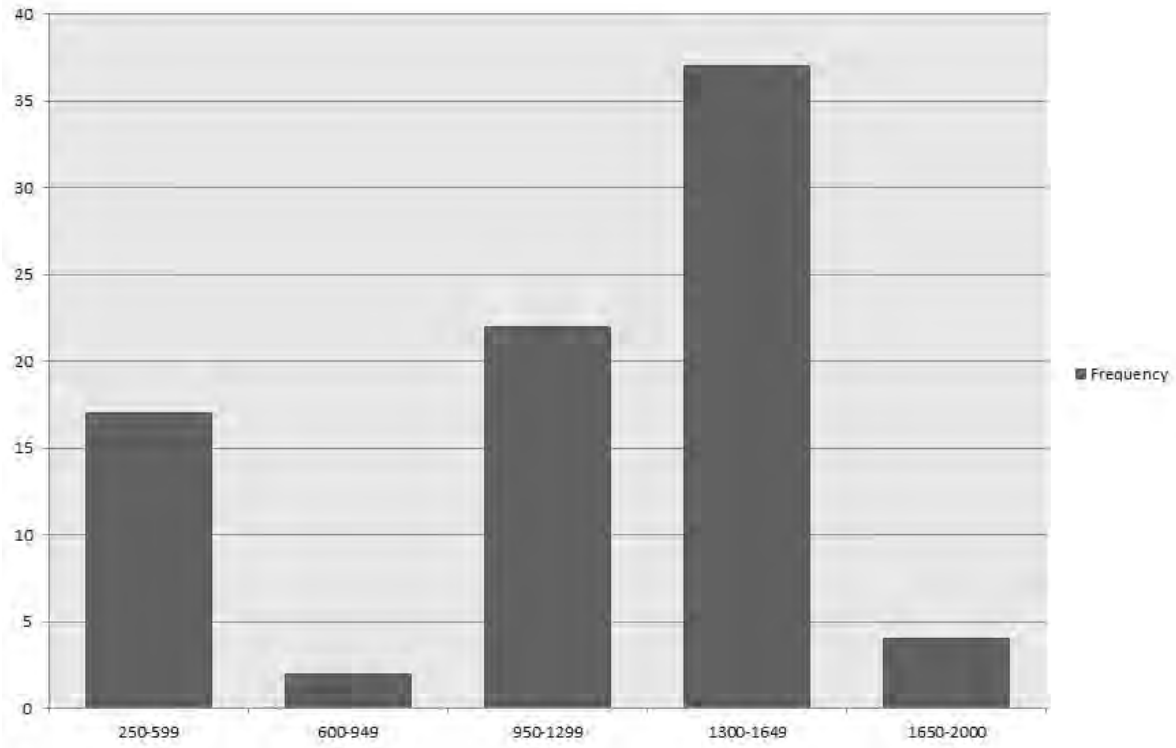


Figure 11 : Frequency of *Hyoscyamus boveanus* among different altitude ranges in St. Catherine Protected Area

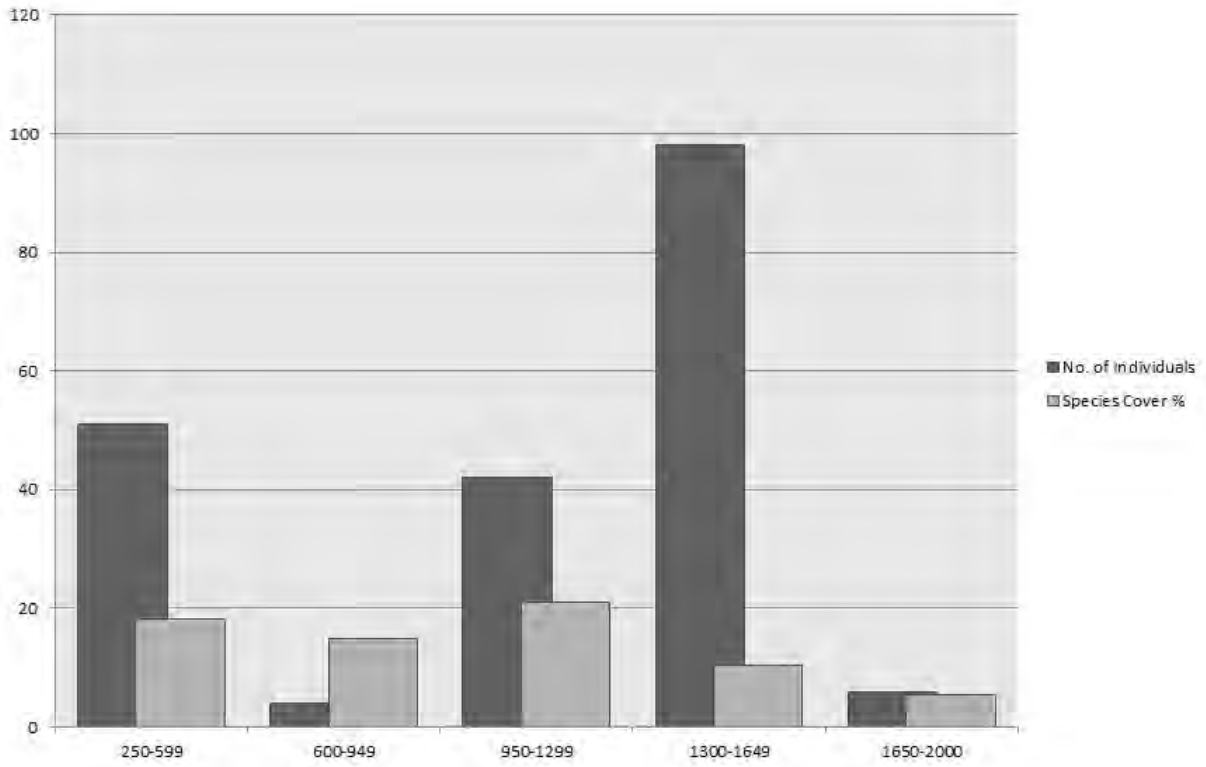


Figure 12. Relation between elevation and *Hyoscyamus boveanus* density and cover%

The cold winter climate (minimum temperature can reach -10°C) and cool summers (maximum temperature of c. 29°C) of the high elevations of Mt. St. Catherine are the coolest on the peninsula (Omar *et al.* 2013). The arid climate has a mean annual rainfall of about 37.5 mm (between 1971-2015), some in the form of snow, but there is great inter-annual variation with up to 300 mm in any one year, usually between October and May. Relative humidity is low, ranging from 10-35% (data for 2005-2015), and potential evaporation rates are very high, in excess of 20 mm/day during August.

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that soils of South Sinai are desert soils (Aridisols), in agreement with Kamh *et al.* (1989), Balba (1995), Moustafa and Zayed (1996), and Omar *et al.* (2013) that soils of the *Hyoscyamus boveanus* distribution area are gravelly in wadis and plains, rocky at mountains in the surface, sandy to loamy sand in texture, alkaline and non-saline to slightly saline. It's characterized by low content of essential nutrients and cation exchange capacity (CEC).

It has been recorded that the most associated species for *Hyoscyamus boveanus* are *Zilla spinosa* (L.) Prantl, *Alkanna orientalis* (L.) Boiss., *Artemisia* judaica L. and *Serphedium herba-alba.*

Table 20: Habitat of *Hyoscyamus boveanus* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6	Rocky areas (eg. inland cliffs, mountain peaks)	(Not Specified)	Suitable	Yes
8.2	Desert -> Desert - Temperate	(Not Specified)	Suitable	Yes

Continuing decline in area, extent and/or quality of habitat? Yes – Observed
System: Terrestrial

TRADE AND USE:

The Bischarin Bedouins of the Egyptian eastern desert occasionally mixed the flowers of this species with tobacco (Nicotiana sp.) and smoked the mixture for its intoxicating effects.A closely related group, the Khushmaan Bedouins, also smoked the leaves for their mind-altering effects. The Arabic name for this plant is saykaran, which means "to become intoxicated".

THREATS:

The vegetation within this species distribution area has been subjected to extreme drought as well as disturbance through human activities including "over grazing, overcutting, uprooting" (Mosallam 2007, Khafagi *et al.* 2012). Due to climate change, the wild population of this species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (2% loss observed). Overgrazing is one of the most threats affect the distribution of this species. Water is being relocated in some localities from elevated wadis which are rich in water to supply to low wadis. This activity leads to consumption of water from wells and results in habitat deterioration and declines in population size (Table 21).

In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (dams and unmanaged human construction). All these factors are pushing *Hyoscyamus boveanus* to the brink of extinction.

Table 21: Threats on *Hyoscyamus boveanus* based on IUCN Threats Classification Scheme

Code	Threat	Timing	Scope	Severity	Impact Score
2.3.1.	Agriculture & aquaculture -> Livestock farming & ranching -> Nomadic grazing	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
6.1.	Human intrusions & disturbance -> Recreational activities	Ongoing	Minority (<50%)	Causing/Could cause fluctuations	Low Impact: 5
6.3.	Human intrusions & disturbance -> Work & other activities	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
7.2.5.	Natural system modifications -> Dams & water management/use -> Abstraction of ground water (domestic use)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
8.1.2.	Invasive and other problematic species, genes & diseases -> Invasive non-native/alien species/diseases -> Equus asinus	Ongoing	Unknown	Unknown	Unknown

8.4.1.	Invasive and other problematic species, genes & diseases -> Problematic species/disease of unknown origin -> Unspecified species	Ongoing	Unknown	Unknown	Unknown
11.2.	Climate change & severe weather -> Droughts	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.3.	Climate change & severe weather -> Temperature extremes	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.4.	Climate change & severe weather -> Storms & flooding	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9

CONSERVATION ACTIONS:

The global distribution of *Hyoscyamus boveanus* is distributed all over Egypt but most of the population size is inside the St. Catherine Protected Area (SCPA). On average 20 checks are made every year to keep a watch on the current situation for the plant and its habitat, and to record any detrimental activities (Table 22). No individuals are protected by enclosures inside SCPA.

Table 22: Conservation Actions In-Place for *Hyoscyamus boveanus* inside the St. Catherine Protected Area

No.	Conservation Actions In-Place	Justification
1	Occur in at least one PA	Yes
2	Percentage of population protected by PA (0-100)	30-60%
3	In-situ Conservation	No
4	Ex-situ Conservation	No
5	Monitoring	Partly Yes

The team record information about the geographical distribution, population characteristics, threats, and habitat. Much more is needed, however (Tables 23, 24).

Table 23: Important Conservation Actions Needed for *Hyoscyamus boveanus*

Code	Conservation Actions	Specific Conservation Actions
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
2.3.	Land/water management	Habitat & natural process restoration
3.1.3.	Species management	Species management -> Limiting population growth
3.2.	Species management	Species recovery
3.4.1.	Species management	Ex-situ conservation -> Captive breeding/artificial propagation
3.4.2.	Species management	Ex-situ conservation -> Genome resource bank
4.2.	Education & awareness	Training
4.3.	Education & awareness	Awareness & communications
5.1.2.	Law & policy	Legislation -> National level
5.4.1.	Law & policy	Compliance and enforcement -> International level

Table 24: Important Research Needed for *Hyoscyamus boveanus*

Code	Research Needed	Specification
1.2.	Research	Population size, distribution & trends

1.3.	Research	Life history & ecology
1.4.	Research	Harvest, use & livelihoods
1.5.	Research	Threats
2.1.	Conservation Planning	Species Action/Recovery Plan
2.2.	Conservation Planning	Area-based Management Plan
3.1.	Monitoring	Population trends
3.4.	Monitoring	Habitat trends

IUCN RED LIST ASSESSMENT RATIONALE:

Hyoscyamus boveanus qualifies as Endangered because it is endemic to a tiny area in Egypt, with an extent of occurrence (EOO) of 3485 km^2 and an area of occupancy (AOO) of 132 km^2. It occurs in the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations (based on climate change as the most serious plausible threat). There is a continuing decline in habitat quality for this species, with evidence of decline in the number of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

Silene leucophylla Boiss. CARYOPHYLLACEAE

Figure 13. *Silene leucophylla* Boiss.

TAXONOMY

Table 25: Taxonomic notes on *Silene leucophylla* Boiss

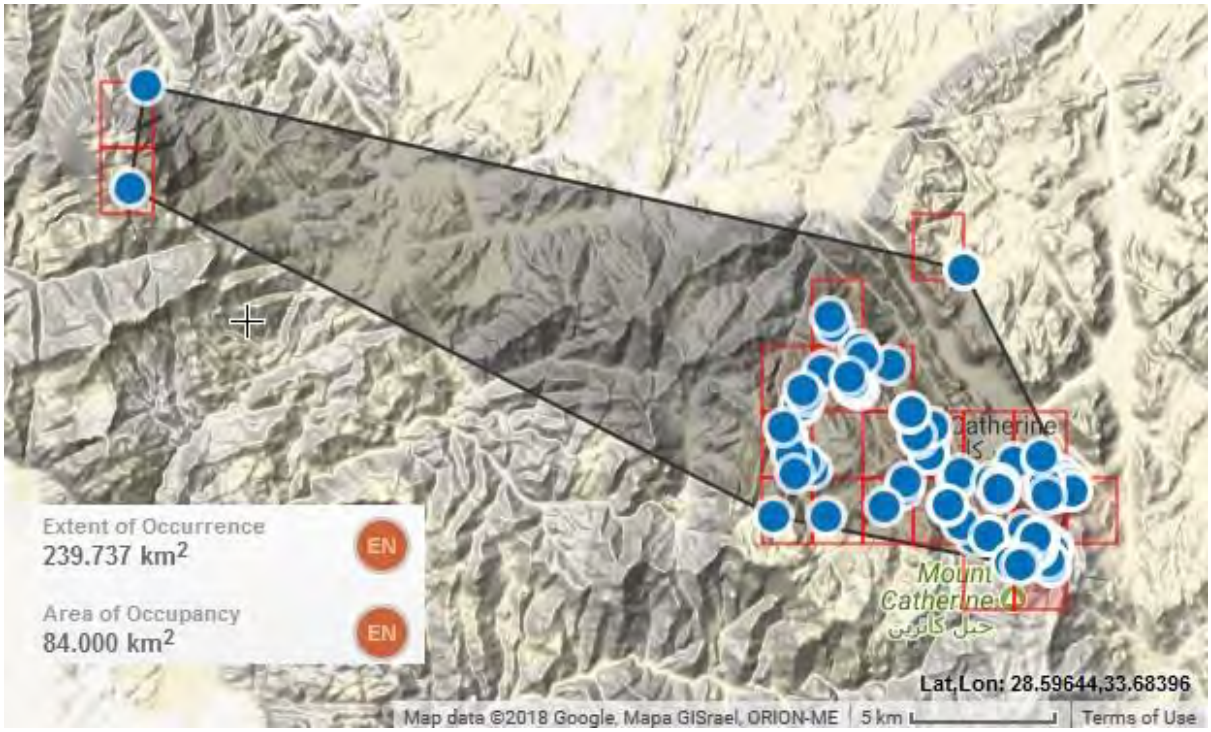
Taxonomic Notes	Justification
Full Name	*Silene leucophylla* Boiss
Level	Species
Parent	*Silene*
Taxonomic Authority	Boiss
Status	Accepted
Taxonomy	PLANTAE-TRACHEOPHYTA-MAGNOLIOPSIDA- CARYOPHYLLALES-CARYOPHYLLACEAE- *Silene leucophylla*
Hybrid	No
Invasive	No
Feral	No
Synonyms	-
Taxonomic Sources	Hassler M. (2018). World Plants: Synonymic Checklists of the Vascular Plants of the World (version Apr 2018). In: Roskov Y., Abucay L., Orrell T., Nicolson D., Bailly N., Kirk P.M., Bourgoin T., DeWalt R.E., Decock W., De Wever A., Nieukerken E. van, Zarucchi J., Penev L., eds. (2018). Species 2000 & ITIS Catalogue of Life, 30th June 2018. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.

GEOGRAPHIC RANGE:

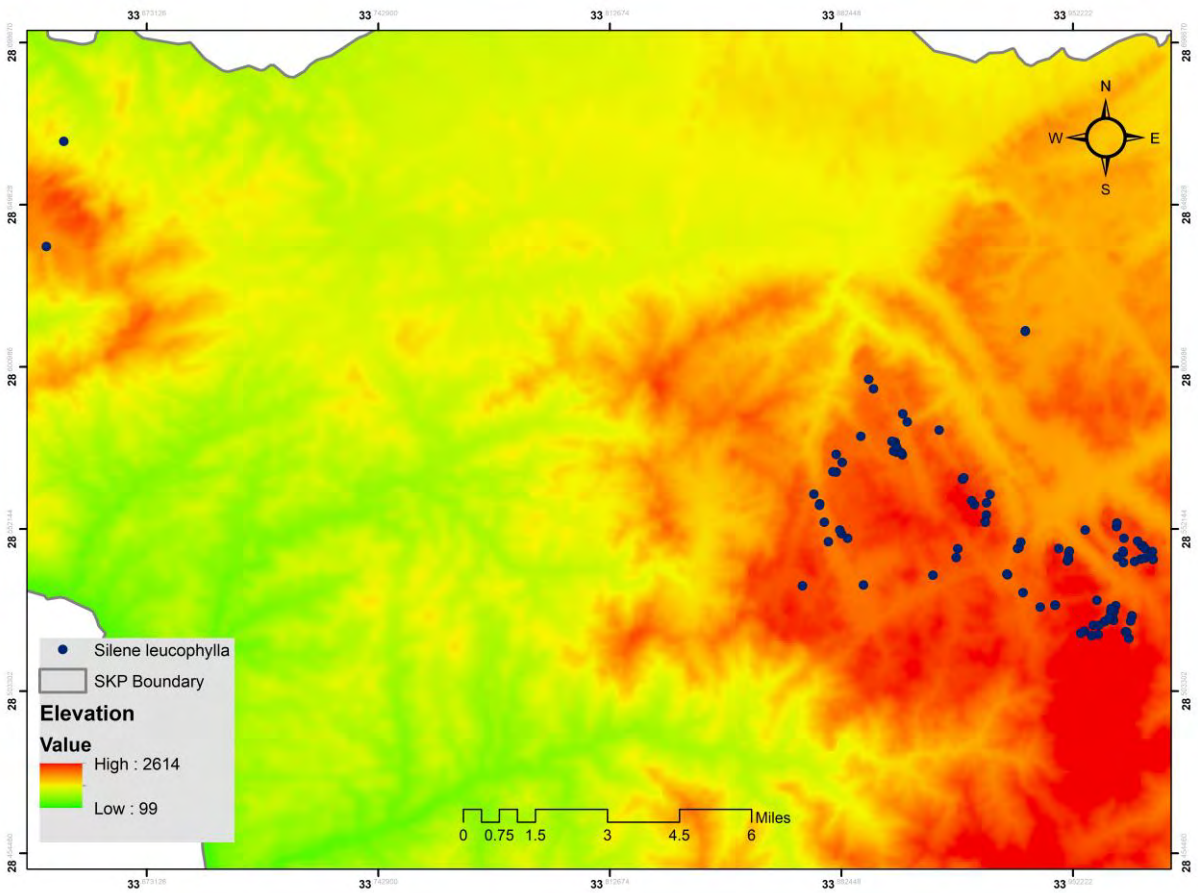
Silene leucophylla is a plant species endemic to St. Catherine PA, with altitudinal range between 1600 and 2300 m asl (Map 16). Its extent of occurrence (EOO) is c. 239.7 km^2, and its area of occupancy (AOO) is 84 km^2 (Table 26, Map 15). This species is clearly distributed in two locations (High Mountain Area, and Serbal Mountain Area). Shak Musa, Wadi Gebal, Gabal Mousa, Shak Abo-Hamman are the most important places for this species within the area of SCPA.

Table 26: Geographical distribution range of *Silene leucophylla* inside St. Catherine Protected Area

Geographical Aspects	Justification
EOO	239.7 km^2
AOO	84 km^2
Elevation Lower Limit (in meters above sea level)	1600
Elevation Upper Limit (in meters above sea level)	2300
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic



Map 15. Geographical Range map of *Silene leucophylla* inside St. Catherine Protected Area



Map 16. Elevation map of *Silene leucophylla* inside St. Catherine Protected Area

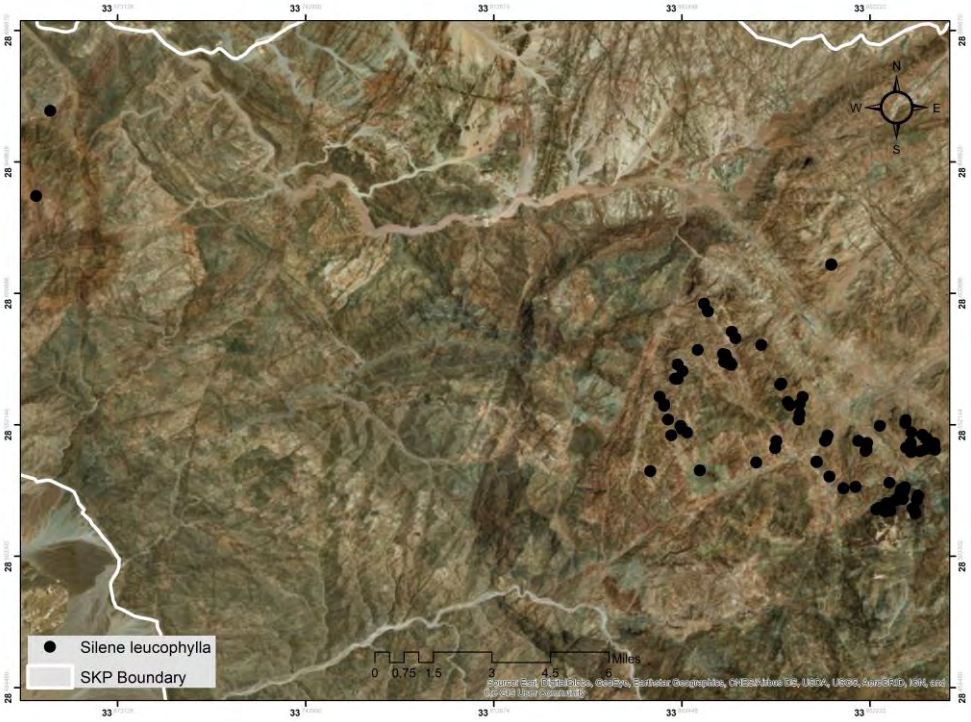
POPULATION INFORMATION:

Most of the *Silene leucophylla* subpopulations are very small, with individual plants occurring sporadically in space in little groups where the soil is rocky. The number of mature plants has been observed to decline sharply as a result of drought, overgrazing. The total global population size estimate ranges from 1500 to 3000 mature individuals (Table 27). There are clearly separate subpopulations and the number of mature individuals range from 1 to 50 in each subpopulation. During the last 10 years these subpopulations have been observed to have slight changes in the total number of individuals, cover and density, due to the mentioned threats.

Table 27: Some facts about population characteristics of *Silene leucophylla*

Population Information	Justification
Locations	2 locations- High Mountain Area, and Serbal Mountain Area
Current Population Trend	Decreasing
Number of mature individuals	1500-3000 – Estimated
Severely fragmented?	Yes - Specific microhabitat and Mountains makes as barriers between different very small subpopulations.
Continuing decline in mature individuals?	Yes – Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	50 – Estimated

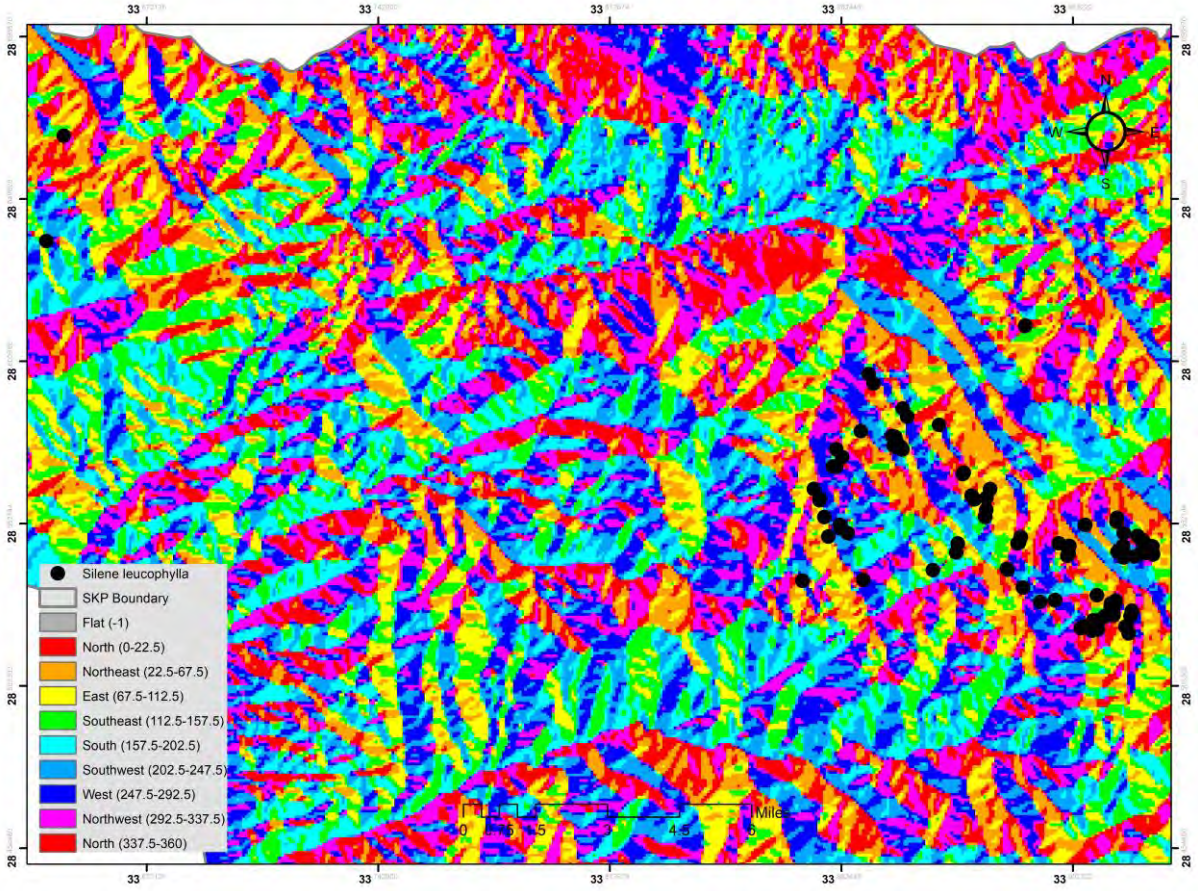
The population is considered severely fragmented as the requirement for a specific microhabitat and the mountains cause barriers between the very small subpopulations. The plant is distributed within two restricted areas and the effects of one threat will be felt by the two areas separately: thus the population is effectively in two clear locations. Shak Musa, Wadi Gebal, Gabal Mousa, and Shak Abo-Hamman are the highest areas for species No. of individuals and cover of this species.



Map 17. Distribution of *Silene leucophylla* inside St. Catherine Protected Area

HABITATS AND ECOLOGY:

Silene leucophylla is a rare perennial herb. It has been observed that flowers appear in late spring and reproduction is by seed in late summer. It is restricted to montane wadis with rocky soil of mountain areas (Table 28), mostly in Slope (79%) gorges (13%) terraces (7%) with steep slopes (Figure 14) of up to 90° on Northwest, North, Northwest, and West. It was found that the optimum elevation ranges for the growth of this species (based on species distribution) is from 1900 to 2050 m asl (Figure 15, 16).



Map 18. Slope Aspect map of *Silene leucophylla* inside St. Catherine Protected Area

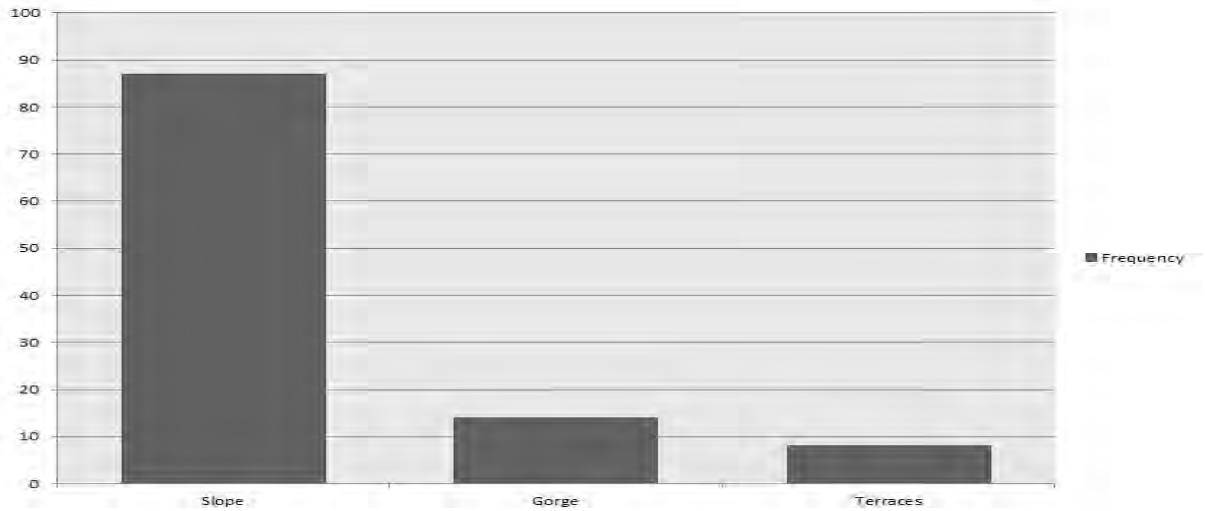


Figure 14 : Frequency of *Silene leucophylla* among different micro-habitat in St. Catherine Protected Area

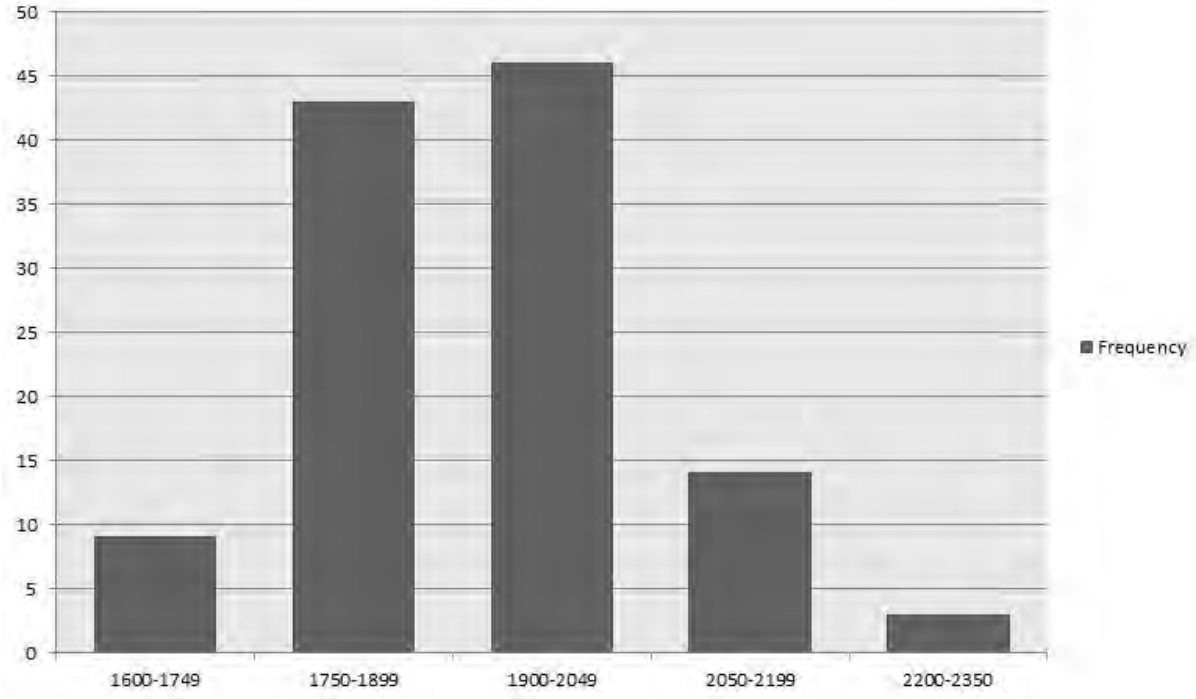


Figure 15 : Frequency of *Silene leucophylla* among different altitude ranges in St. Catherine Protected Area

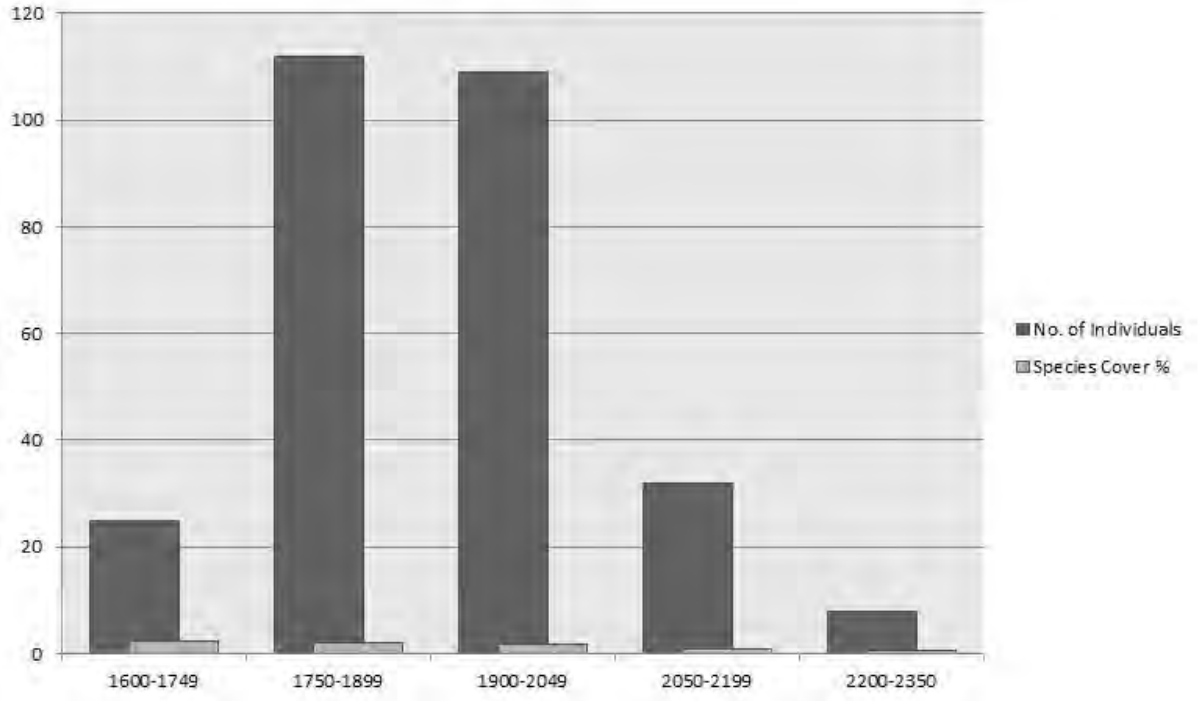


Figure 16. Relation between elevation and *Silene leucophylla* density and cover%

The cold winter climate (minimum temperature can reach -10°C) and cool summers (maximum temperature of c. 29°C) of the high elevations of Mt. St. Catherine are the coolest on the peninsula (Omar *et al.* 2013). The arid climate has a mean annual rainfall of about 37.5 mm (between 1971-2015), some in the form of snow, but there is great inter-annual variation with up to 300 mm in any one year, usually between October and

May. Relative humidity is low, ranging from 10-35% (data for 2005-2015), and potential evaporation rates are very high, in excess of 20 mm/day during August.

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that soils of South Sinai are desert soils (Aridisols), in agreement with Kamh *et al.* (1989), Balba (1995), Moustafa and Zayed (1996), and Omar *et al.* (2013) that soils of the *Silene leucophylla* distribution area are gravelly in wadis and plains, rocky at mountains in the surface, sandy to loamy sand in texture, alkaline and non-saline to slightly saline. It's characterized by low content of essential nutrients and cation exchange capacity (CEC).

It has been recorded that the most associated species for *Silene leucophylla* are *Chiliadenus montanus* (Vahl) Brullo., *Gallium setaceum* Lam., *Echinops glaberrimus* DC., and *Tanacetum sinaicum.*

Table 28: Habitat of *Silene leucophylla* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6	Rocky areas (eg. inland cliffs, mountain peaks)	(Not Specified)	Suitable	Yes
8.2	Desert -> Desert - Temperate	(Not Specified)	Suitable	Yes

Continuing decline in area, extent and/or quality of habitat? Yes – Observed
System: Terrestrial

TRADE AND USE:

The plant is highly grazed by domestic animals. The genus is used to treat leprosy, diarrhea, heal cuts & inflamed wounds; root show hepato-protactive function

THREATS:

The vegetation within this species distribution area has been subjected to extreme drought as well as disturbance through human activities including "over grazing, overcutting, uprooting" (Mosallam 2007, Khafagi *et al.* 2012). Due to climate change, the wild population of this species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (2% loss observed). Overgrazing is one of the most threats affect the distribution of this species. Water is being relocated in some localities from elevated wadis which are rich in water to supply to low wadis. This activity leads to consumption of water from wells and results in habitat deterioration and declines in population size (Table 29).

Sakr et al. (2011) found that the maximum germination percentage of *S. leucophylla,* although seems to have no specific problems with germination, nevertheless has as low percentage as only 30%. It was noticed that 50% of the geminated seedlings were unable to survive. The inappropriate population size, low seed fitting and the low seedling's survival rate of this species are among factors which lead to the

disappearance of this species from the wild habitats of SCPA and to be included among the threatened species list of SCPA.

In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (dams and unmanaged human construction). All these factors are pushing *Silene leucophylla* to the brink of extinction.

Table 29: Threats on *Silene leucophylla* based on IUCN Threats Classification Scheme

Code	Threat	Timing	Scope	Severity	Impact Score
2.3.1.	Agriculture & aquaculture -> Livestock farming & ranching -> Nomadic grazing	Ongoing	Majority (50-90%)	Rapid, Significant Declines	Medium Impact: 9
6.1.	Human intrusions & disturbance -> Recreational activities	Ongoing	Minority (<50%)	Causing/Could cause fluctuations	Low Impact: 5
6.3.	Human intrusions & disturbance -> Work & other activities	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
7.2.5.	Natural system modifications -> Dams & water management/use -> Abstraction of ground water (domestic use)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
8.1.2.	Invasive and other problematic species, genes & diseases -> Invasive non-native/alien species/diseases -> Equus asinus	Ongoing	Unknown	Unknown	Unknown
8.4.1.	Invasive and other problematic species, genes & diseases -> Problematic species/disease of unknown origin -> Unspecified species	Ongoing	Unknown	Unknown	Unknown
11.2.	Climate change & severe weather -> Droughts	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.3.	Climate change & severe weather -> Temperature extremes	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.4.	Climate change & severe weather -> Storms & flooding	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9

CONSERVATION ACTIONS:

The global distribution of *Silene leucophylla* is distributed only inside the St. Catherine Protected Area (SCPA). On average 20 checks are made every year to keep a watch on the current situation for the plant and its habitat, and to record any detrimental activities (Table 30). No individuals are protected by enclosures inside SCPA.

Table 30: Conservation Actions In-Place for *Silene leucophylla* inside the St. Catherine Protected Area

No.	Conservation Actions In-Place	Justification
1	Occur in at least one PA	Yes
2	Percentage of population protected by PA (0-100)	90-100%
3	In-situ Conservation	No

4	Ex-situ Conservation	No
5	Monitoring	Partly Yes

The team record information about the geographical distribution, population characteristics, threats, and habitat. Much more is needed, however (Tables 31, 32).

Table 31: Important Conservation Actions Needed for *Silene leucophylla*

Code	Conservation Actions	Specific Conservation Actions
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
2.3.	Land/water management	Habitat & natural process restoration
3.1.3.	Species management	Species management -> Limiting population growth
3.2.	Species management	Species recovery
3.4.1.	Species management	Ex-situ conservation -> Captive breeding/artificial propagation
3.4.2.	Species management	Ex-situ conservation -> Genome resource bank
4.2.	Education & awareness	Training
4.3.	Education & awareness	Awareness & communications
5.1.2.	Law & policy	Legislation -> National level
5.4.1.	Law & policy	Compliance and enforcement -> International level

Table 32: Important Research Needed for *Silene leucophylla*

Code	Research Needed	Specification
1.2.	Research	Population size, distribution & trends
1.3.	Research	Life history & ecology
1.4.	Research	Harvest, use & livelihoods
1.5.	Research	Threats
2.1.	Conservation Planning	Species Action/Recovery Plan
2.2.	Conservation Planning	Area-based Management Plan
3.1.	Monitoring	Population trends
3.4.	Monitoring	Habitat trends

IUCN RED LIST ASSESSMENT RATIONALE:

Silene leucophylla qualifies as Endangered because it is endemic to a tiny area in Egypt, with an extent of occurrence (EOO) of 239.7 km^2 and an area of occupancy (AOO) of 84 km^2. It occurs in the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations (based on climate change as the most serious plausible threat). There is a continuing decline in habitat quality for this species, with evidence of decline in the number of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

Ballota kaiseri Tackh. LAMIACEAE

Figure 17. *Ballota kaiseri* Tackh.

TAXONOMY

Table 33: Taxonomic notes on *Ballota kaiseri* Tackh.

Taxonomic Notes	Justification
Full Name	*Ballota kaiseri* Tackh.
Level	Species
Parent	*Ballota*
Taxonomic Authority	Tackh.
Status	Accepted
Taxonomy	PLANTAE-TRACHEOPHYTA-MAGNOLIOPSIDA- LAMIALES-LAMIACEAE- *Ballota kaiseri*
Hybrid	No
Invasive	No
Feral	No
Synonyms	-
Taxonomic Sources	Govaerts R. (ed). For a full list of reviewers see: http://apps.kew.org/wcsp/compilersReviewers.do (2018). WCSP: World Checklist of Selected Plant Families (version Aug 2017). In: Roskov Y., Abucay L., Orrell T., Nicolson D., Bailly N., Kirk P.M., Bourgoin T., DeWalt R.E., Decock W., De Wever A., Nieukerken E. van, Zarucchi J., Penev L., eds. (2018). Species 2000 & ITIS Catalogue of Life, 30th June 2018. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.

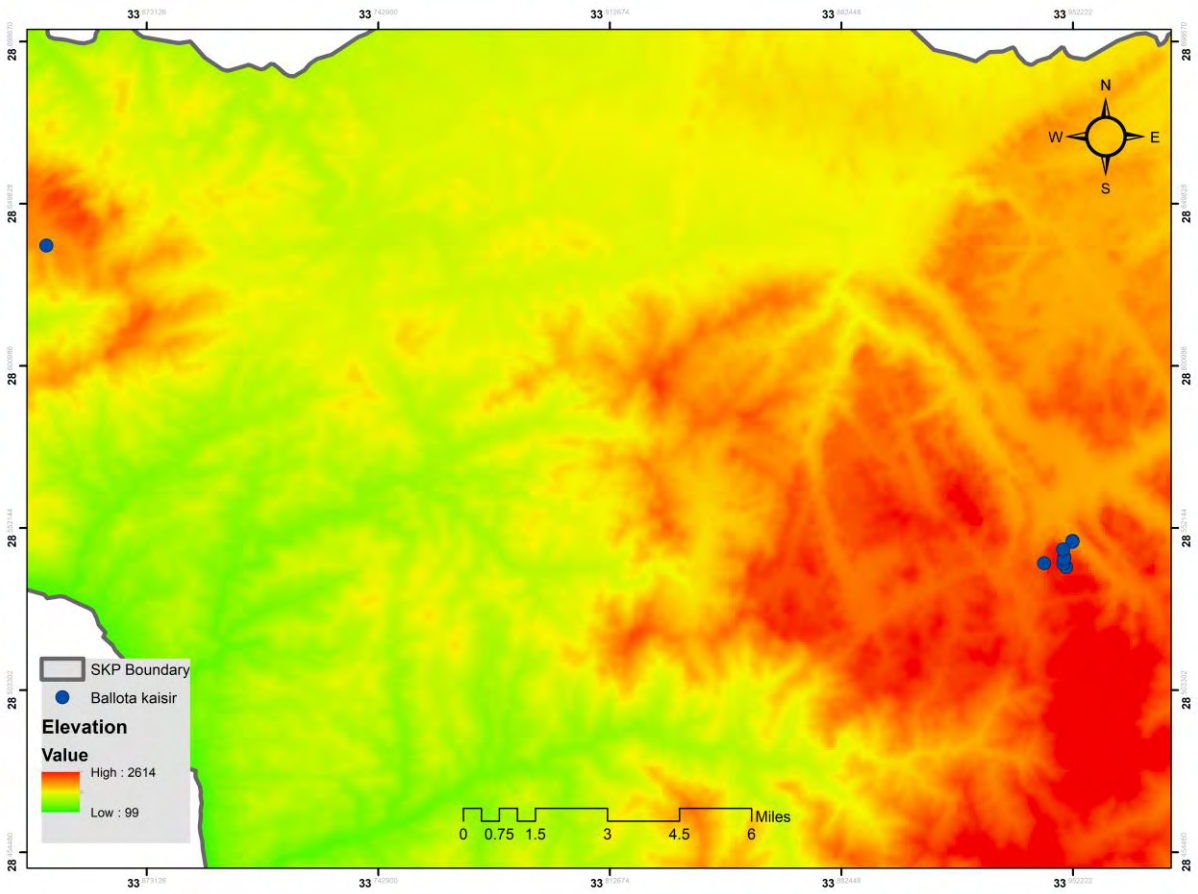
GEOGRAPHIC RANGE:

Ballota kaiseri is a plant species endemic to St. Catherine PA, with altitudinal range between 1600 and 2100 m asl (Map 20). Its extent of occurrence (EOO) is c. 15.8 km^2, and its area of occupancy (AOO) is 12 km^2 (Table 34, Map 19). This species is clearly distributed in two locations (High Mountain Area, and Serbal Mountain Area). Wadi El-Arbaein, and Shak Abo-Hamman are the most important places for this species within the area of SCPA.

Table 34: Geographical distribution range of *Ballota kaiseri* inside St. Catherine Protected Area

Geographical Aspects	Justification
EOO	15.8 km^2
AOO	12 km^2
Elevation Lower Limit (in meters above sea level)	1600
Elevation Upper Limit (in meters above sea level)	2100
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic

Map 19. Geographical Range map of *Ballota kaiseri* inside St. Catherine Protected Area



Map 20. Elevation map of *Ballota kaiseri* inside St. Catherine Protected Area

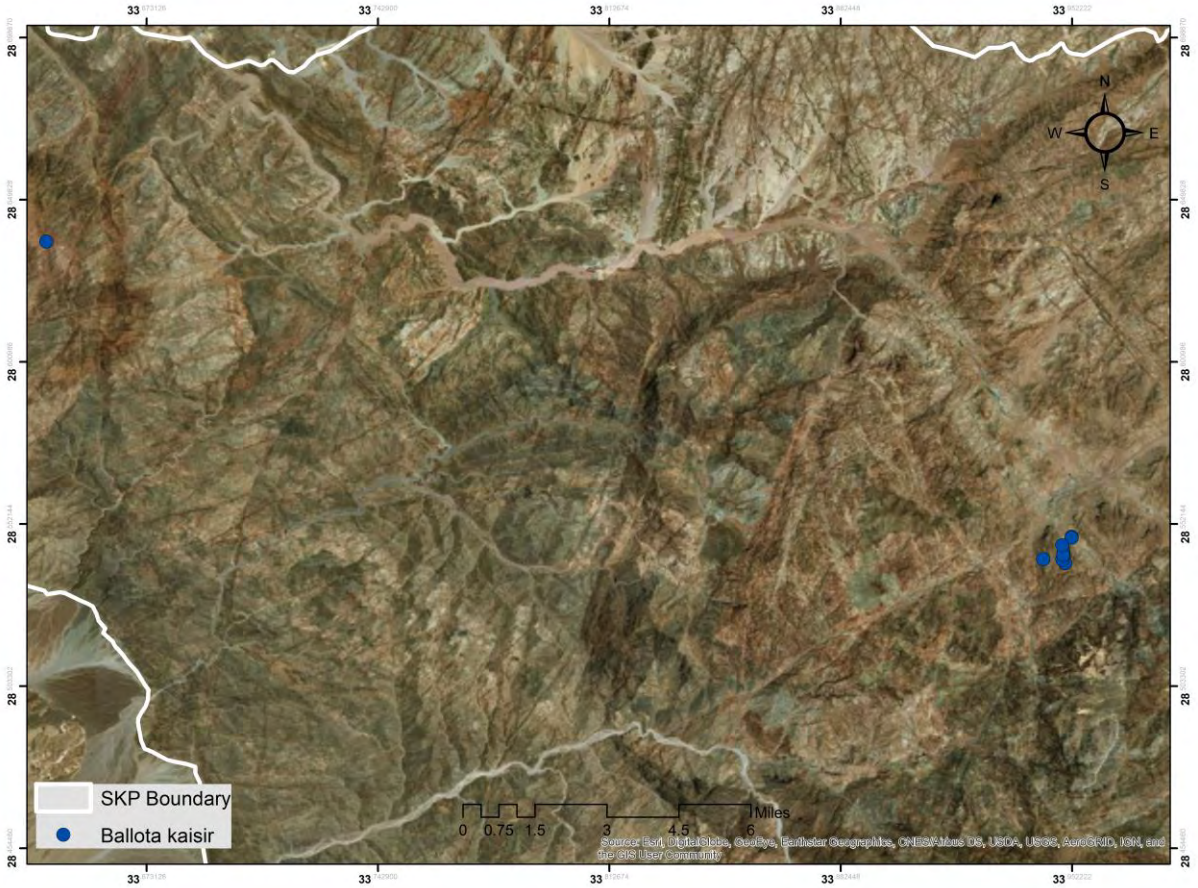
POPULATION INFORMATION:

Ballota kaiseri subpopulations are very small, with individual plants occurring sporadically in space in little groups where the soil is rocky. The number of mature plants has been observed to decline sharply as a result of drought. The total global population size estimate ranges from 50 to 200 mature individuals (Table 35). There are clearly separate subpopulations and the number of mature individuals range from 1 to 10 in each subpopulation. During the last 10 years these subpopulations have been observed to have slight changes in the total number of individuals, cover and density, due to the mentioned threats.

Table 35: Some facts about population characteristics of *Ballota kaiseri*

Population Information	Justification
Locations	2 locations- High Mountain Area, and Serbal Mountain Area
Current Population Trend	Decreasing
Number of mature individuals	50-200 - Estimated
Severely fragmented?	Yes - Specific microhabitat and Mountains makes as barriers between different very small subpopulations.
Continuing decline in mature individuals?	Yes - Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	10 - Estimated

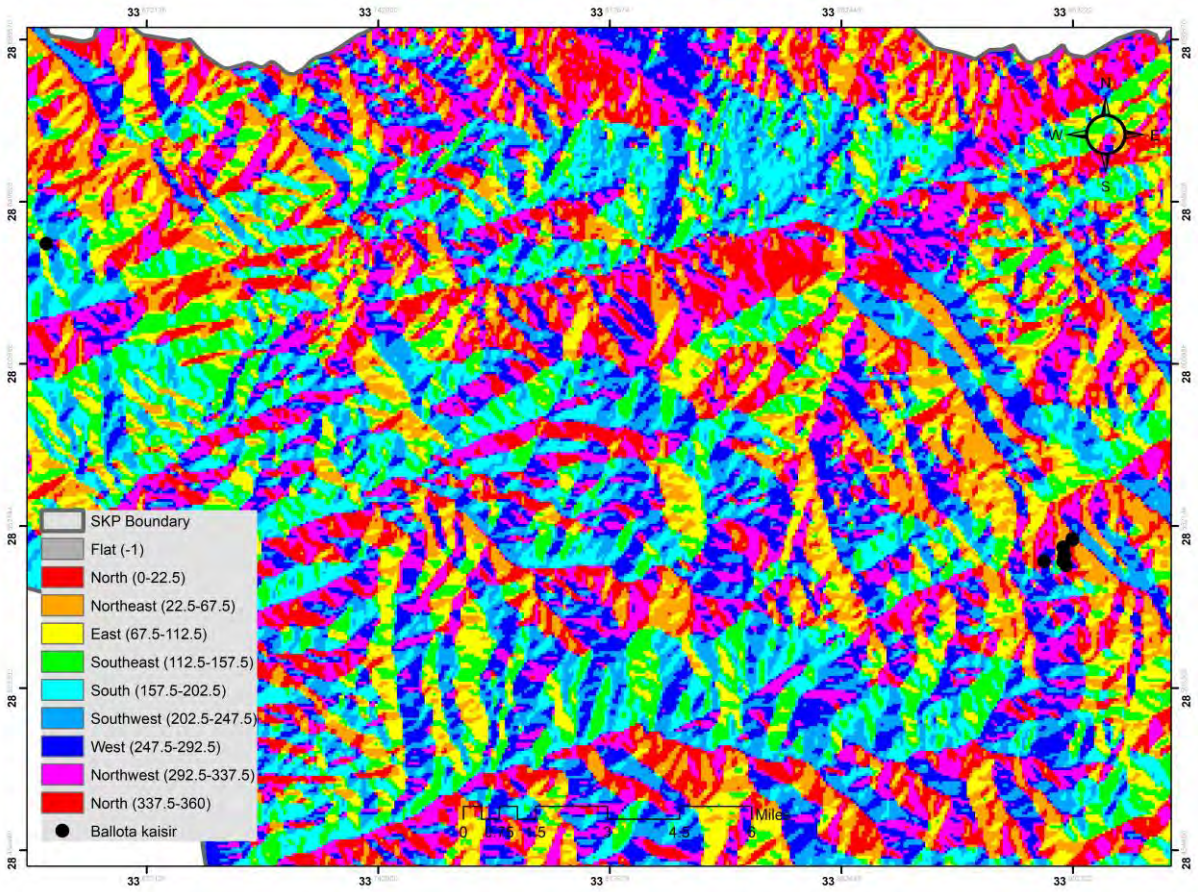
The population is considered severely fragmented as the requirement for a specific microhabitat and the mountains cause barriers between the very small subpopulations. The plant is distributed within two restricted areas and the effects of one threat will be felt by the two areas separately: thus the population is effectively in two clear locations. Wadi El-Arbaein, and Shak Abo-Hamman are the highest areas for species No. of individuals and cover of this species.



Map 21. Distribution of *Ballota kaiseri* inside St. Catherine Protected Area

HABITATS AND ECOLOGY:

Ballota kaiseri is a rare perennial herb endemic species restricted to crevices in outcrops of smooth-faced granite, to elongated gaps, and to narrow ravines in such rocky terrain. It has been observed that flowers appear in late spring and reproduction is by seed in late summer. It is restricted to montane wadis with rocky soil of mountain areas (Table 36), mostly in Wadi bed (38%) gorges (38%) terraces (15%) with steep slopes (Figure 18) of up to 90° on Northwest, Northwest, and West. It was found that the optimum elevation ranges for the growth of this species (based on species distribution) is from 1800 to 2000 m asl (Figures 19, 20).



Map 22. Slope Aspect map of *Ballota kaiseri* inside St. Catherine Protected Area

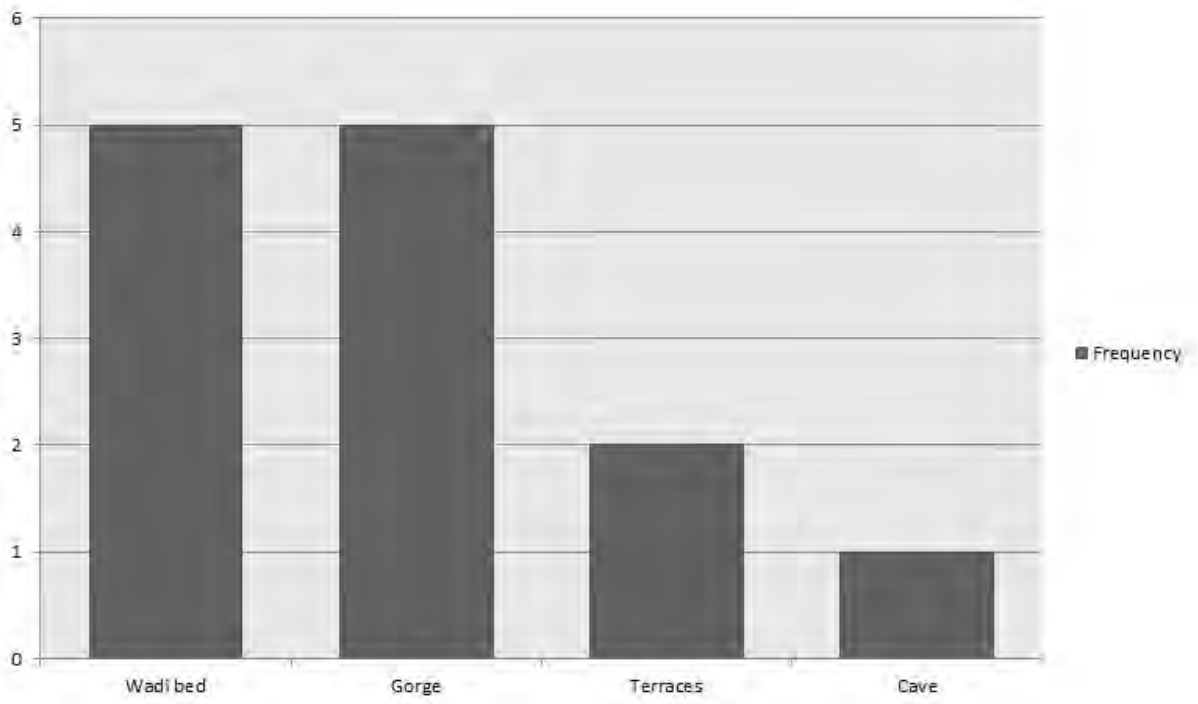


Figure 18 : Frequency of *Ballota kaiseri* among different micro-habitat in St. Catherine Protected Area

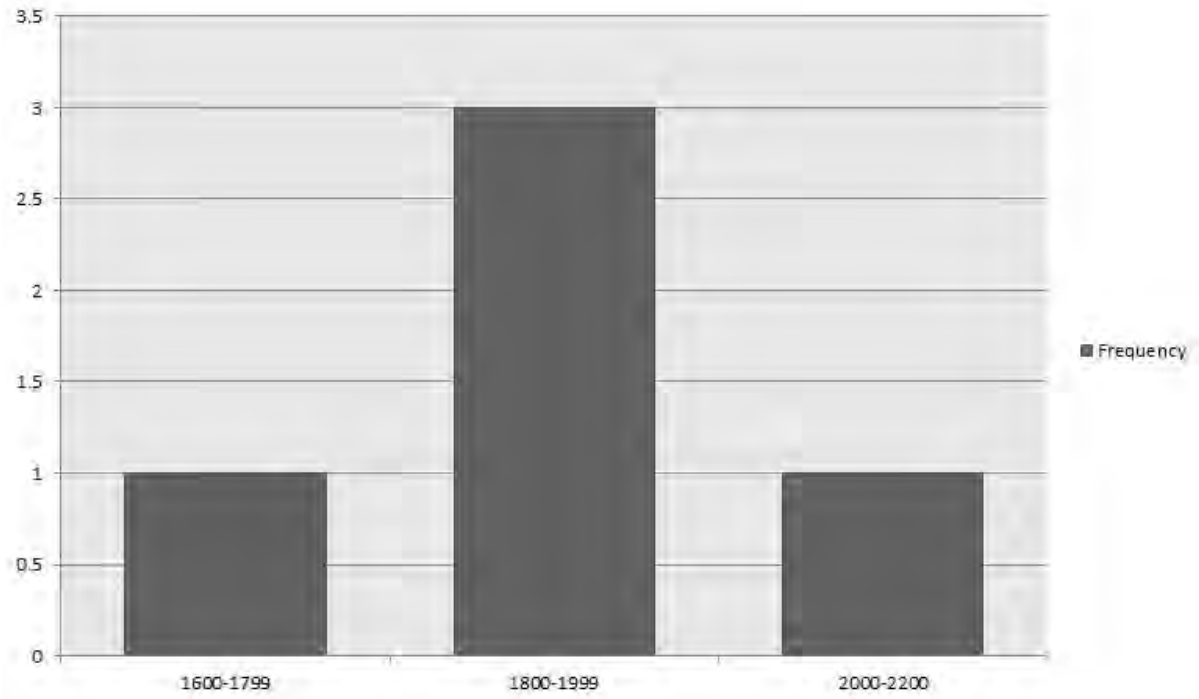


Figure 19 : Frequency of *Ballota kaiseri* among different altitude ranges in St. Catherine Protected Area

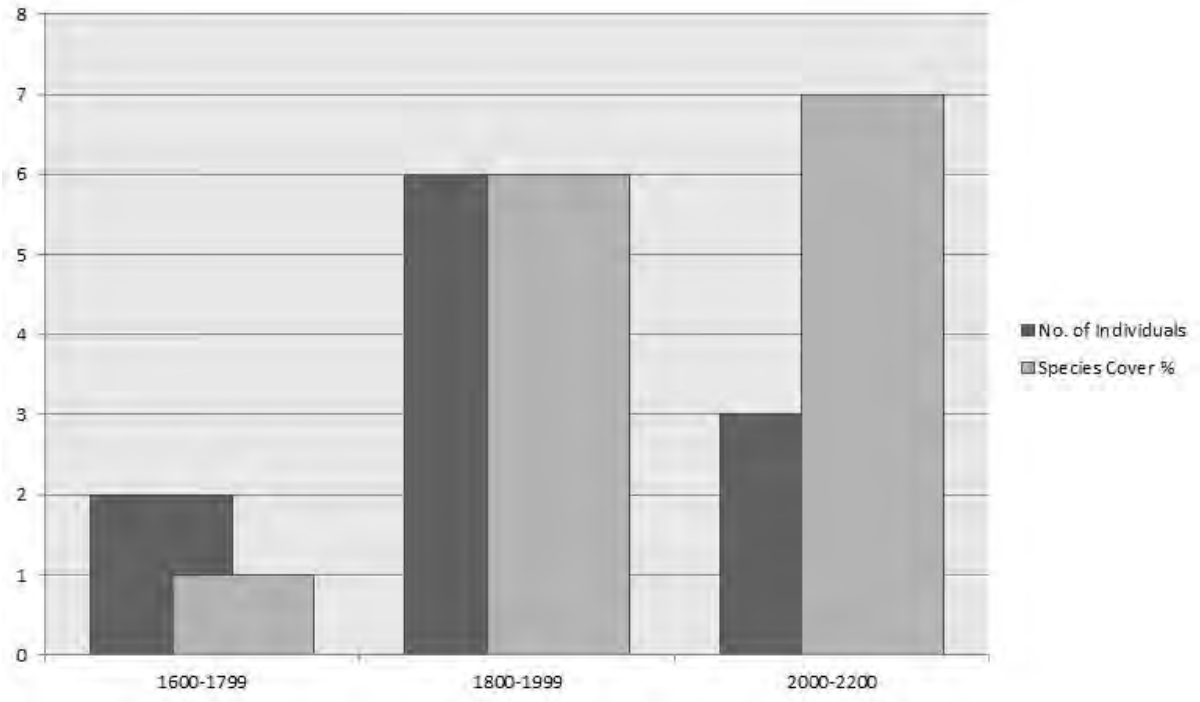


Figure 20. Relation between elevation and *Ballota kaiseri* density and cover%

The cold winter climate (minimum temperature can reach -10°C) and cool summers (maximum temperature of c. 29°C) of the high elevations of Mt. St. Catherine are the coolest on the peninsula (Omar *et al.* 2013). The arid climate has a mean annual rainfall of about 37.5 mm (between 1971-2015), some in the form of snow, but there is great inter-annual variation with up to 300 mm in any one year, usually between October and

May. Relative humidity is low, ranging from 10-35% (data for 2005-2015), and potential evaporation rates are very high, in excess of 20 mm/day during August.

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that soils of South Sinai are desert soils (Aridisols), in agreement with Kamh *et al.* (1989), Balba (1995), Moustafa and Zayed (1996), and Omar *et al.* (2013) that soils of the *Ballota kaiseri* distribution area are gravelly in wadis and plains, rocky at mountains in the surface, sandy to loamy sand in texture, alkaline and non-saline to slightly saline. It's characterized by low content of essential nutrients and cation exchange capacity (CEC).

It has been recorded that the most associated species for *Ballota kaiseri* are *Tanacetum sinaicum*, *Nepeta septemcrenata*, and *Origanum syriacum* L subsp. sinaicum.

Table 36: Habitat of *Ballota kaiseri* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6	Rocky areas (eg. inland cliffs, mountain peaks)	(Not Specified)	Suitable	Yes
7.1.	Caves and Subterranean Habitats (non-aquatic) - Caves	Resident	Suitable	Yes
8.2	Desert -> Desert - Temperate	(Not Specified)	Suitable	Yes

Continuing decline in area, extent and/or quality of habitat? Yes – Observed
System: Terrestrial

TRADE AND USE:

Ballota species are used as food plants by the larvae of some Lepidoptera. *Ballota* species have been used in Turkish folk medicine as antiulcer, antispasmodic, diuretic, choleretic, antihaemorrhoidal, and sedative agent

THREATS:

The vegetation within this species distribution area has been subjected to extreme drought (Mosallam 2007, Khafagi *et al.* 2012). Due to climate change, the wild population of this species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (2% loss observed). Water is being relocated in some localities from elevated wadis which are rich in water to supply to low wadis. This activity leads to consumption of water from wells and results in habitat deterioration and declines in population size (Table 37).

In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (dams and unmanaged human construction). All these factors are pushing *Ballota kaiseri* to the brink of extinction.

Table 37: Threats on *Ballota kaiseri* based on IUCN Threats Classification Scheme

Code	Threat	Timing	Scope	Severity	Impact Score
6.3.	Human intrusions & disturbance -> Work & other activities	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
7.2.5.	Natural system modifications -> Dams & water management/use -> Abstraction of ground water (domestic use)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
11.2.	Climate change & severe weather -> Droughts	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.3.	Climate change & severe weather -> Temperature extremes	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.4.	Climate change & severe weather -> Storms & flooding	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9

CONSERVATION ACTIONS:

The global distribution of *Ballota kaiseri* is distributed only inside the St. Catherine Protected Area (SCPA). On average 20 checks are made every year to keep a watch on the current situation for the plant and its habitat, and to record any detrimental activities (Table 38). No individuals are protected by enclosures inside SCPA.

Table 38: Conservation Actions In-Place for *Ballota kaiseri* inside the St. Catherine Protected Area

No.	Conservation Actions In-Place	Justification
1	Occur in at least one PA	Yes
2	Percentage of population protected by PA (0-100)	90-100%
3	In-situ Conservation	No
4	Ex-situ Conservation	No
5	Monitoring	Partly Yes

The team record information about the geographical distribution, population characteristics, threats, and habitat. Much more is needed, however (Tables 39, 40).

Table 39: Important Conservation Actions Needed for *Ballota kaiseri*

Code	Conservation Actions	Specific Conservation Actions
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
2.3.	Land/water management	Habitat & natural process restoration
3.1.3.	Species management	Species management -> Limiting population growth
3.2.	Species management	Species recovery
3.4.1.	Species management	Ex-situ conservation -> Captive breeding/artificial propagation
3.4.2.	Species management	Ex-situ conservation -> Genome resource bank
4.2.	Education & awareness	Training
4.3.	Education & awareness	Awareness & communications
5.1.2.	Law & policy	Legislation -> National level
5.4.1.	Law & policy	Compliance and enforcement -> International level

Table 40: Important Research Needed for *Ballota kaiseri*

Code	Research Needed	Specification
1.2.	Research	Population size, distribution & trends
1.3.	Research	Life history & ecology
1.4.	Research	Harvest, use & livelihoods
1.5.	Research	Threats
2.1.	Conservation Planning	Species Action/Recovery Plan
2.2.	Conservation Planning	Area-based Management Plan
3.1.	Monitoring	Population trends
3.4.	Monitoring	Habitat trends

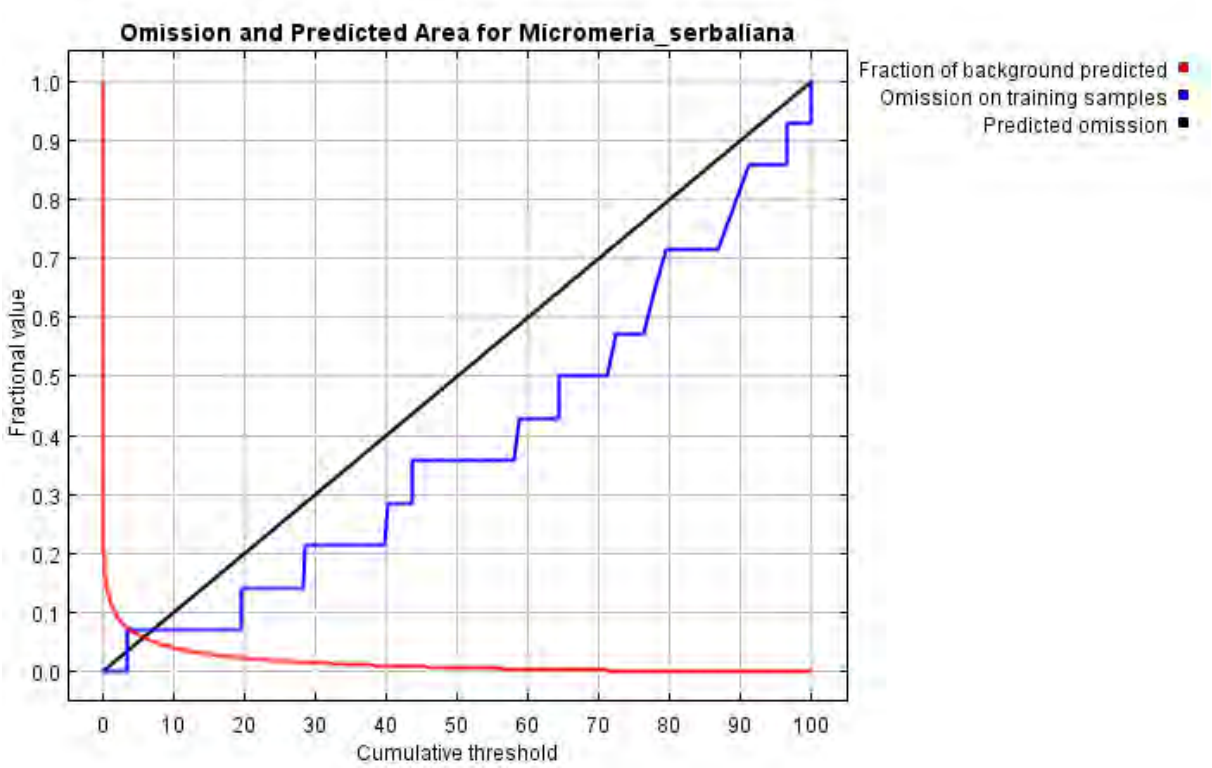
IUCN RED LIST ASSESSMENT RATIONALE:

Ballota kaiseri qualifies as Critically Endangered because it is endemic to a tiny area in Egypt, with an extent of occurrence (EOO) of 15.8 km^2 and an area of occupancy (AOO) of 12 km^2. It occurs in the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations (based on climate change as the most serious plausible threat). There is a continuing decline in habitat quality for this species, with evidence of decline in the number of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

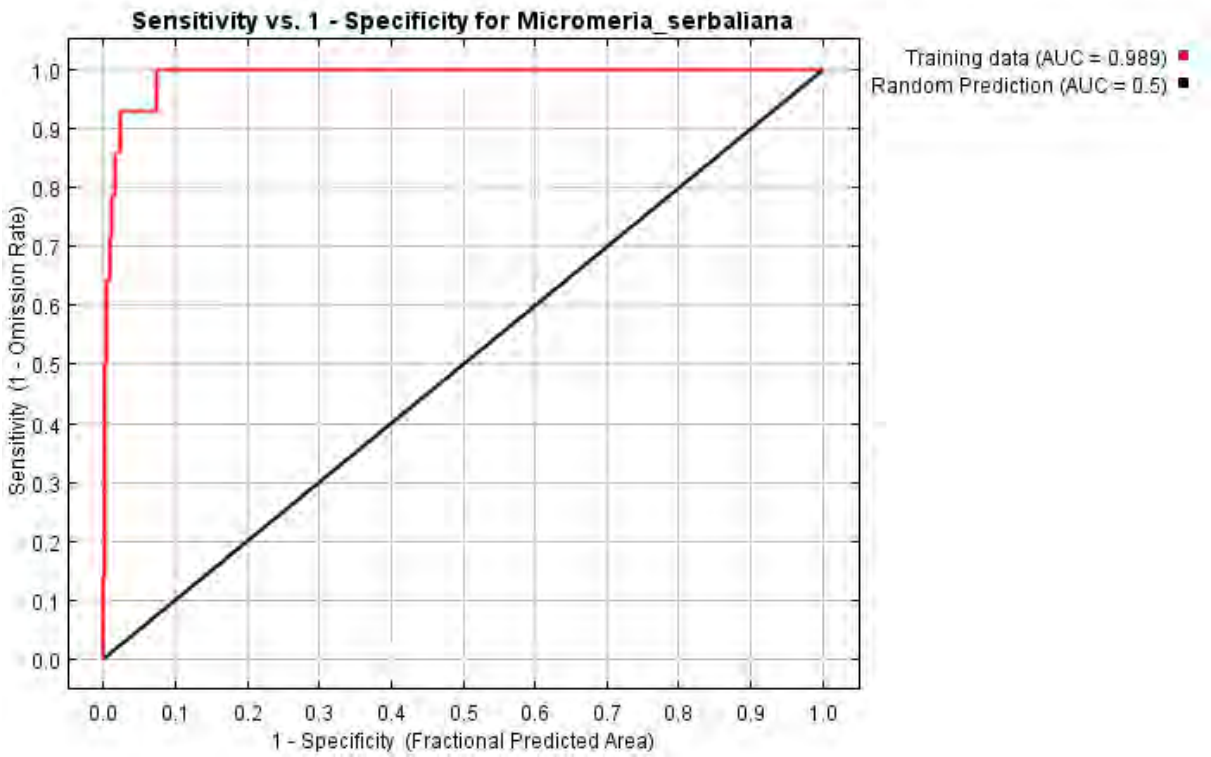
Maxent model for Micromeria serbaliana

Analysis of omission/commission

The following picture shows the omission rate and predicted area as a function of the cumulative threshold. The omission rate is calculated both on the training presence records, and (if test data are used) on the test records. The omission rate should be close to the predicted omission, because of the definition of the cumulative threshold.



The next picture is the receiver operating characteristic (ROC) curve for the same data. Note that the specificity is defined using predicted area, rather than true commission (see the paper by Phillips, Anderson and Schapire cited on the help page for discussion of what this means). This implies that the maximum achievable AUC is less than 1. If test data is drawn from the Maxent distribution itself, then the maximum possible test AUC would be 0.982 rather than 1; in practice the test AUC may exceed this bound.



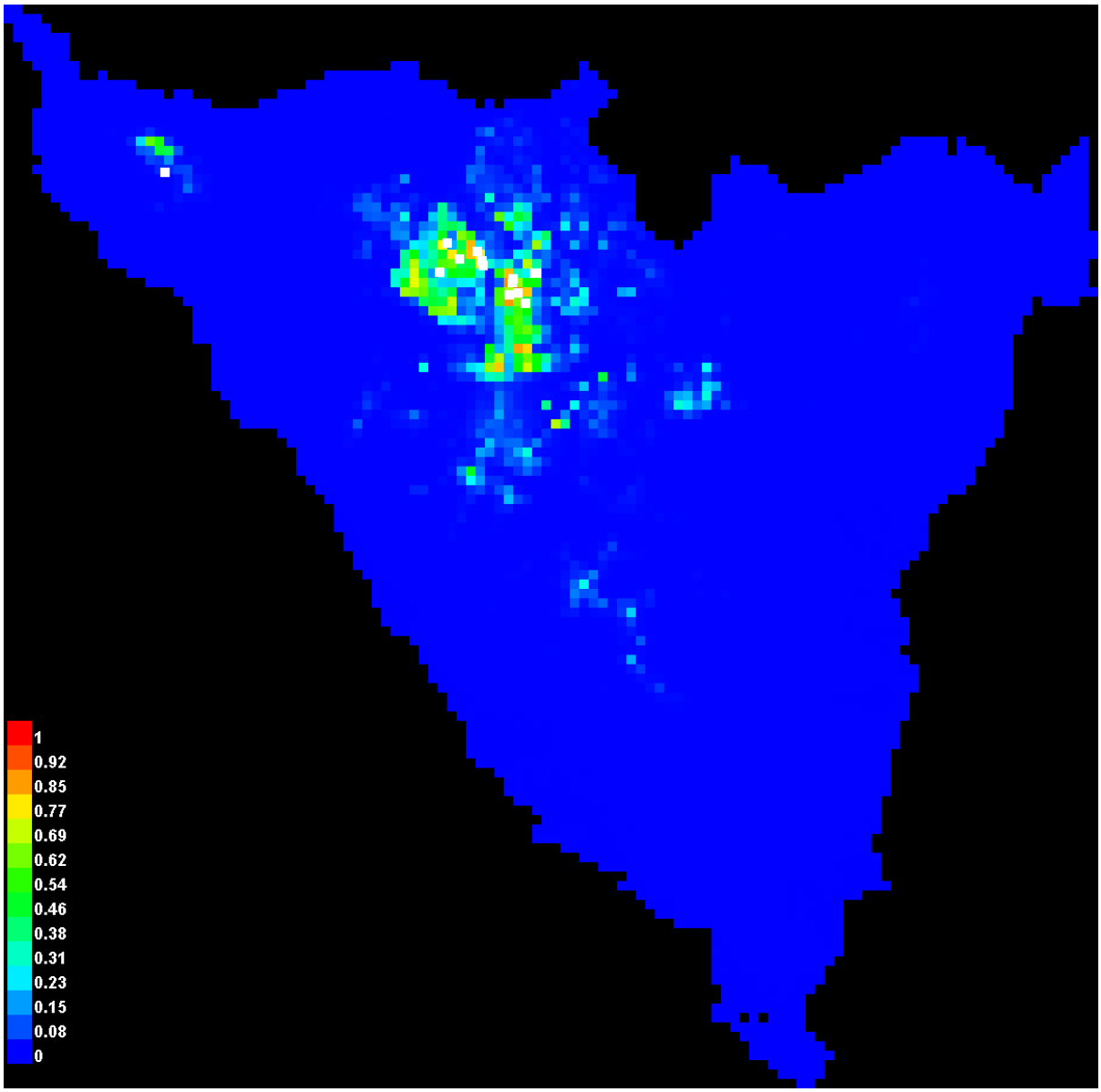
Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that test points are predicted no better than by a random prediction with the same fractional predicted area. The "Balance" threshold minimizes 6 * training omission rate + .04 * cumulative threshold + 1.6 * fractional predicted area.

Cumulative threshold	Logistic threshold	Description	Fractional predicted area	Training omission rate
1.000	0.009	Fixed cumulative value 1	0.120	0.000
5.000	0.056	Fixed cumulative value 5	0.062	0.071
10.000	0.111	Fixed cumulative value 10	0.041	0.071
3.446	0.037	Minimum training presence	0.074	0.000
19.546	0.241	10 percentile training presence	0.024	0.071
3.795	0.042	Equal training sensitivity and specificity	0.071	0.071
3.446	0.037	Maximum training sensitivity plus specificity	0.074	0.000
1.538	0.015	Balance training omission, predicted area and threshold value	0.103	0.000
11.259	0.129	Equate entropy of thresholded and original distributions	0.037	0.071

Pictures of the model

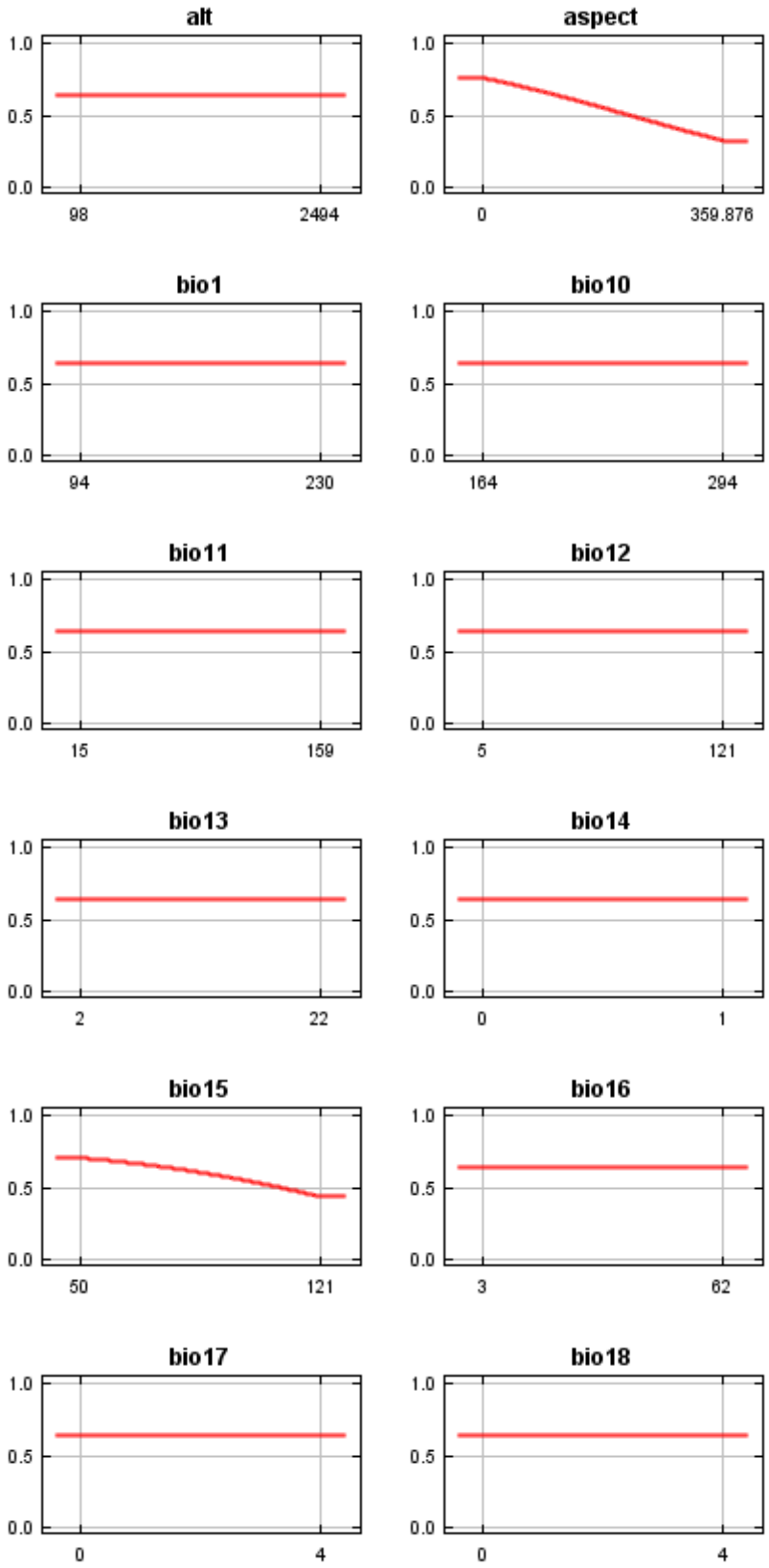
This is a representation of the Maxent model for Micromeria_serbaliana. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size

version.



Response curves

These curves show how each environmental variable affects the Maxent prediction. The curves show how the logistic prediction changes as each environmental variable is varied, keeping all other environmental variables at their average sample value. Click on a response curve to see a larger version. Note that the curves can be hard to interpret if you have strongly correlated variables, as the model may depend on the correlations in ways that are not evident in the curves. In other words, the curves show the marginal effect of changing exactly one variable, whereas the model may take advantage of sets of variables changing together.


alt
1.0
0.5
0.0
98
2494
aspect
1.0
0.5
0.0
0
359.876
bio1
1.0
0.5
0.0
94
230
bio10
1.0
0.5
0.0
164
294
bio11
1.0
0.5
0.0
15
159
bio12
1.0
0.5
0.0
5
121
bio13
1.0
0.5
0.0
2
22
bio14
1.0
0.5
0.0
0
1
bio15
1.0
0.5
0.0
50
121
bio16
1.0
0.5
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bio18
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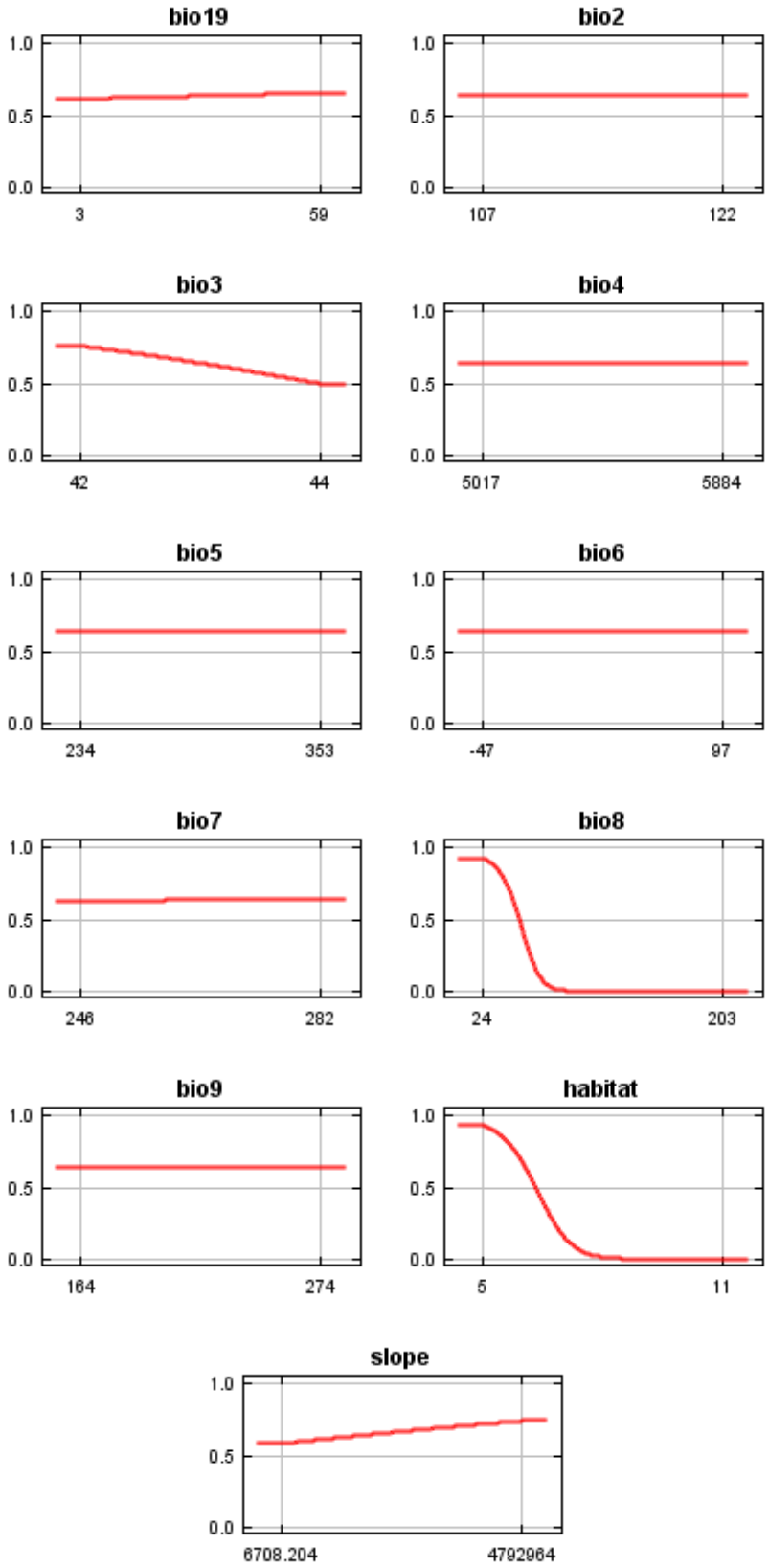
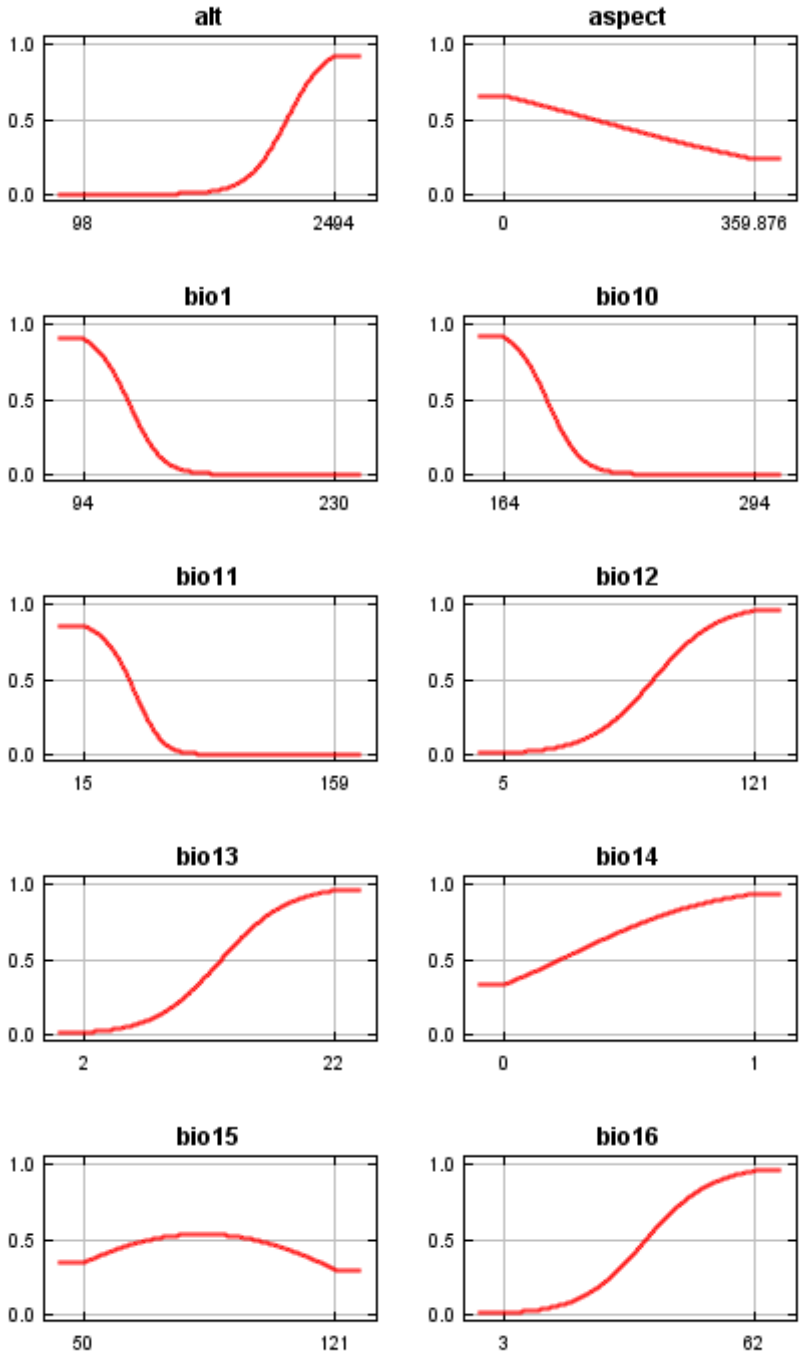
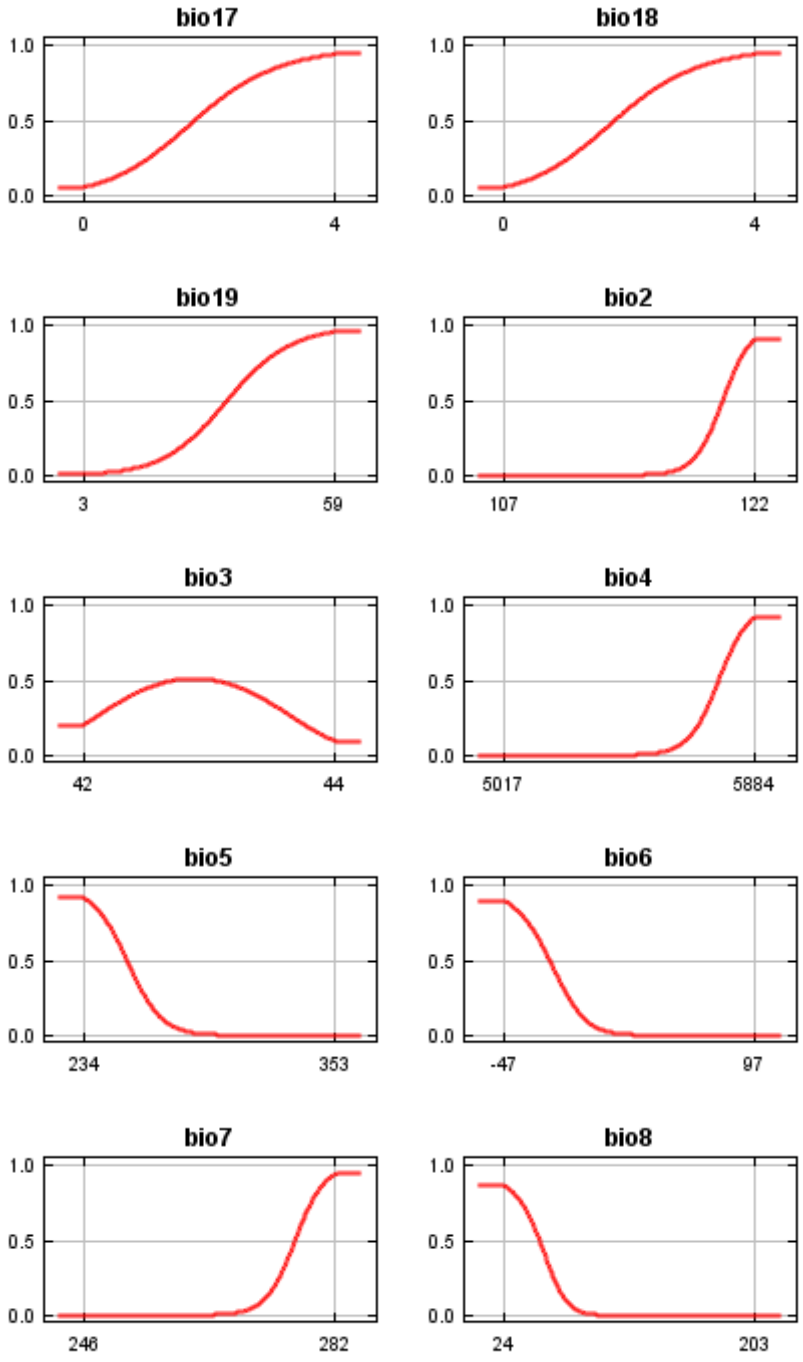
0.0
0
4



In contrast to the above marginal response curves, each of the following curves represents a different model, namely, a Maxent model created using only the

corresponding variable. These plots reflect the dependence of predicted suitability both on the selected variable and on dependencies induced by correlations between the selected variable and other variables. They may be easier to interpret if there are strong correlations between variables.




bio17
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0.5
0.0
0
4
bio18
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0.5
0.0
0
4
bio19
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0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
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bio7
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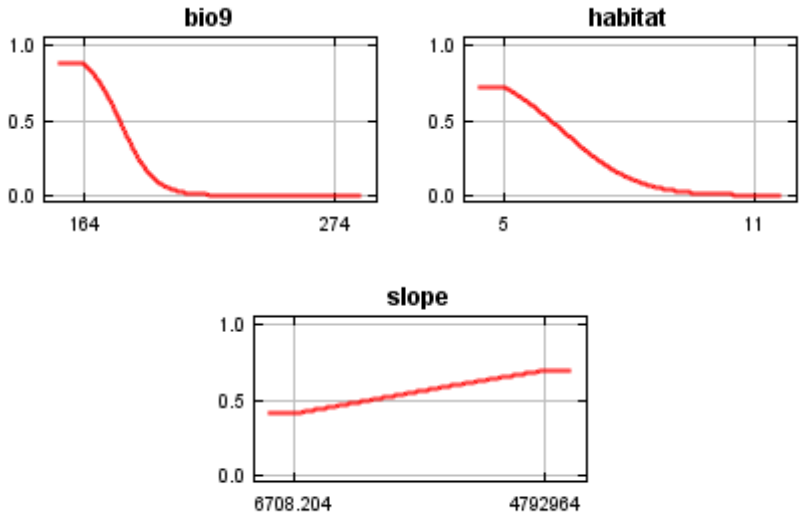
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203

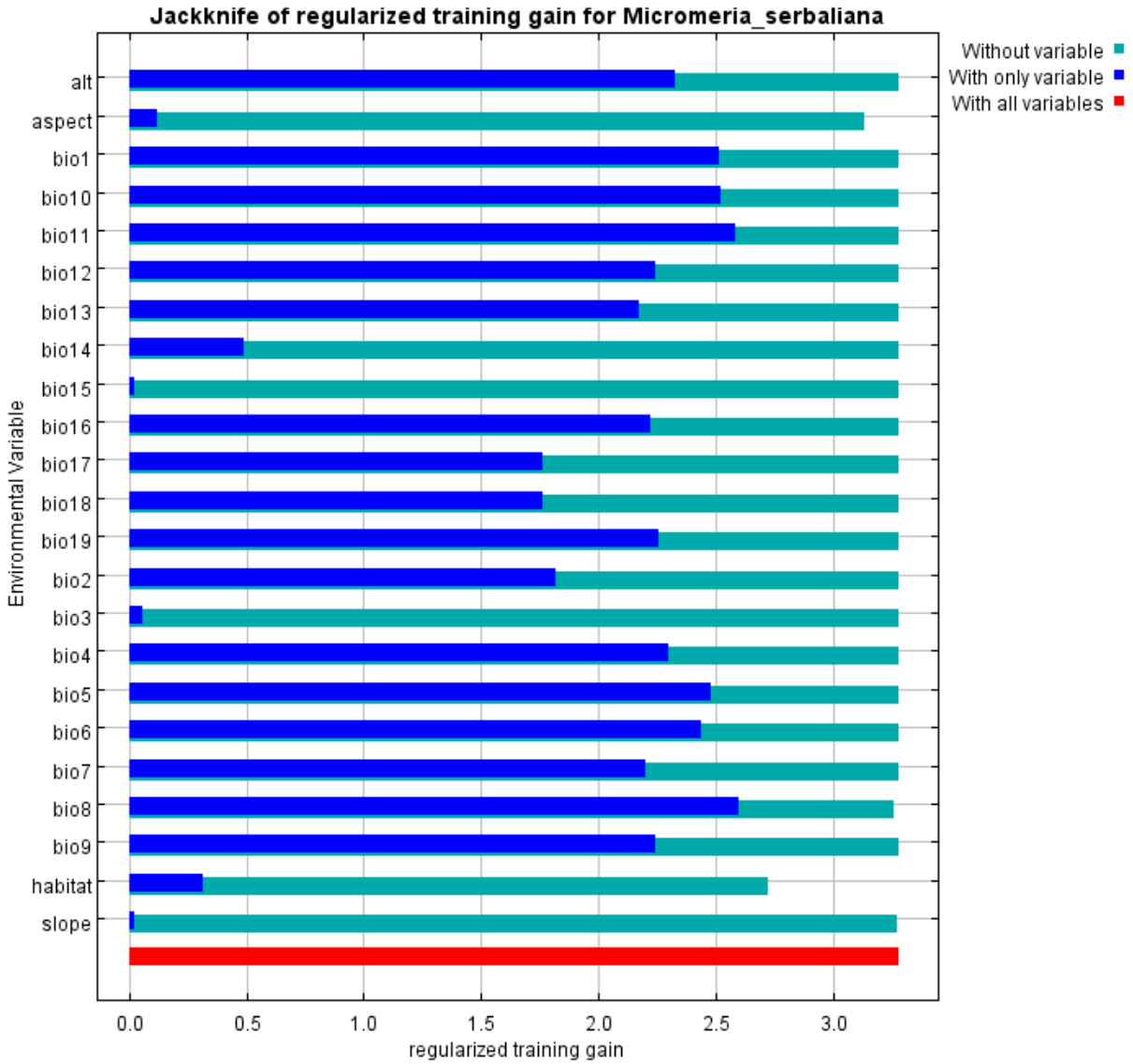


Analysis of variable contributions

The following table gives a heuristic estimate of relative contributions of the environmental variables to the Maxent model. To determine the estimate, in each iteration of the training algorithm, the increase in regularized gain is added to the contribution of the corresponding variable, or subtracted from it if the change to the absolute value of lambda is negative. As with the jackknife, variable contributions should be interpreted with caution when the predictor variables are correlated.

Variable	Percent contribution
bio17	35.3
habitat	20.1
bio11	12.4
bio16	8.6
bio1	8
aspect	3.8
bio18	2.7
bio19	2.1
bio10	1.9
alt	1.8
bio8	1.5
bio9	0.7
bio14	0.6
slope	0.3
bio3	0
bio15	0
bio7	0
bio4	0
bio5	0
bio6	0
bio13	0
bio12	0
bio2	0

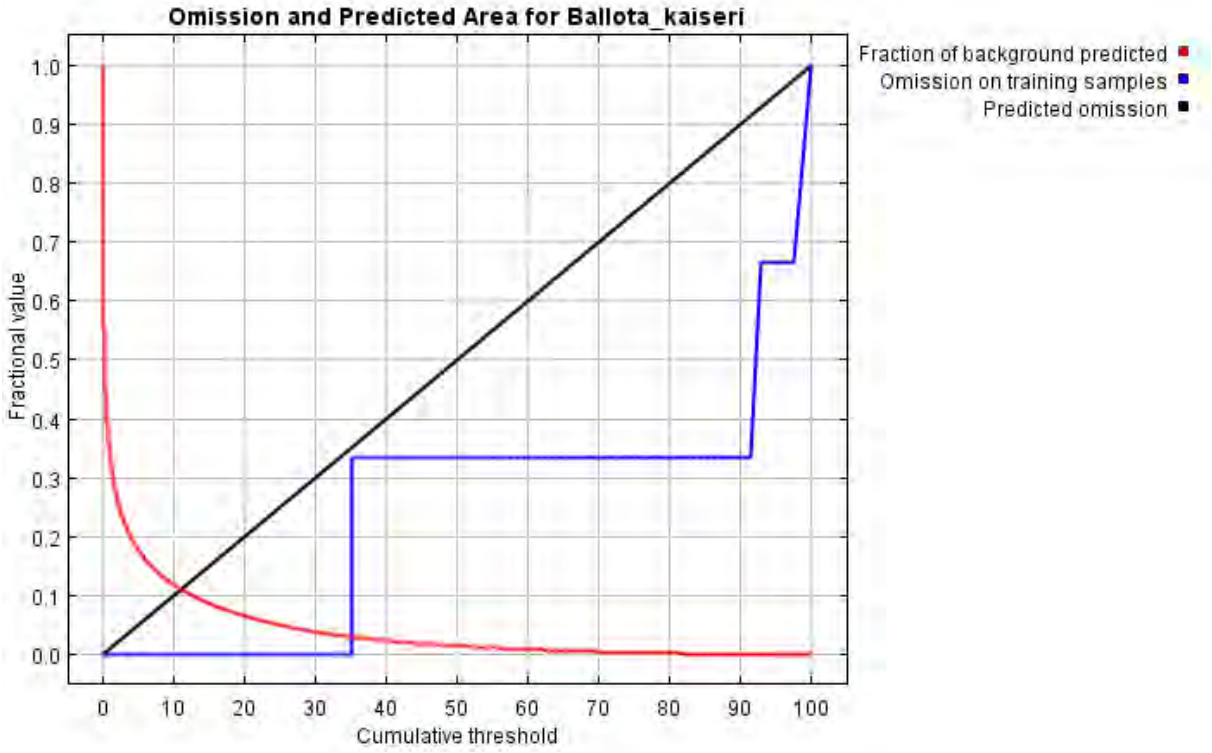
The following picture shows the results of the jackknife test of variable importance. The environmental variable with highest gain when used in isolation is bio8, which therefore appears to have the most useful information by itself. The environmental variable that decreases the gain the most when it is omitted is habitat, which therefore appears to have the most information that isn't present in the other variables.



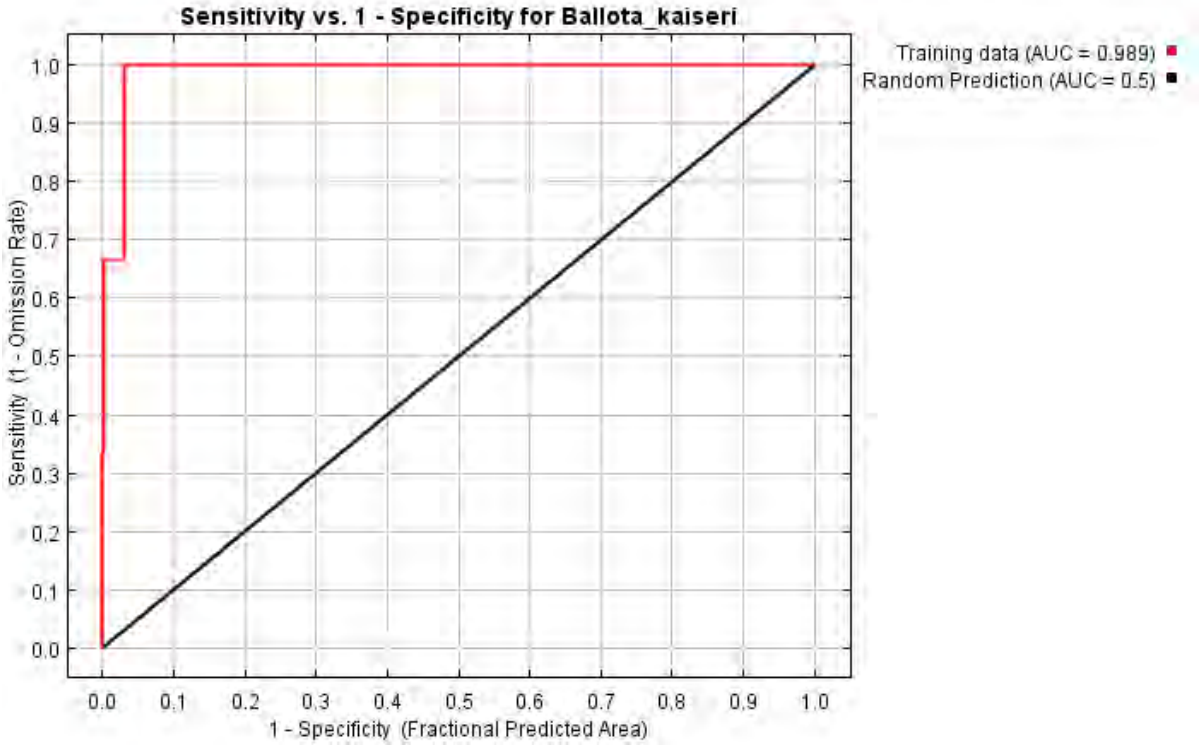
Maxent model for Ballota kaiseri

Analysis of omission/commission

The following picture shows the omission rate and predicted area as a function of the cumulative threshold. The omission rate is is calculated both on the training presence records, and (if test data are used) on the test records. The omission rate should be close to the predicted omission, because of the definition of the cumulative threshold.



The next picture is the receiver operating characteristic (ROC) curve for the same data. Note that the specificity is defined using predicted area, rather than true commission (see the paper by Phillips, Anderson and Schapire cited on the help page for discussion of what this means). This implies that the maximum achievable AUC is less than 1. If test data is drawn from the Maxent distribution itself, then the maximum possible test AUC would be 0.953 rather than 1; in practice the test AUC may exceed this bound.

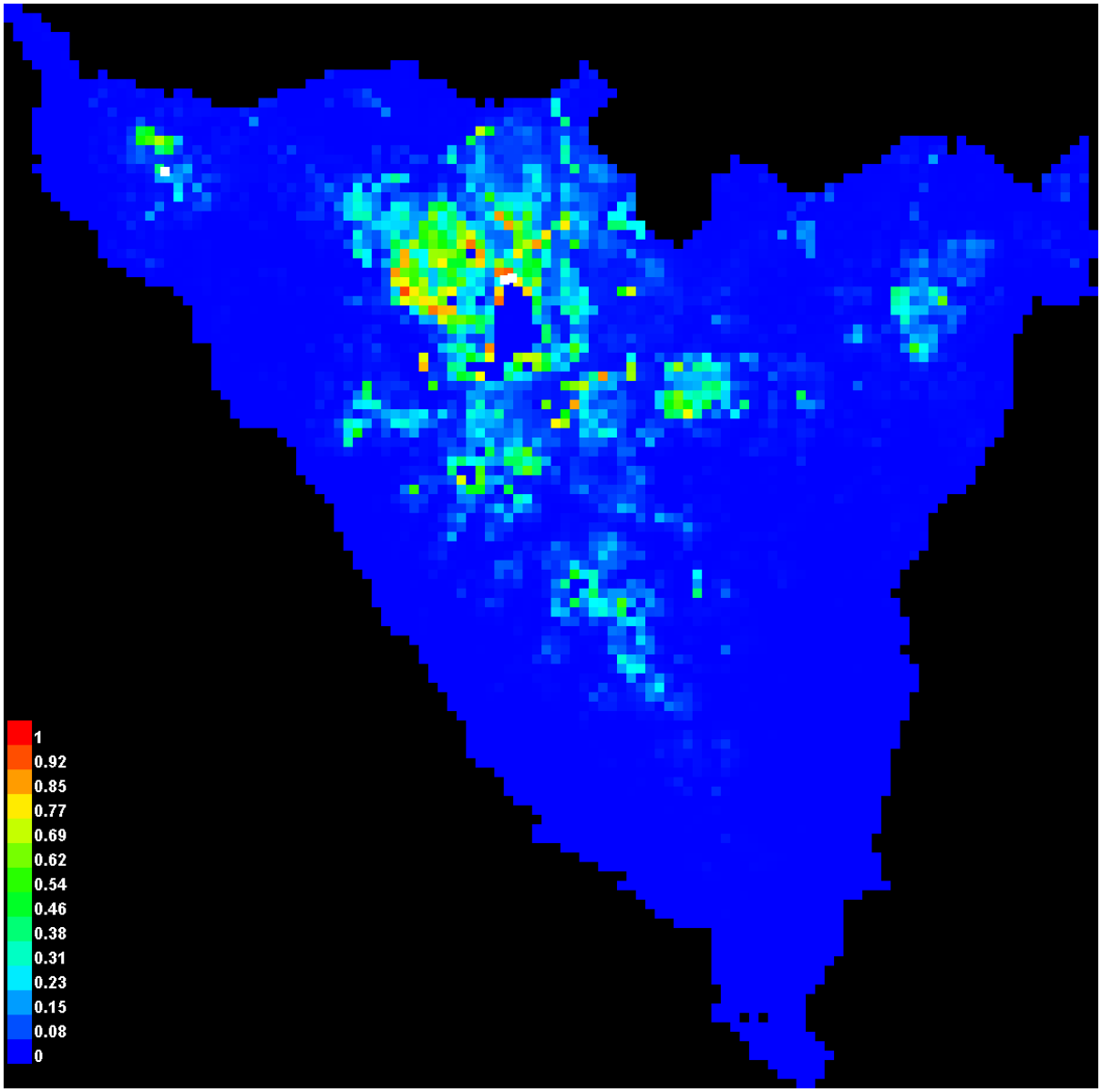


Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that test points are predicted no better than by a random prediction with the same fractional predicted area. The "Balance" threshold minimizes 6 * training omission rate + .04 * cumulative threshold + 1.6 * fractional predicted area.

Cumulative threshold	Logistic threshold	Description	Fractional predicted area	Training omission rate
1.000	0.009	Fixed cumulative value 1	0.338	0.000
5.000	0.049	Fixed cumulative value 5	0.178	0.000
10.000	0.102	Fixed cumulative value 10	0.119	0.000
35.192	0.388	Minimum training presence	0.031	0.000
35.192	0.388	10 percentile training presence	0.031	0.000
35.192	0.388	Equal training sensitivity and specificity	0.031	0.000
35.192	0.388	Maximum training sensitivity plus specificity	0.031	0.000
3.738	0.036	Balance training omission, predicted area and threshold value	0.204	0.000
13.997	0.147	Equate entropy of thresholded and original distributions	0.093	0.000

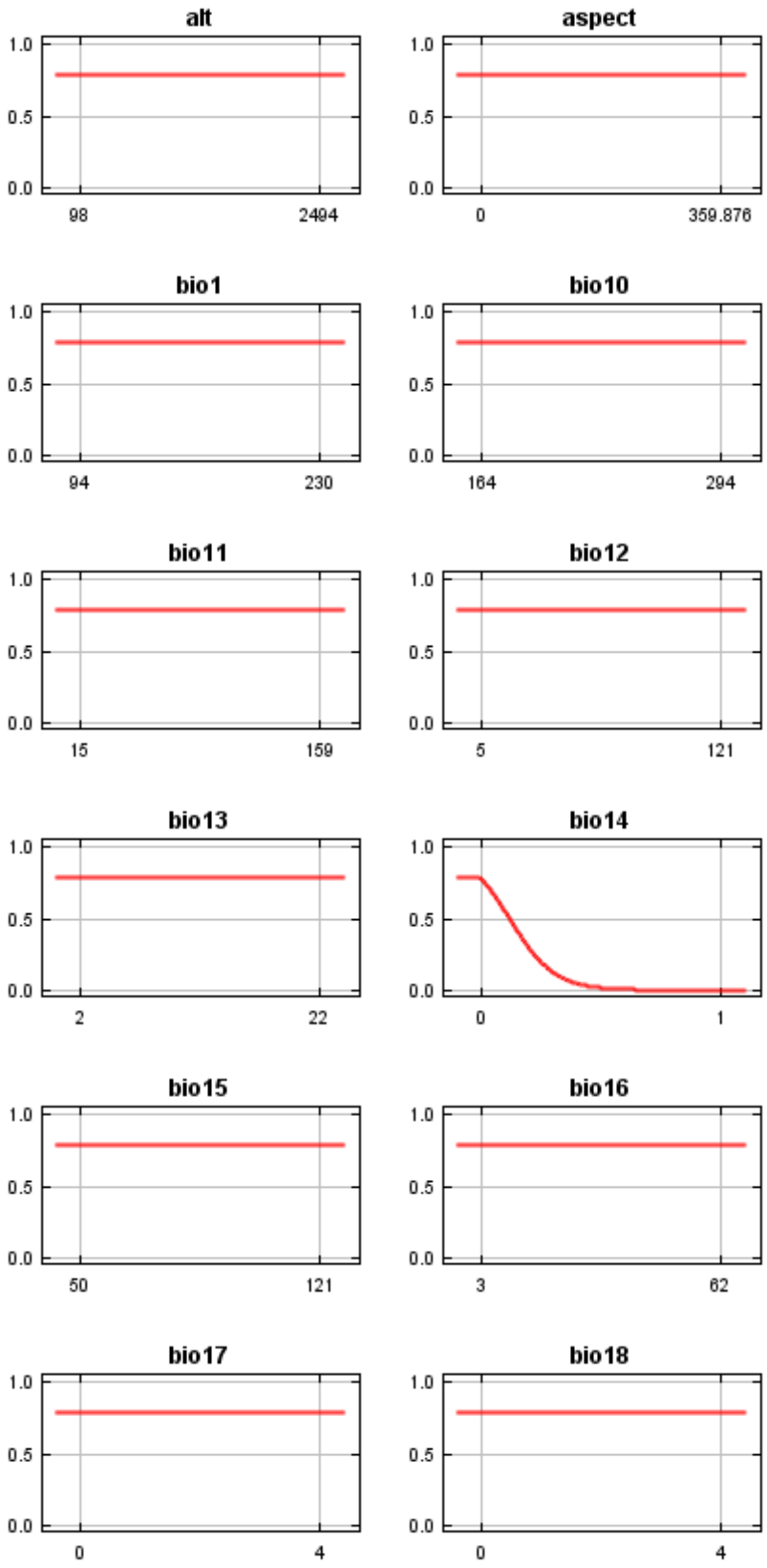
Pictures of the model

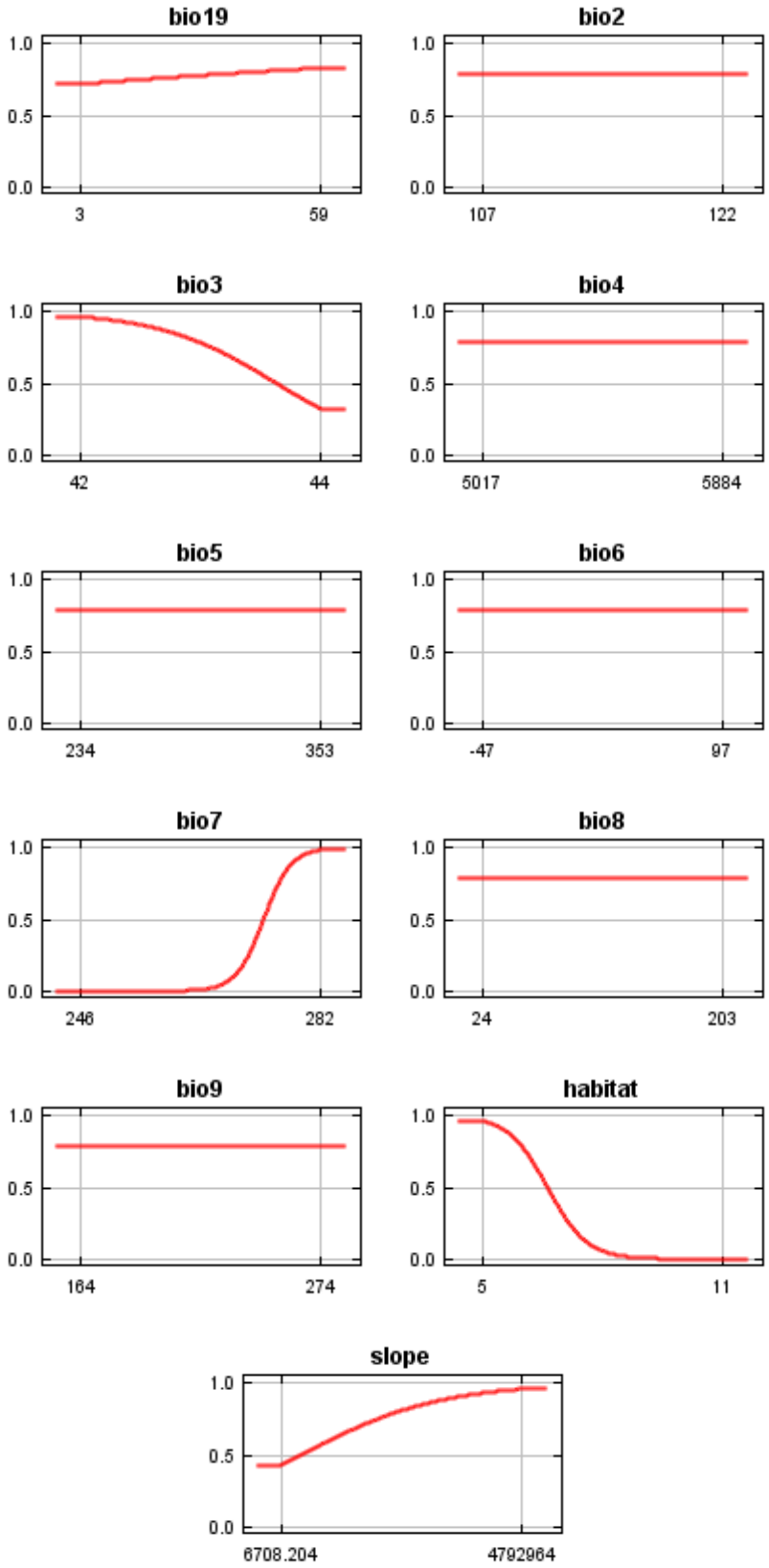
This is a representation of the Maxent model for Ballota_kaiseri. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size version.



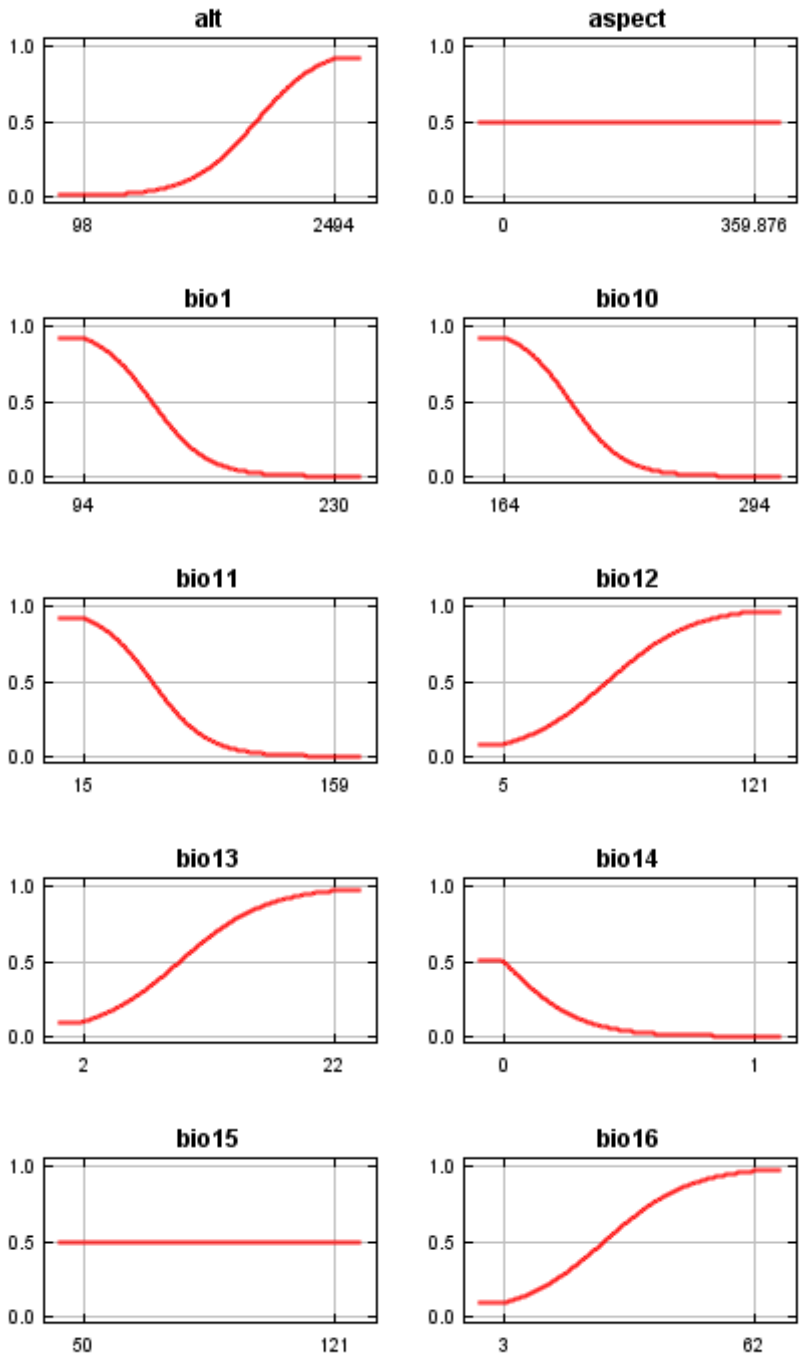
Response curves

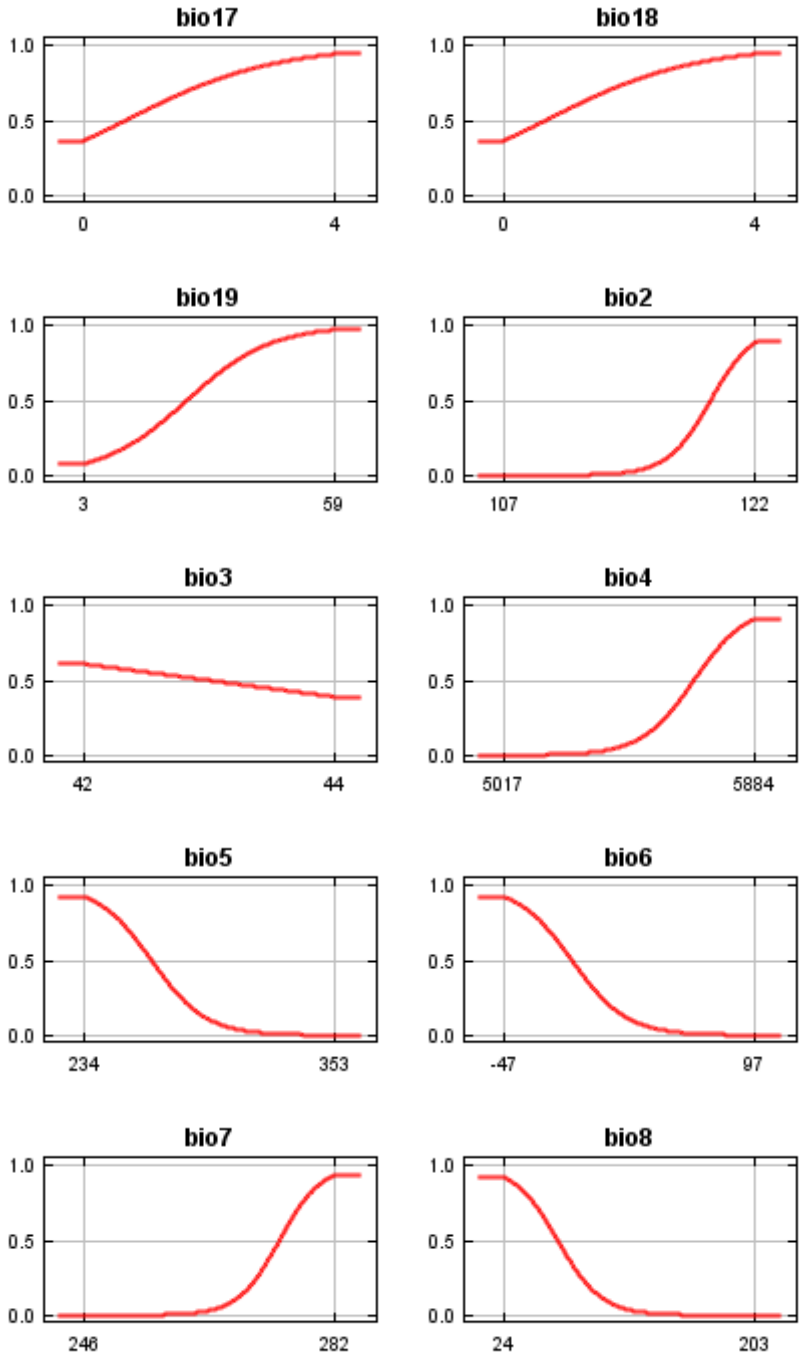
These curves show how each environmental variable affects the Maxent prediction. The curves show how the logistic prediction changes as each environmental variable is varied, keeping all other environmental variables at their average sample value. Click on a response curve to see a larger version. Note that the curves can be hard to interpret if you have strongly correlated variables, as the model may depend on the correlations in ways that are not evident in the curves. In other words, the curves show the marginal effect of changing exactly one variable, whereas the model may take advantage of sets of variables changing together.

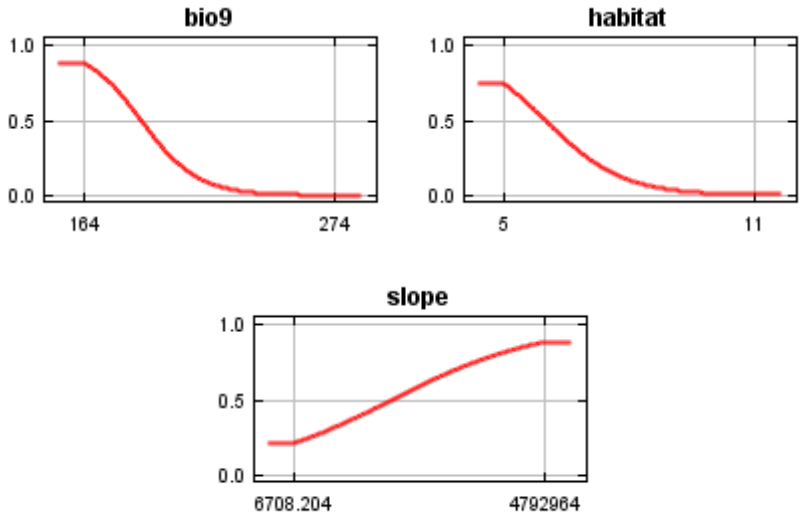

alt
1.0
0.5
0.0
98
2494
aspect
1.0
0.5
0.0
0
359.876
bio1
1.0
0.5
0.0
94
230
bio10
1.0
0.5
0.0
164
294
bio11
1.0
0.5
0.0
15
159
bio12
1.0
0.5
0.0
5
121
bio13
1.0
0.5
0.0
2
22
bio14
1.0
0.5
0.0
0
1
bio15
1.0
0.5
0.0
50
121
bio16
1.0
0.5
0.0
3
62
bio17
1.0
0.5
0.0
0
4
bio18
1.0
0.5
0.0
0
4


bio19
1.0
0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
1.0
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203
bio9
1.0
0.5
0.0
164
274
habitat
1.0
0.5
0.0
5
11
slope
1.0
0.5
0.0
6708.204
4792964

In contrast to the above marginal response curves, each of the following curves represents a different model, namely, a Maxent model created using only the corresponding variable. These plots reflect the dependence of predicted suitability both on the selected variable and on dependencies induced by correlations between the selected variable and other variables. They may be easier to interpret if there are strong correlations between variables.




bio17
1.0
0.5
0.0
0
4
bio18
1.0
0.5
0.0
0
4
bio19
1.0
0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
1.0
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203

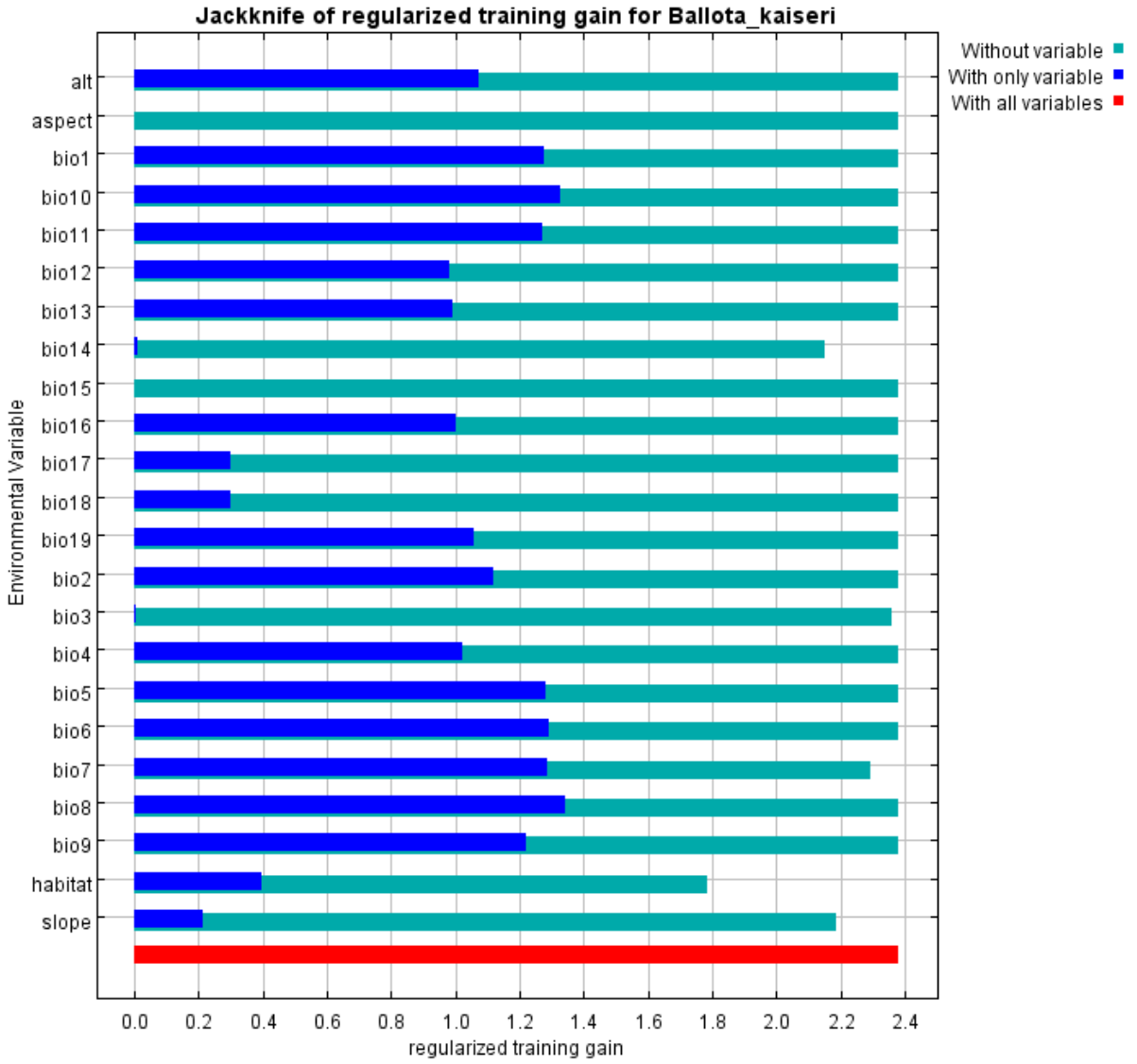


Analysis of variable contributions

The following table gives a heuristic estimate of relative contributions of the environmental variables to the Maxent model. To determine the estimate, in each iteration of the training algorithm, the increase in regularized gain is added to the contribution of the corresponding variable, or subtracted from it if the change to the absolute value of lambda is negative. As with the jackknife, variable contributions should be interpreted with caution when the predictor variables are correlated.

Variable	Percent contribution
habitat	25.1
bio13	23.8
bio6	9
bio10	8.5
bio19	8.3
bio14	6.5
bio7	6.5
slope	6.4
alt	1.6
bio3	1.5
bio9	1.5
bio11	1.3
bio17	0
bio16	0
bio15	0
bio5	0
bio8	0
bio12	0
bio1	0
aspect	0
bio2	0
bio4	0
bio18	0

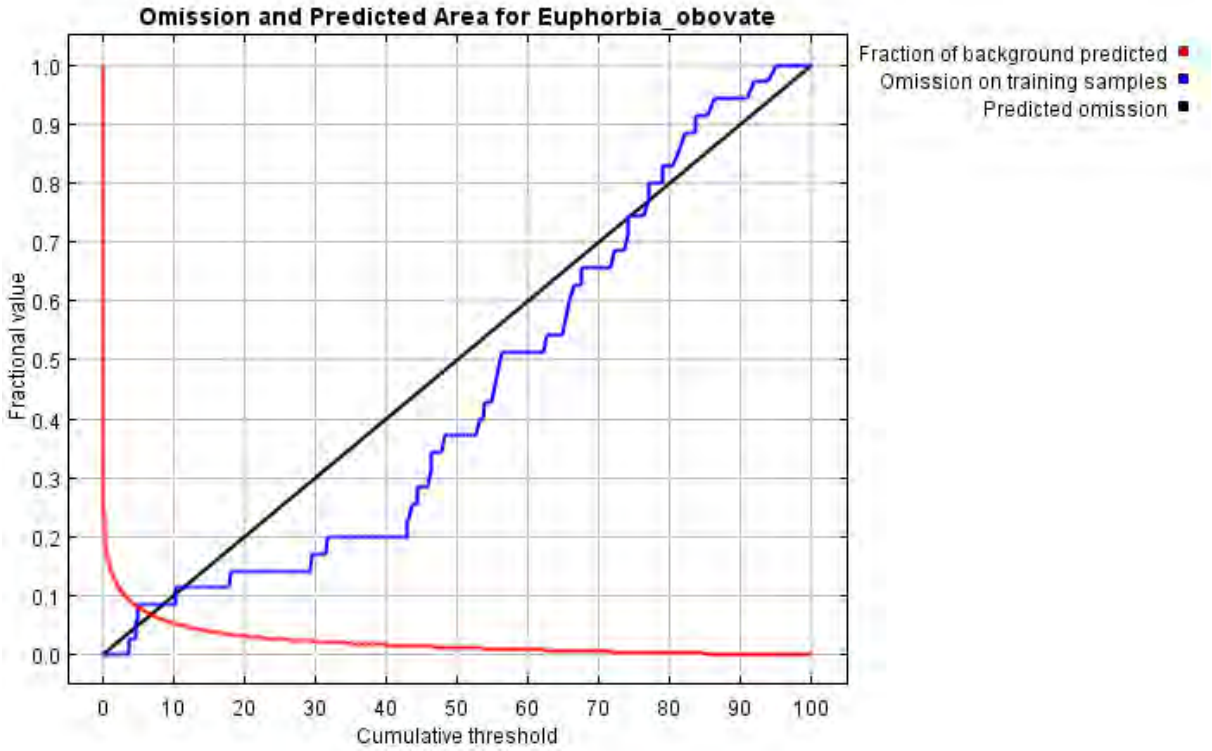
The following picture shows the results of the jackknife test of variable importance. The environmental variable with highest gain when used in isolation is bio8, which therefore appears to have the most useful information by itself. The environmental variable that decreases the gain the most when it is omitted is habitat, which therefore appears to have the most information that isn't present in the other variables.



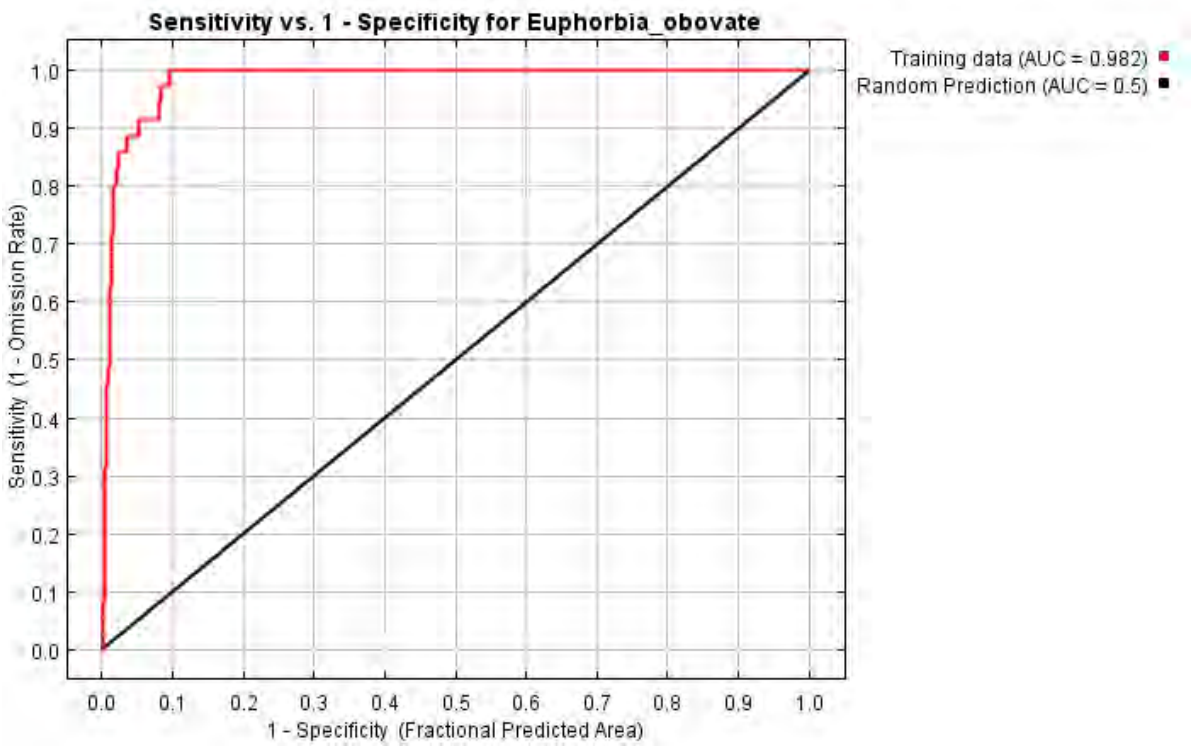
Maxent model for Euphorbia obovata

Analysis of omission/commission

The following picture shows the omission rate and predicted area as a function of the cumulative threshold. The omission rate is is calculated both on the training presence records, and (if test data are used) on the test records. The omission rate should be close to the predicted omission, because of the definition of the cumulative threshold.



The next picture is the receiver operating characteristic (ROC) curve for the same data. Note that the specificity is defined using predicted area, rather than true commission (see the paper by Phillips, Anderson and Schapire cited on the help page for discussion of what this means). This implies that the maximum achievable AUC is less than 1. If test data is drawn from the Maxent distribution itself, then the maximum possible test AUC would be 0.976 rather than 1; in practice the test AUC may exceed this bound.

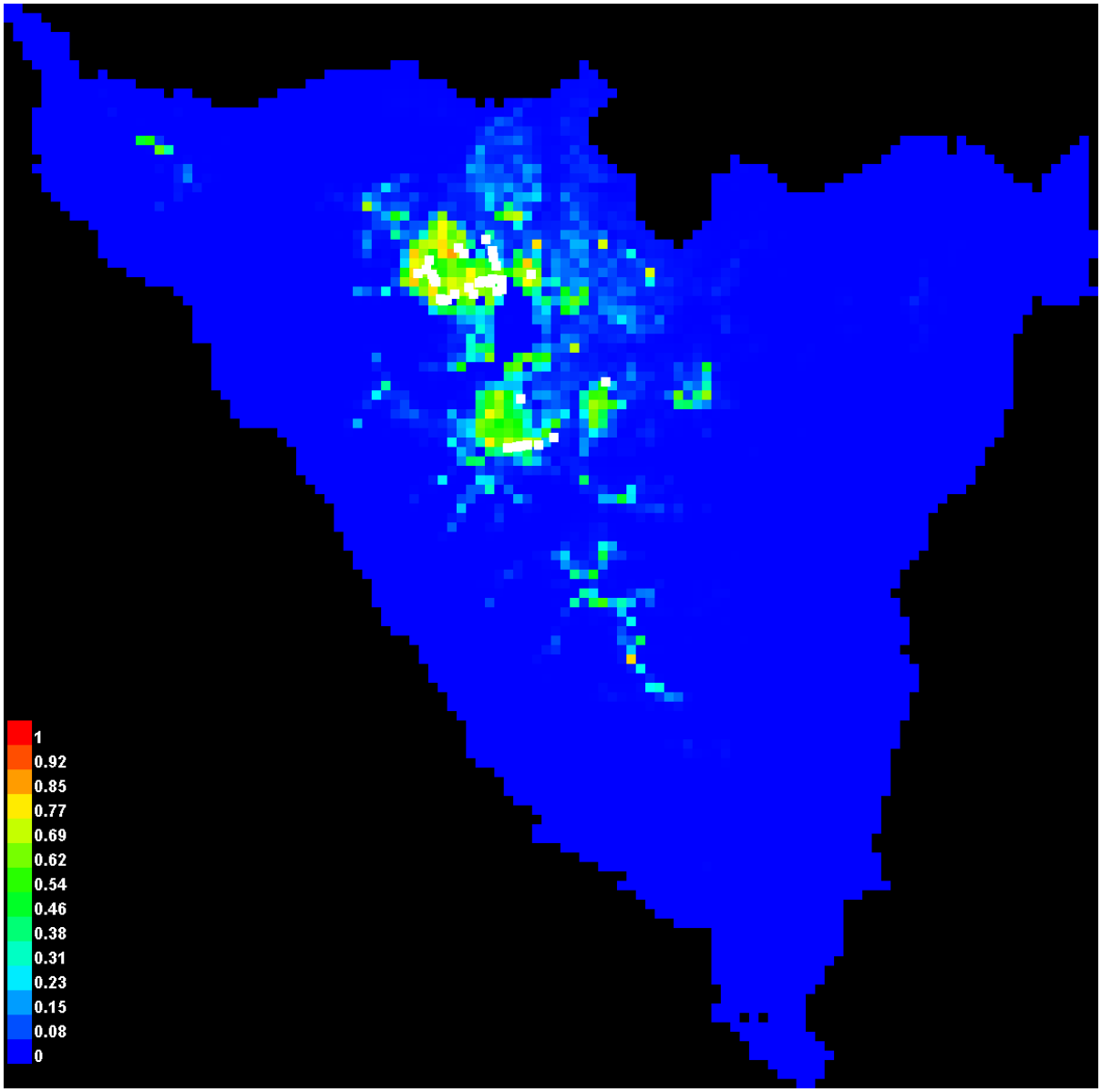


Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that test points are predicted no better than by a random prediction with the same fractional predicted area. The "Balance" threshold minimizes 6 * training omission rate + .04 * cumulative threshold + 1.6 * fractional predicted area.

Cumulative threshold	Logistic threshold	Description	Fractional predicted area	Training omission rate
1.000	0.015	Fixed cumulative value 1	0.148	0.000
5.000	0.066	Fixed cumulative value 5	0.081	0.086
10.000	0.144	Fixed cumulative value 10	0.054	0.086
3.604	0.046	Minimum training presence	0.095	0.000
10.307	0.146	10 percentile training presence	0.053	0.086
4.937	0.065	Equal training sensitivity and specificity	0.081	0.086
3.604	0.046	Maximum training sensitivity plus specificity	0.095	0.000
1.599	0.023	Balance training omission, predicted area and threshold value	0.129	0.000
8.927	0.127	Equate entropy of thresholded and original distributions	0.058	0.086

Pictures of the model

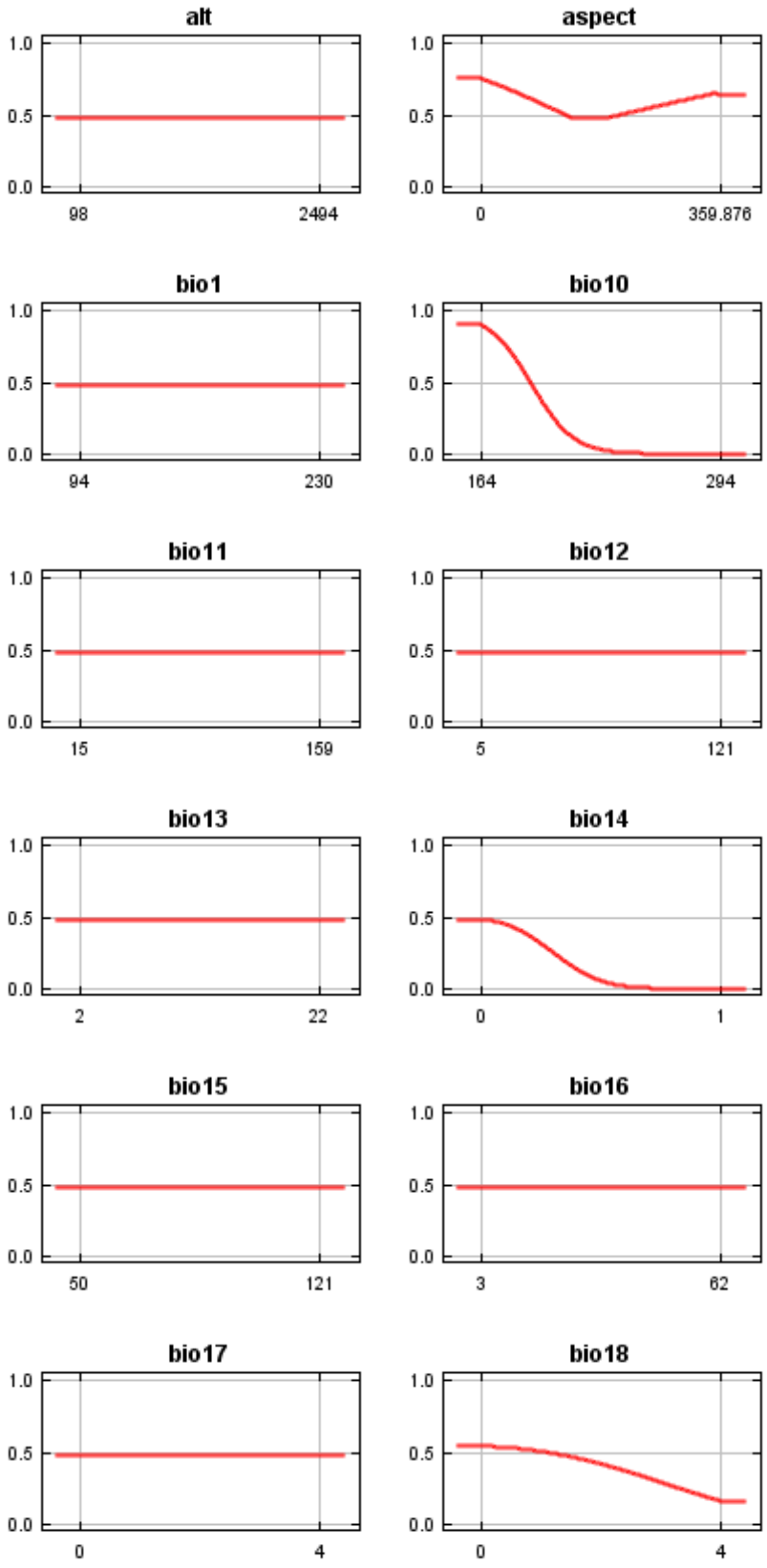
This is a representation of the Maxent model for Euphorbia_obovate. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size version.

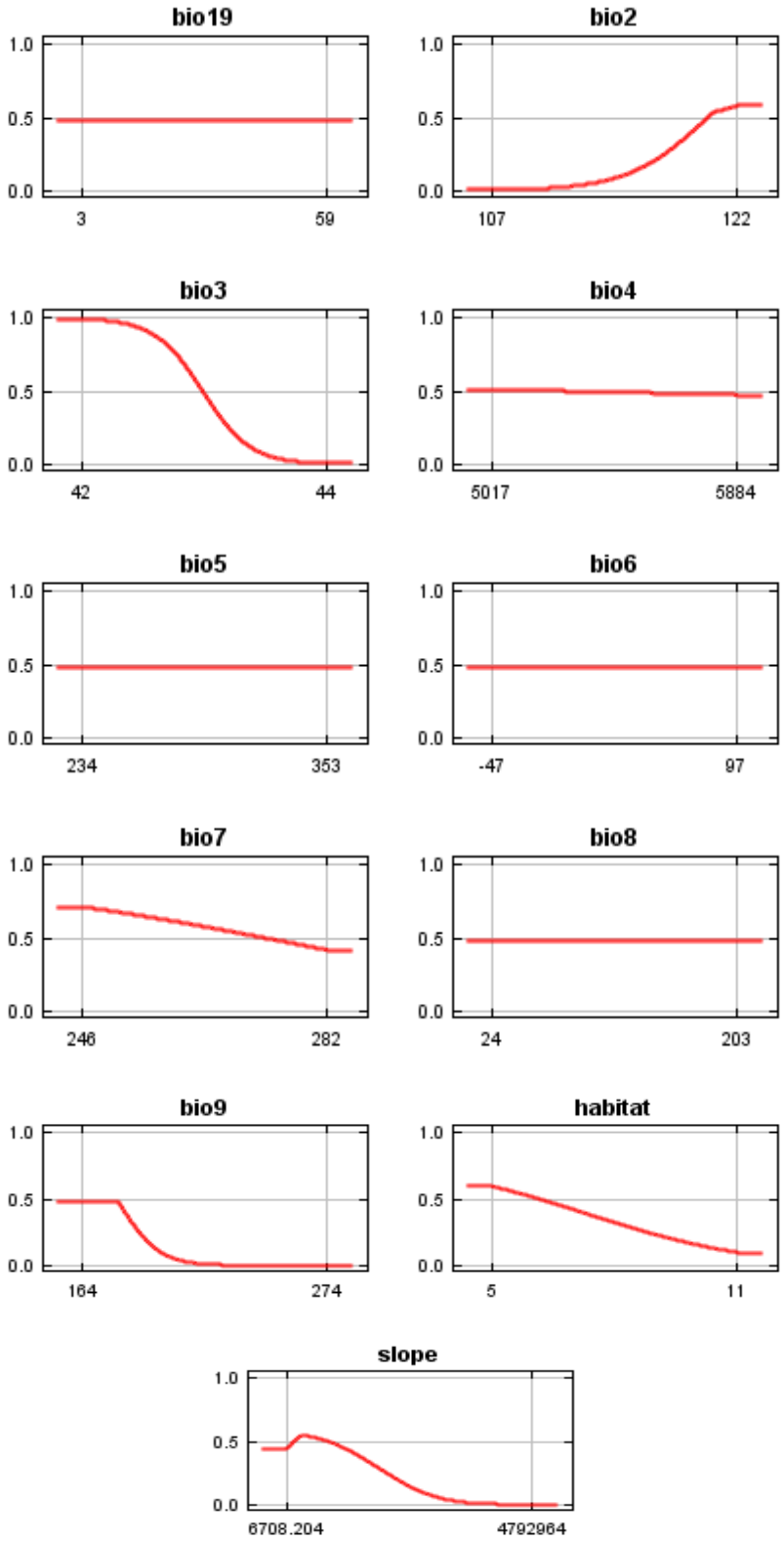


Response curves

These curves show how each environmental variable affects the Maxent prediction. The curves show how the logistic prediction changes as each environmental variable is varied, keeping all other environmental variables at their average sample value. Click on a response curve to see a larger version. Note that the curves can be hard to interpret if you have strongly correlated variables, as the model may depend on the correlations in ways that are not evident in the curves. In other words, the curves show the marginal

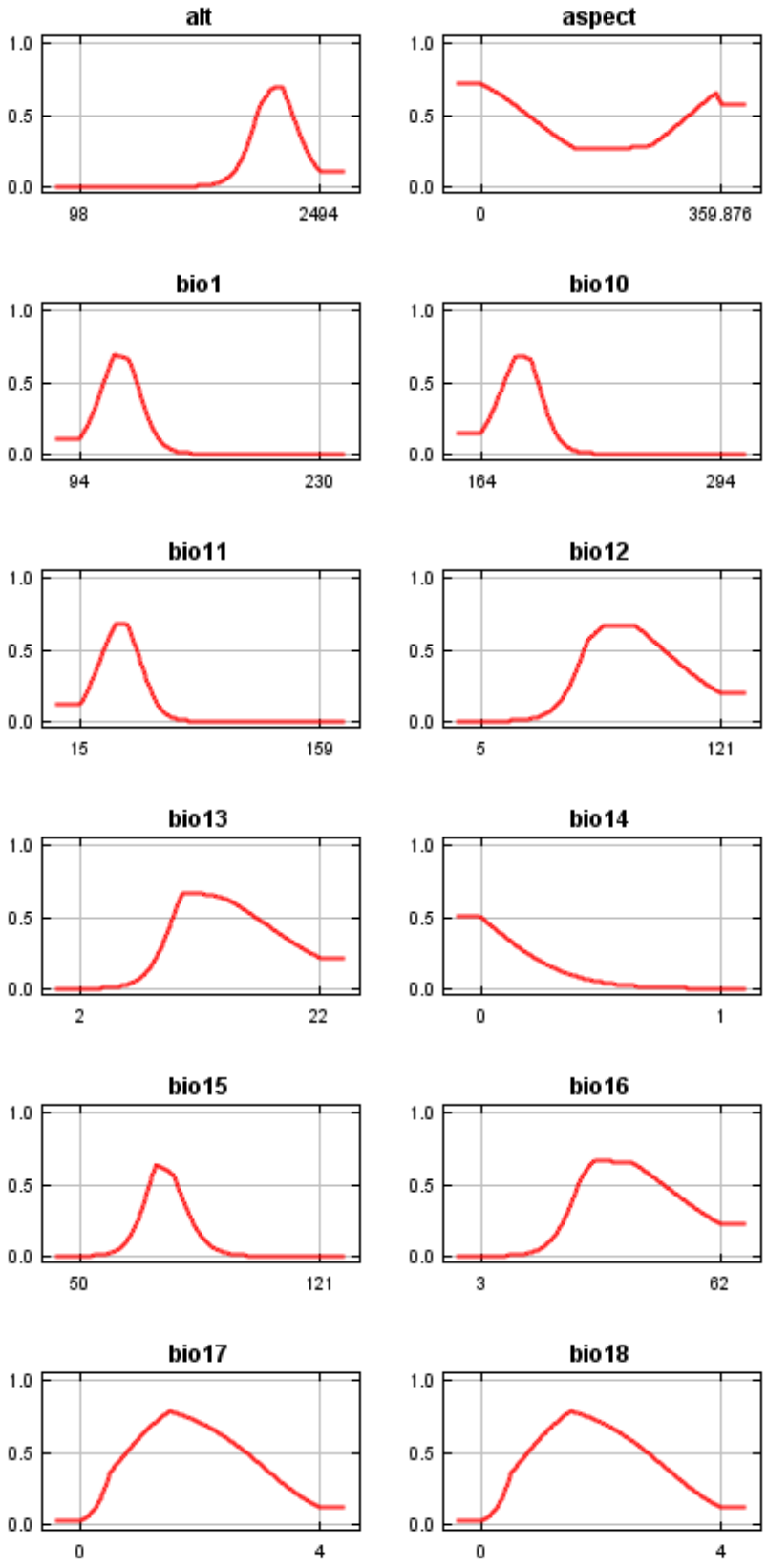
effect of changing exactly one variable, whereas the model may take advantage of sets of variables changing together.

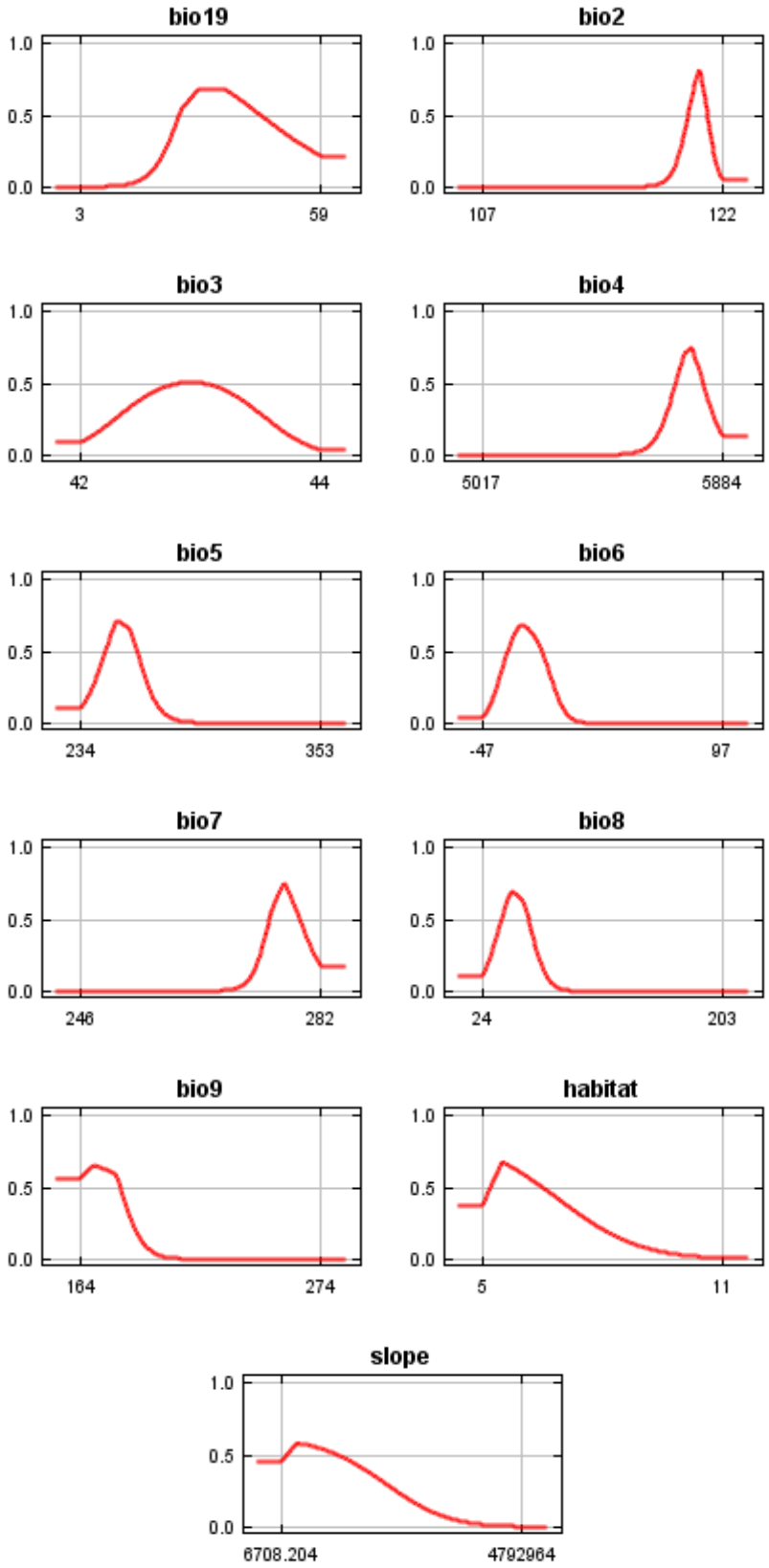




In contrast to the above marginal response curves, each of the following curves represents a different model, namely, a Maxent model created using only the corresponding variable. These plots reflect the dependence of predicted suitability both on the selected variable and on dependencies induced by correlations between the

selected variable and other variables. They may be easier to interpret if there are strong correlations between variables.



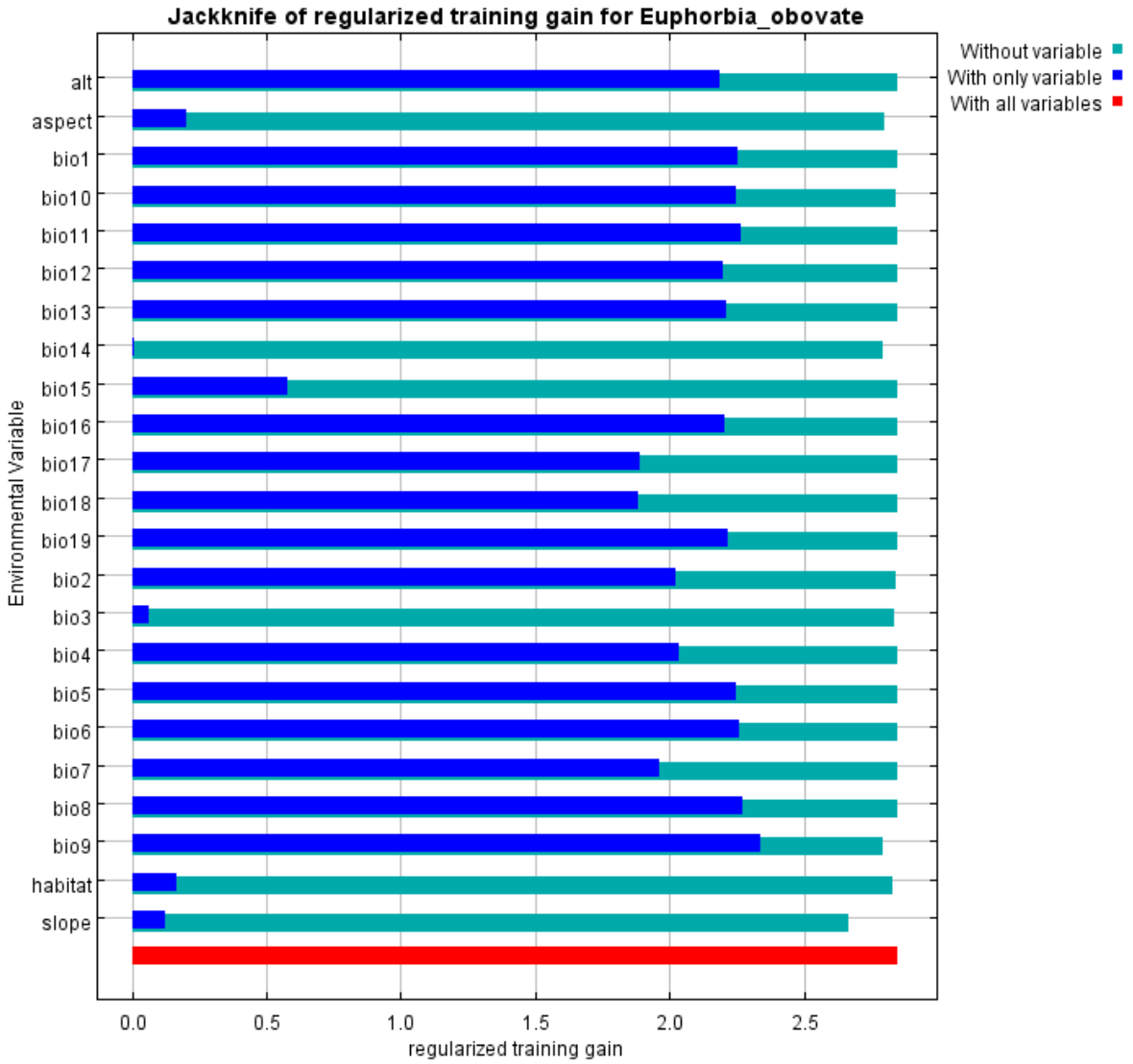

bio19
1.0
0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
1.0
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203
bio9
1.0
0.5
0.0
164
274
habitat
1.0
0.5
0.0
5
11
slope
1.0
0.5
0.0
6708.204
4792964

Analysis of variable contributions

The following table gives a heuristic estimate of relative contributions of the environmental variables to the Maxent model. To determine the estimate, in each iteration of the training algorithm, the increase in regularized gain is added to the contribution of the corresponding variable, or subtracted from it if the change to the absolute value of lambda is negative. As with the jackknife, variable contributions should be interpreted with caution when the predictor variables are correlated.

Variable	Percent contribution
bio17	54.3
bio13	17
slope	8.2
bio19	4
bio14	3.8
bio11	3.4
aspect	2.9
bio9	2
bio1	1.8
bio8	1.1
habitat	0.5
bio3	0.4
bio10	0.4
bio2	0.3
bio18	0.1
bio7	0
bio4	0
bio12	0
bio5	0
bio6	0
bio15	0
bio16	0
alt	0

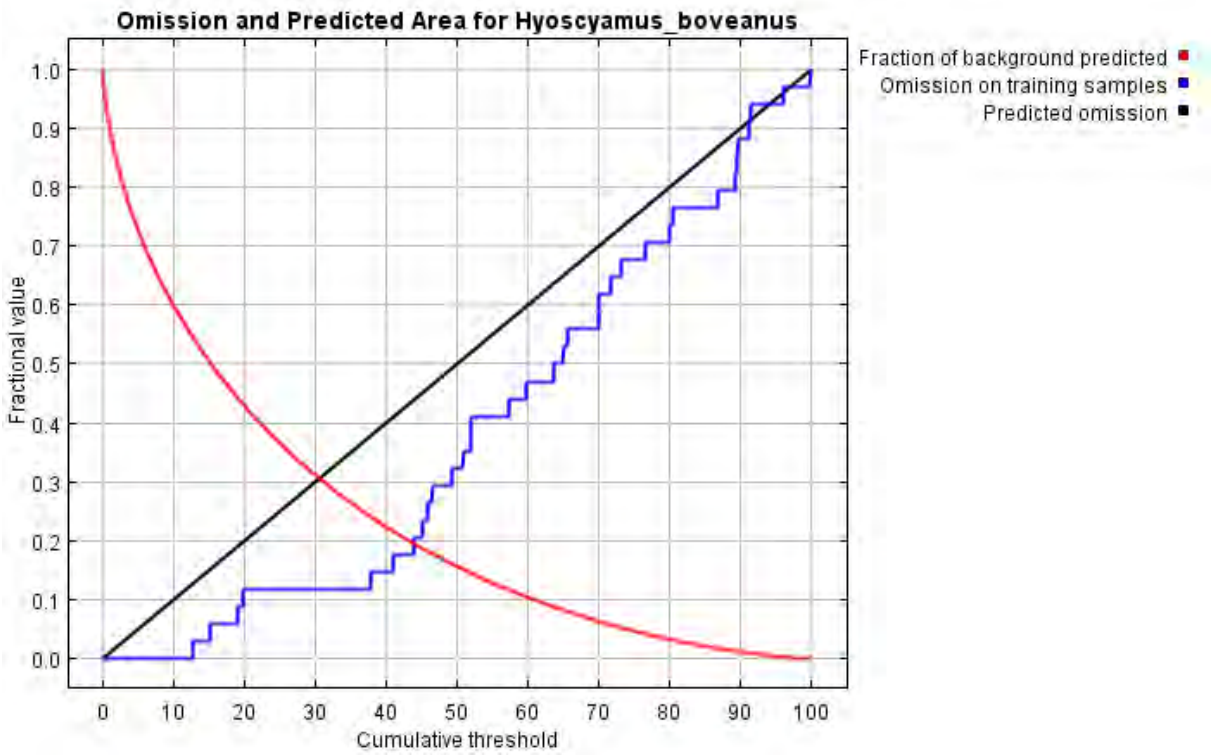
The following picture shows the results of the jackknife test of variable importance. The environmental variable with highest gain when used in isolation is bio9, which therefore appears to have the most useful information by itself. The environmental variable that decreases the gain the most when it is omitted is slope, which therefore appears to have the most information that isn't present in the other variables.


Jackknife of regularized training gain for Euphorbia_obovate
Without variable
With only variable
With all variables
Environmental Variable
alt
aspect
bio1
bio10
bio11
bio12
bio13
bio14
bio15
bio16
bio17
bio18
bio19
bio2
bio3
bio4
bio5
bio6
bio7
bio8
bio9
habitat
slope
0.0
0.5
1.0
1.5
2.0
2.5
regularized training gain

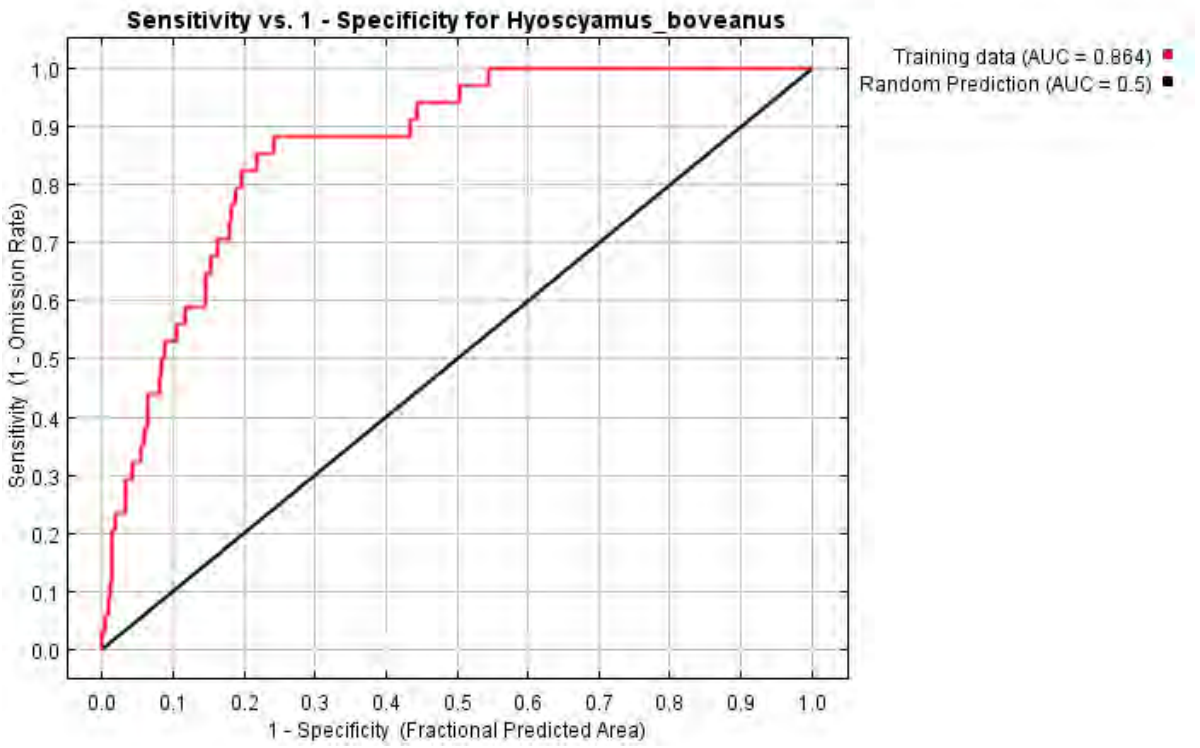
Maxent model for Hyoscyamus boveanus

Analysis of omission/commission

The following picture shows the omission rate and predicted area as a function of the cumulative threshold. The omission rate is is calculated both on the training presence records, and (if test data are used) on the test records. The omission rate should be close to the predicted omission, because of the definition of the cumulative threshold.



The next picture is the receiver operating characteristic (ROC) curve for the same data. Note that the specificity is defined using predicted area, rather than true commission (see the paper by Phillips, Anderson and Schapire cited on the help page for discussion of what this means). This implies that the maximum achievable AUC is less than 1. If test data is drawn from the Maxent distribution itself, then the maximum possible test AUC would be 0.763 rather than 1; in practice the test AUC may exceed this bound.

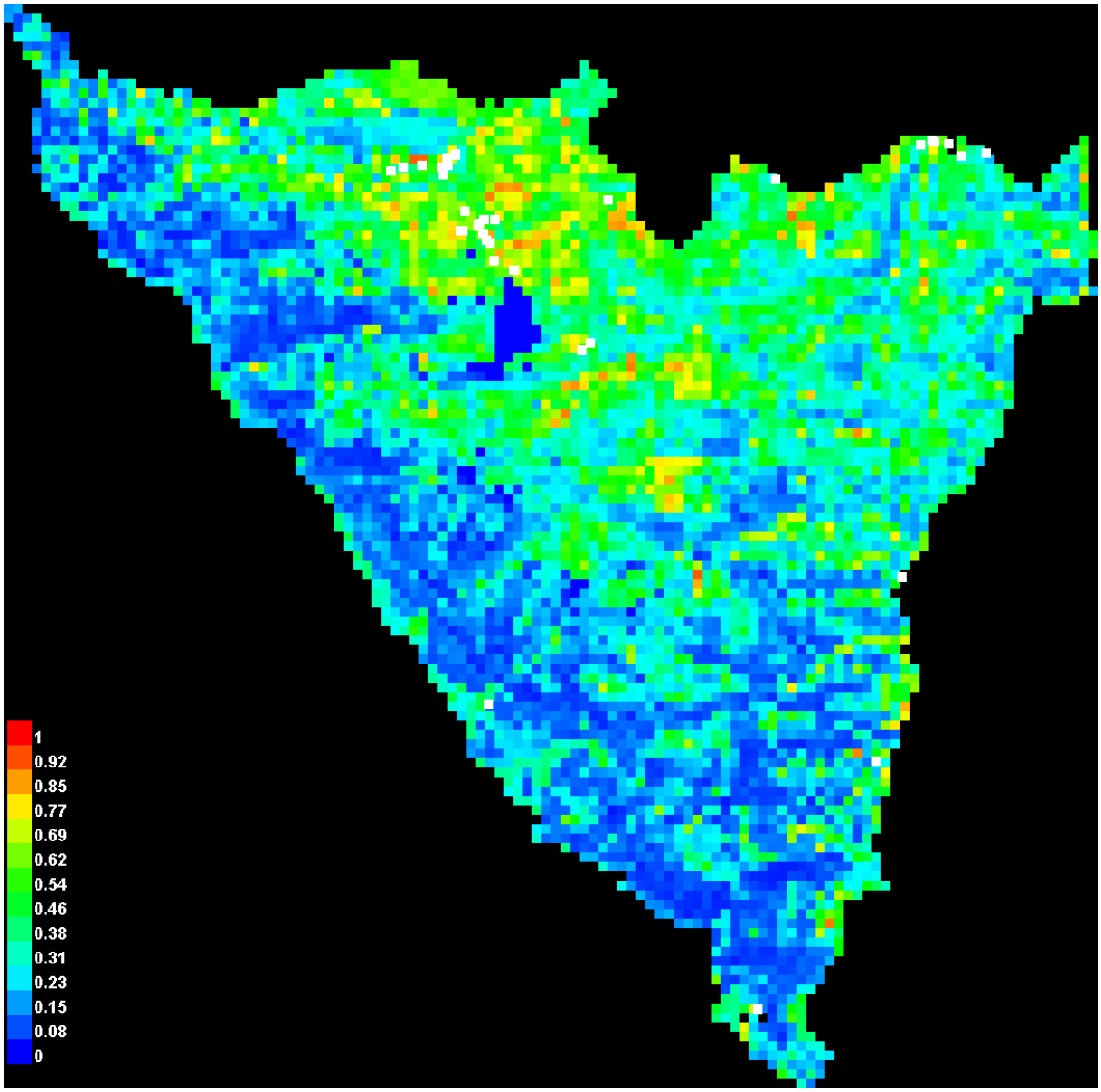


Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that test points are predicted no better than by a random prediction with the same fractional predicted area. The "Balance" threshold minimizes 6 * training omission rate + .04 * cumulative threshold + 1.6 * fractional predicted area.

Cumulative threshold	Logistic threshold	Description	Fractional predicted area	Training omission rate
1.000	0.084	Fixed cumulative value 1	0.898	0.000
5.000	0.165	Fixed cumulative value 5	0.725	0.000
10.000	0.220	Fixed cumulative value 10	0.599	0.000
12.739	0.247	Minimum training presence	0.545	0.000
19.656	0.301	10 percentile training presence	0.434	0.088
43.854	0.466	Equal training sensitivity and specificity	0.196	0.206
37.858	0.429	Maximum training sensitivity plus specificity	0.241	0.118
7.473	0.194	Balance training omission, predicted area and threshold value	0.657	0.000
9.796	0.218	Equate entropy of thresholded and original distributions	0.603	0.000

Pictures of the model

This is a representation of the Maxent model for Hyoscyamus_boveanus. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size version.



Response curves

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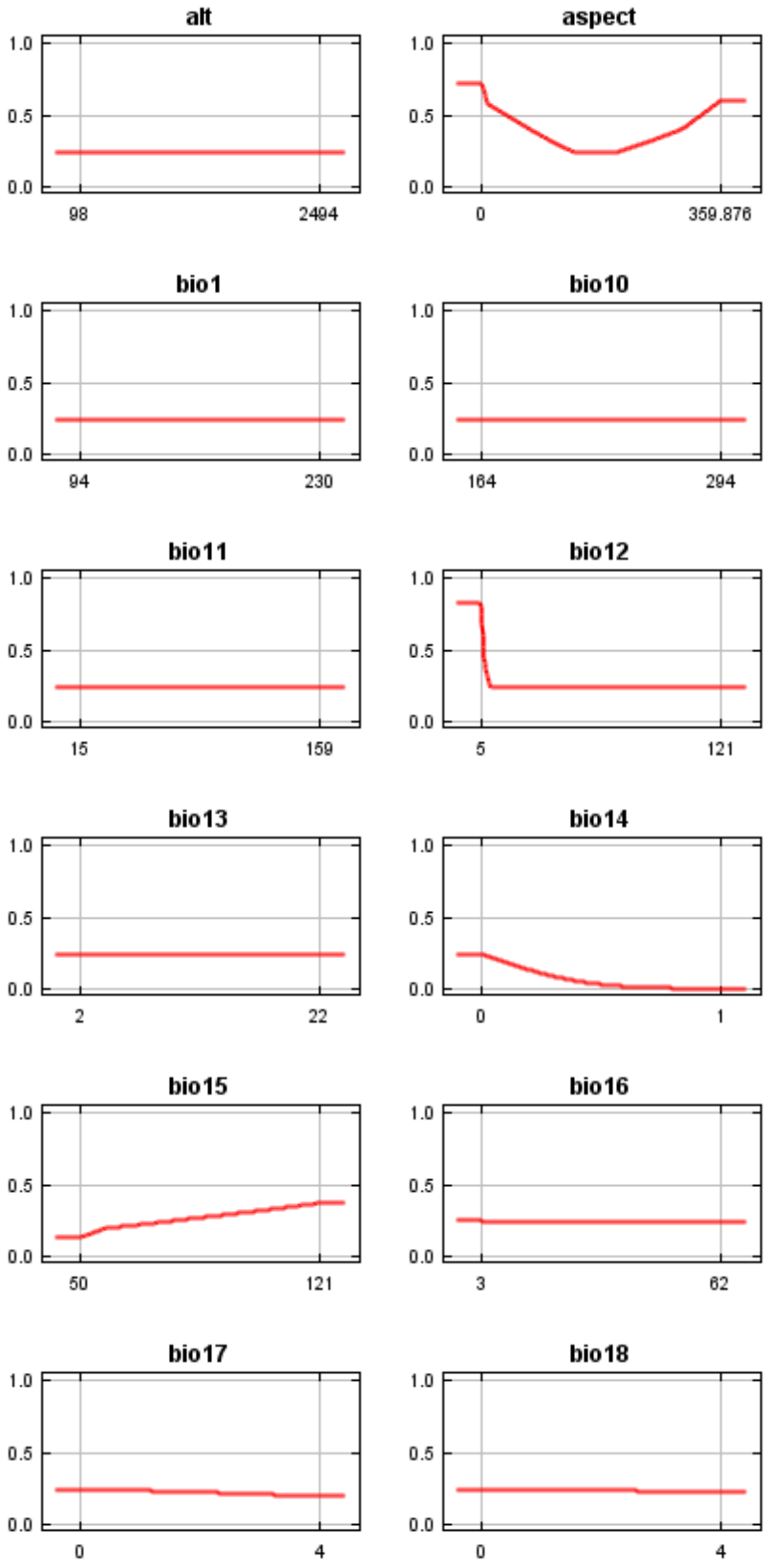
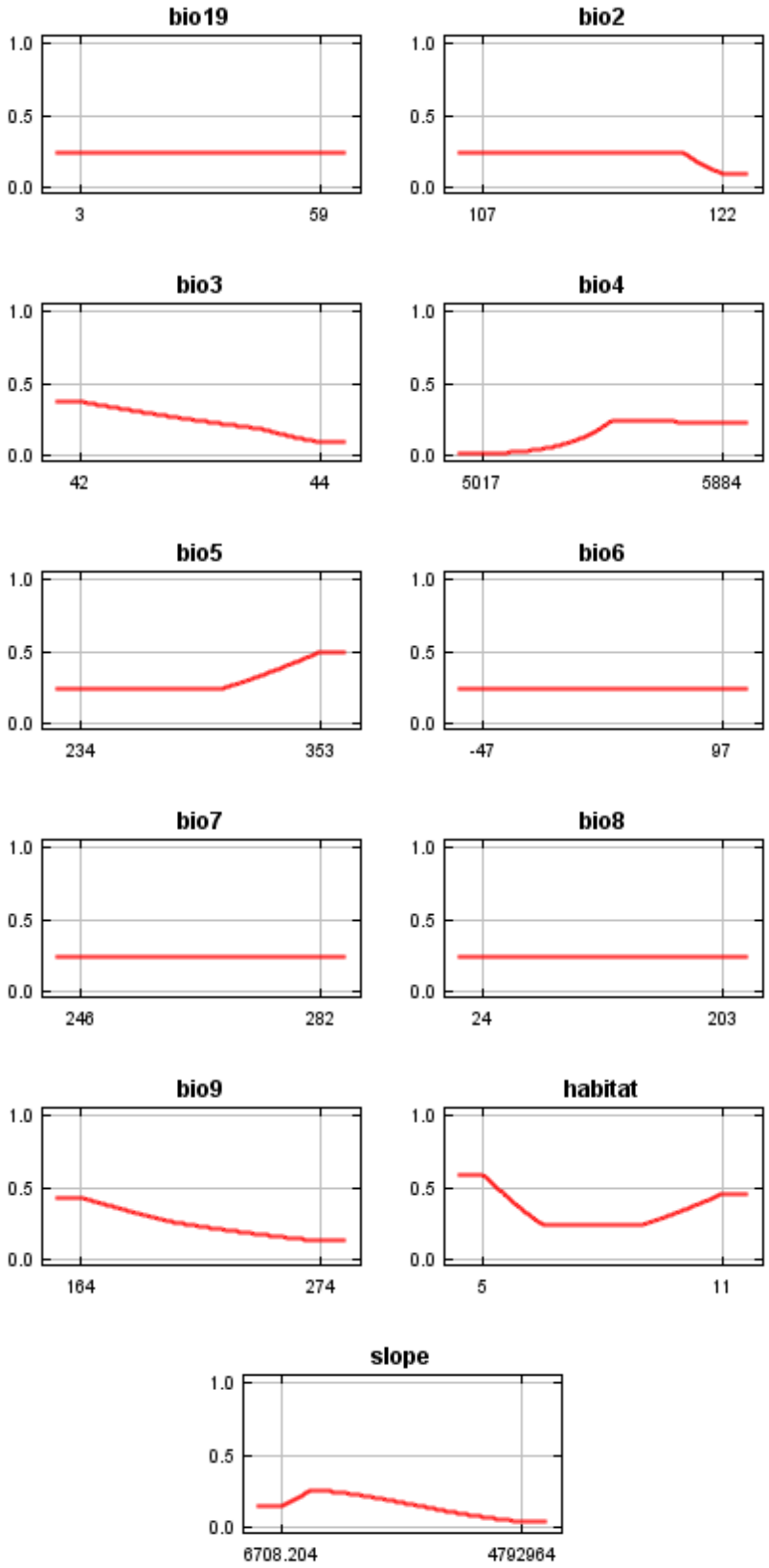
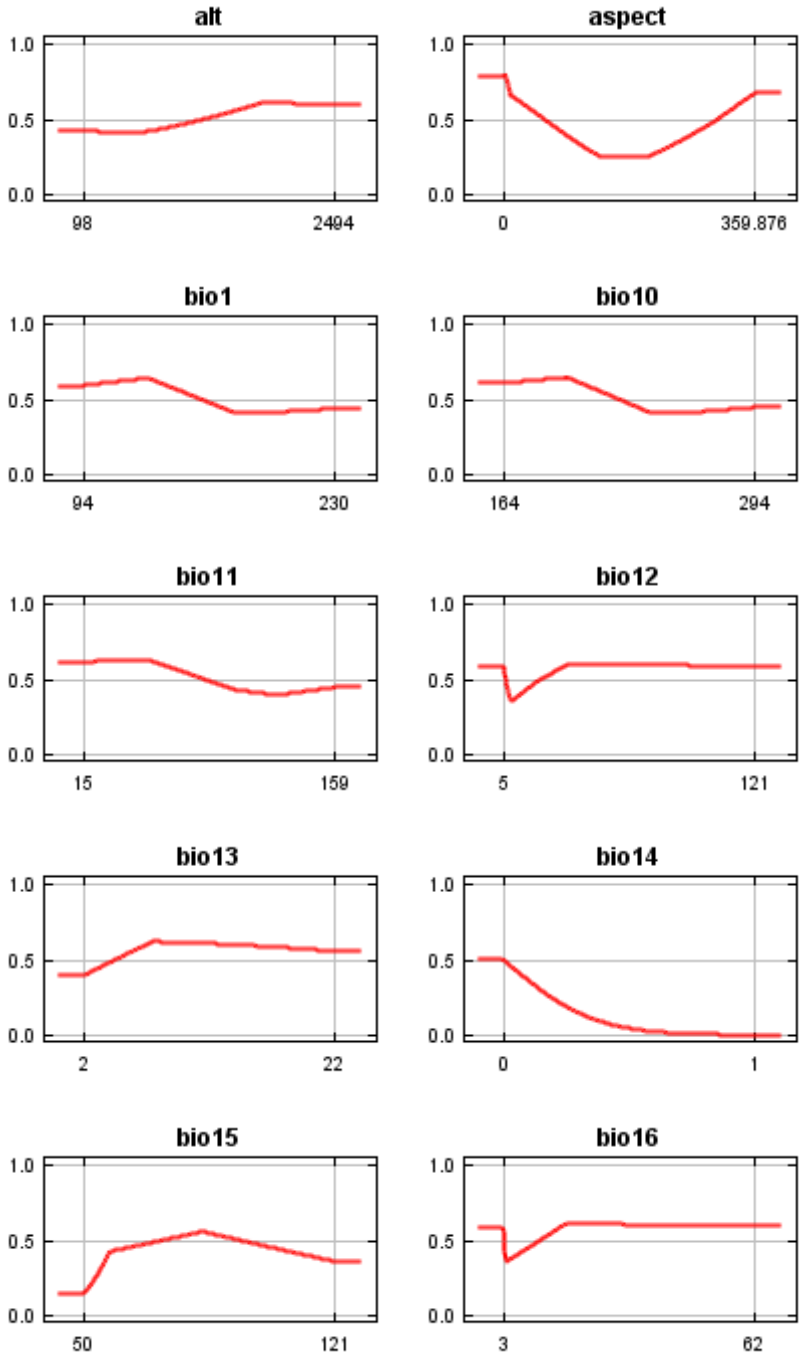
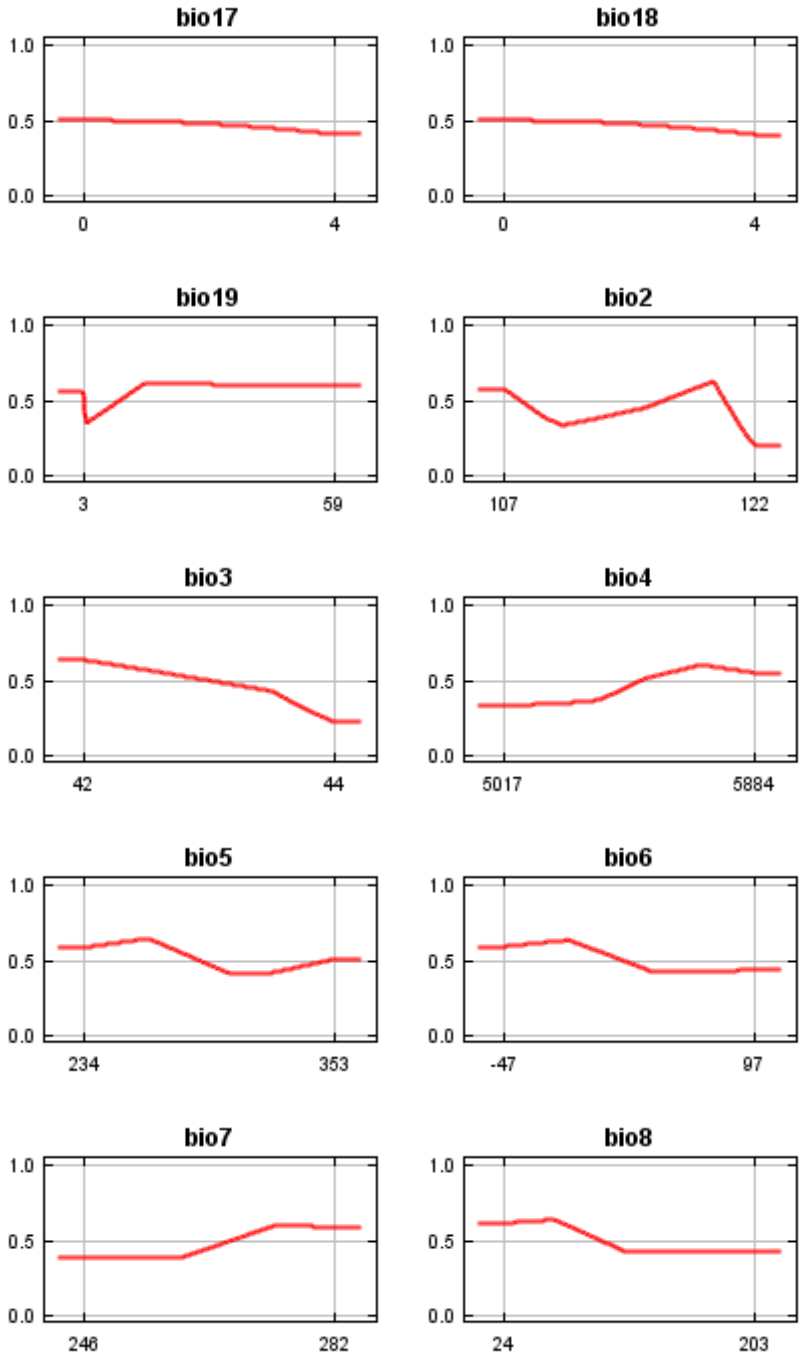
effect of changing exactly one variable, whereas the model may take advantage of sets of variables changing together.




bio19
1.0
0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
1.0
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203
bio9
1.0
0.5
0.0
164
274
habitat
1.0
0.5
0.0
5
11
slope
1.0
0.5
0.0
6708.204
4792964

In contrast to the above marginal response curves, each of the following curves represents a different model, namely, a Maxent model created using only the corresponding variable. These plots reflect the dependence of predicted suitability both on the selected variable and on dependencies induced by correlations between the selected variable and other variables. They may be easier to interpret if there are strong correlations between variables.




bio17
1.0
0.5
0.0
0
4
bio18
1.0
0.5
0.0
0
4
bio19
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0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
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42
44
bio4
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0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
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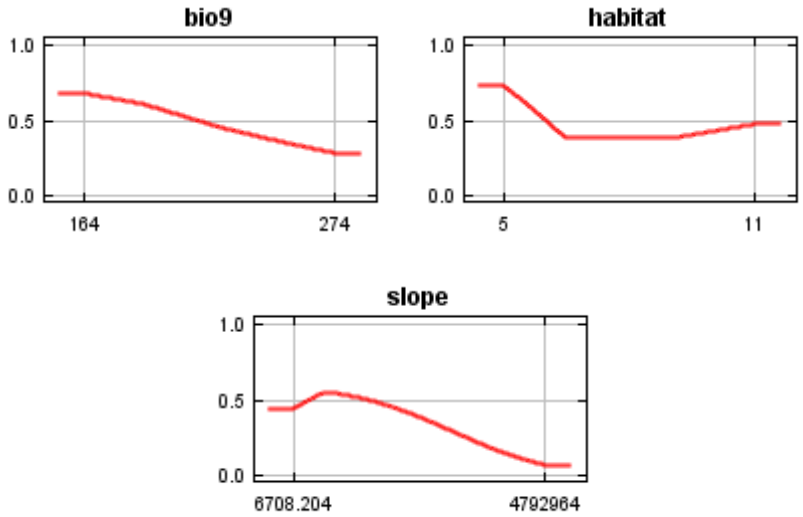
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203

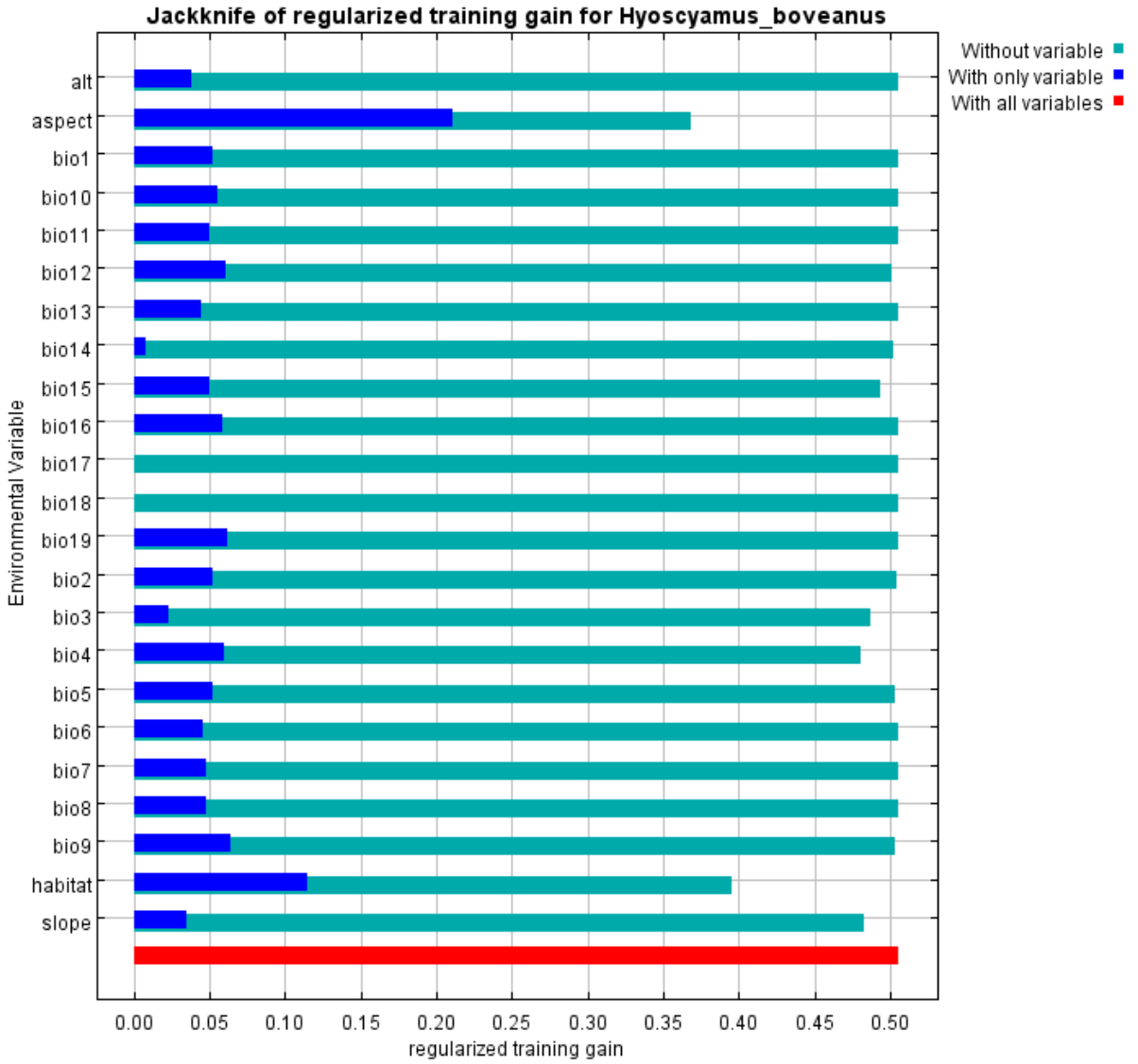


Analysis of variable contributions

The following table gives a heuristic estimate of relative contributions of the environmental variables to the Maxent model. To determine the estimate, in each iteration of the training algorithm, the increase in regularized gain is added to the contribution of the corresponding variable, or subtracted from it if the change to the absolute value of lambda is negative. As with the jackknife, variable contributions should be interpreted with caution when the predictor variables are correlated.

Variable	Percent contribution
aspect	35.9
habitat	28.1
bio9	8.5
bio4	6.9
bio15	5.9
slope	4.7
bio3	2.8
bio14	2.5
bio12	2
bio16	1.3
bio2	1
bio5	0.3
bio17	0
bio18	0
bio19	0
bio6	0
bio13	0
bio7	0
bio11	0
bio10	0
bio1	0
bio8	0
alt	0

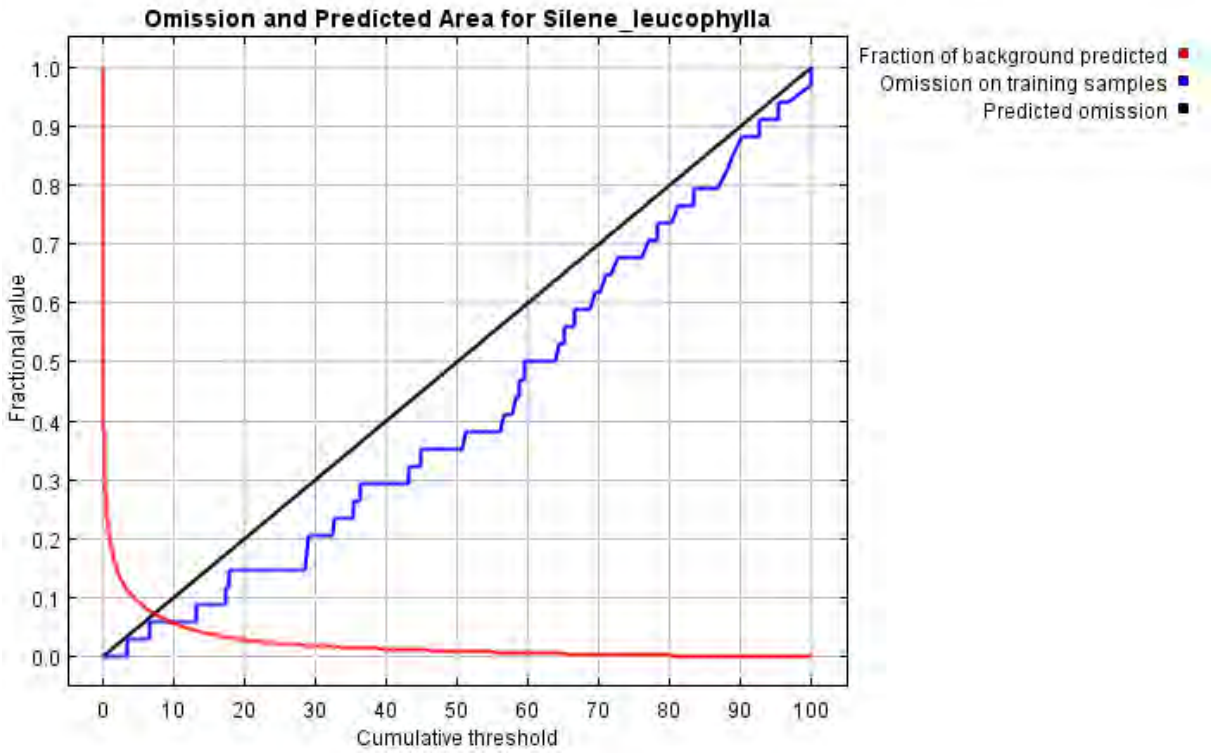
The following picture shows the results of the jackknife test of variable importance. The environmental variable with highest gain when used in isolation is aspect, which therefore appears to have the most useful information by itself. The environmental variable that decreases the gain the most when it is omitted is aspect, which therefore appears to have the most information that isn't present in the other variables.



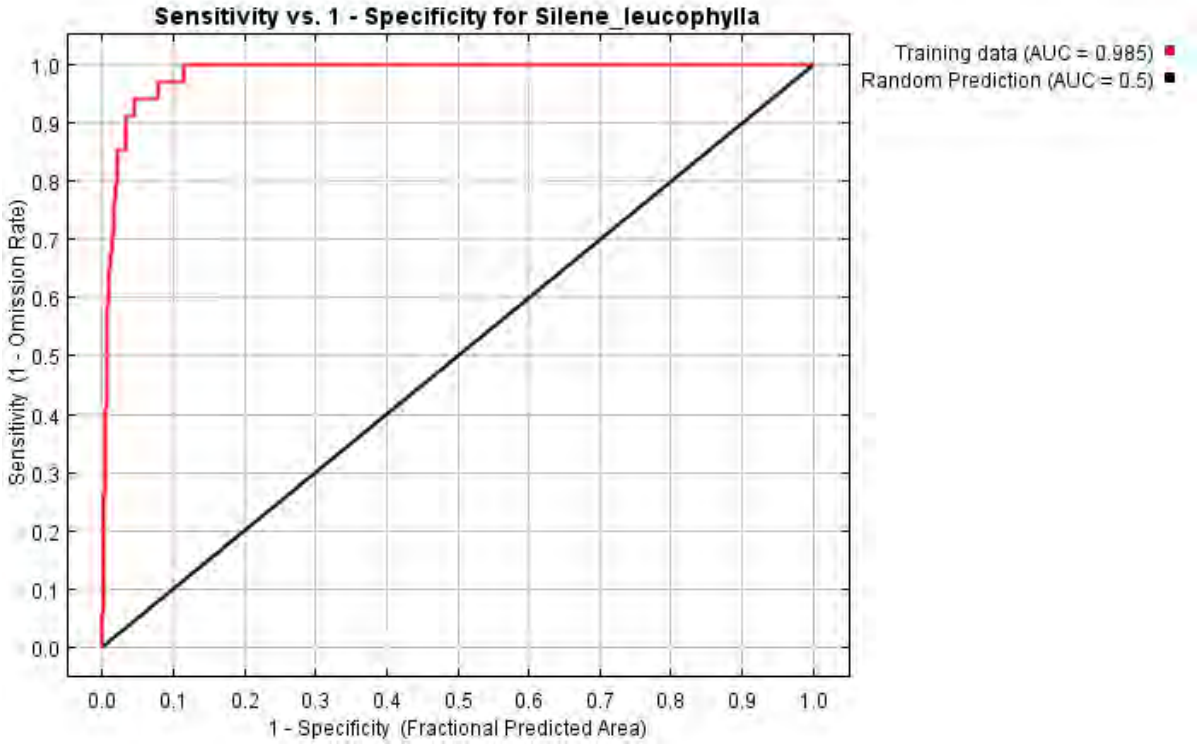
Maxent model for Silene leucophylla

Analysis of omission/commission

The following picture shows the omission rate and predicted area as a function of the cumulative threshold. The omission rate is is calculated both on the training presence records, and (if test data are used) on the test records. The omission rate should be close to the predicted omission, because of the definition of the cumulative threshold.



The next picture is the receiver operating characteristic (ROC) curve for the same data. Note that the specificity is defined using predicted area, rather than true commission (see the paper by Phillips, Anderson and Schapire cited on the help page for discussion of what this means). This implies that the maximum achievable AUC is less than 1. If test data is drawn from the Maxent distribution itself, then the maximum possible test AUC would be 0.973 rather than 1; in practice the test AUC may exceed this bound.

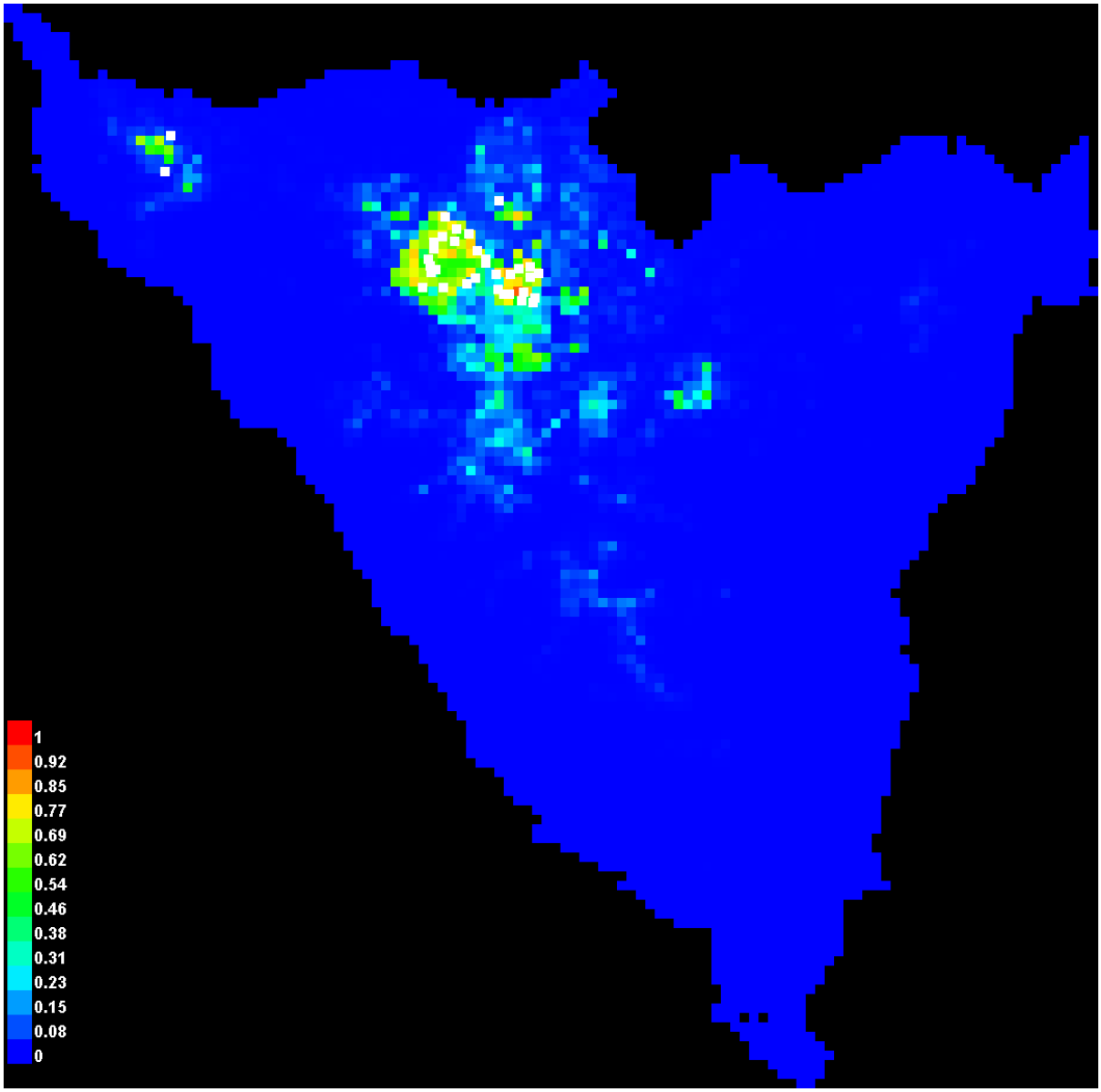


Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that test points are predicted no better than by a random prediction with the same fractional predicted area. The "Balance" threshold minimizes 6 * training omission rate + .04 * cumulative threshold + 1.6 * fractional predicted area.

Cumulative threshold	Logistic threshold	Description	Fractional predicted area	Training omission rate
1.000	0.007	Fixed cumulative value 1	0.198	0.000
5.000	0.046	Fixed cumulative value 5	0.093	0.029
10.000	0.099	Fixed cumulative value 10	0.057	0.059
3.452	0.032	Minimum training presence	0.114	0.000
17.405	0.203	10 percentile training presence	0.034	0.088
9.679	0.097	Equal training sensitivity and specificity	0.059	0.059
13.249	0.141	Maximum training sensitivity plus specificity	0.045	0.059
2.503	0.021	Balance training omission, predicted area and threshold value	0.132	0.000
11.044	0.111	Equate entropy of thresholded and original distributions	0.053	0.059

Pictures of the model

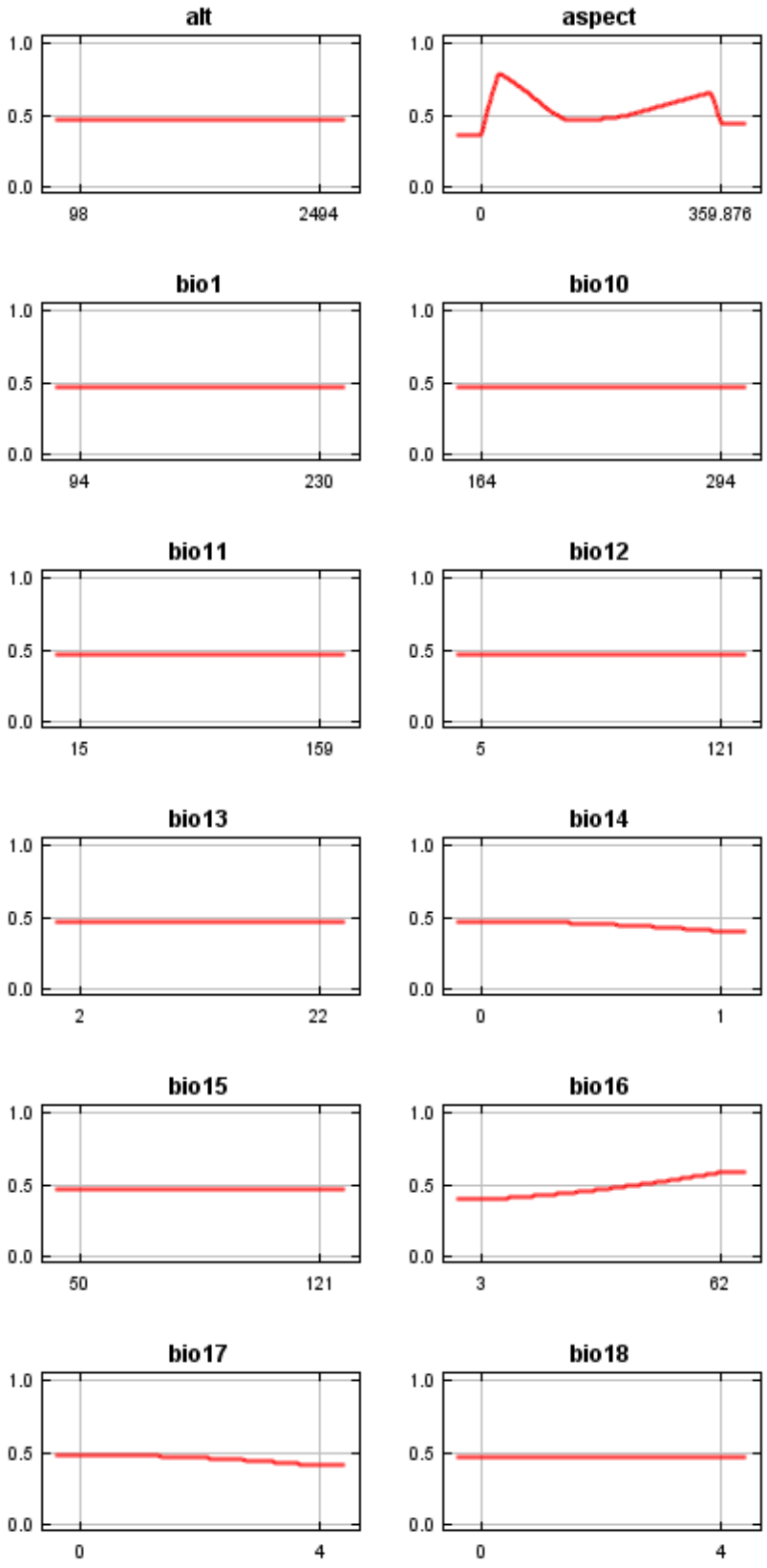
This is a representation of the Maxent model for Silene_leucophylla. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size version.

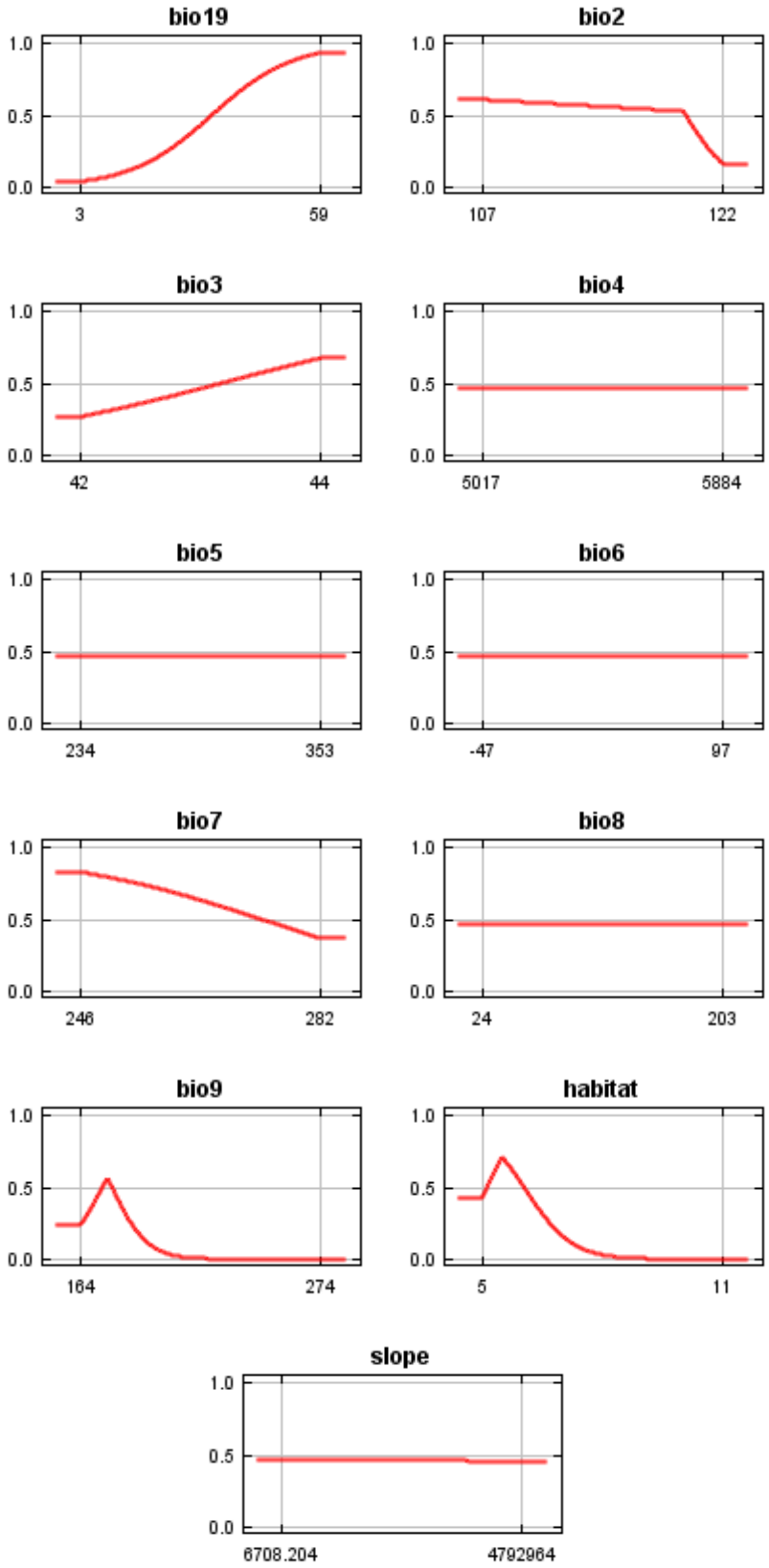


Response curves

These curves show how each environmental variable affects the Maxent prediction. The curves show how the logistic prediction changes as each environmental variable is varied, keeping all other environmental variables at their average sample value. Click on a response curve to see a larger version. Note that the curves can be hard to interpret if you have strongly correlated variables, as the model may depend on the correlations in ways that are not evident in the curves. In other words, the curves show the marginal

effect of changing exactly one variable, whereas the model may take advantage of sets of variables changing together.




bio19
1.0
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0.0
3
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bio2
1.0
0.5
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107
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bio3
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42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
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234
353
bio6
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-47
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bio7
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246
282
bio8
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203
bio9
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habitat
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slope
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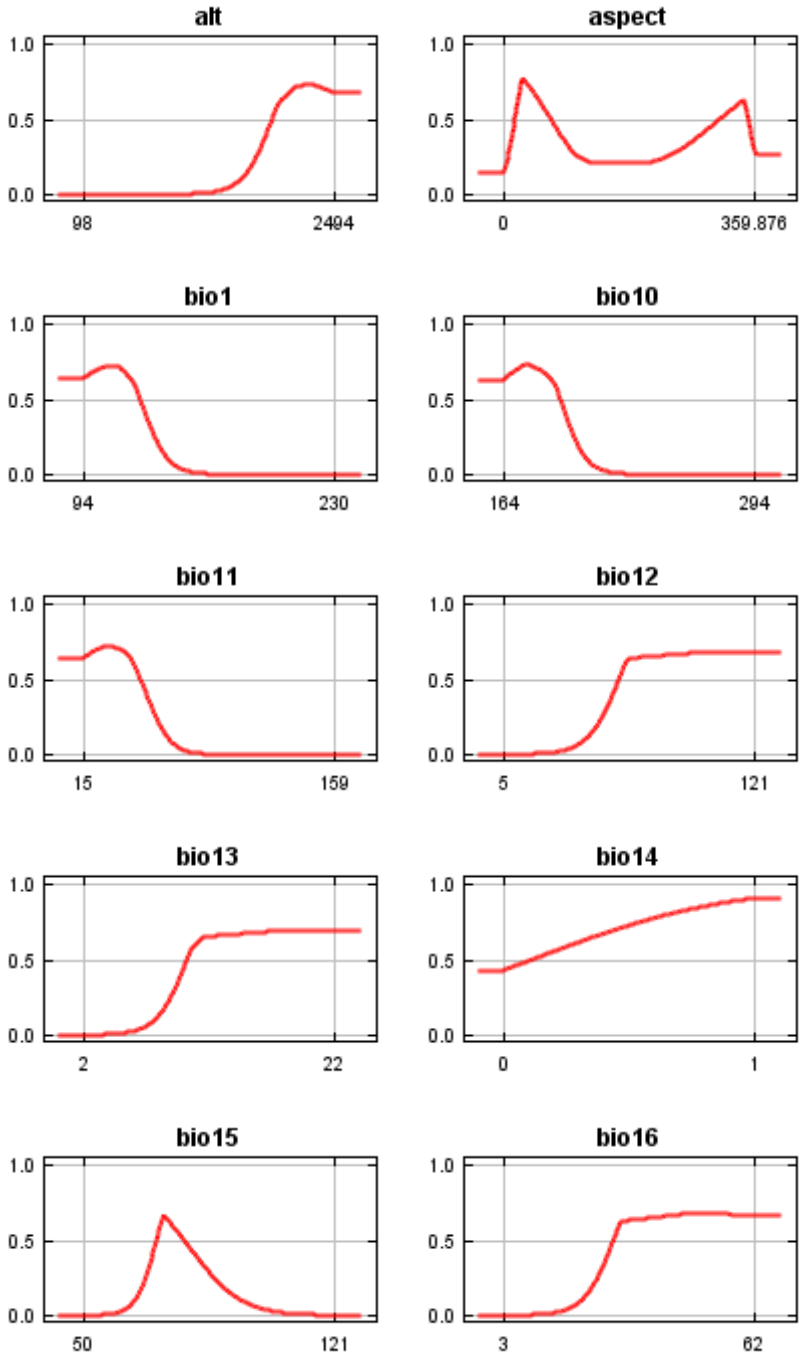
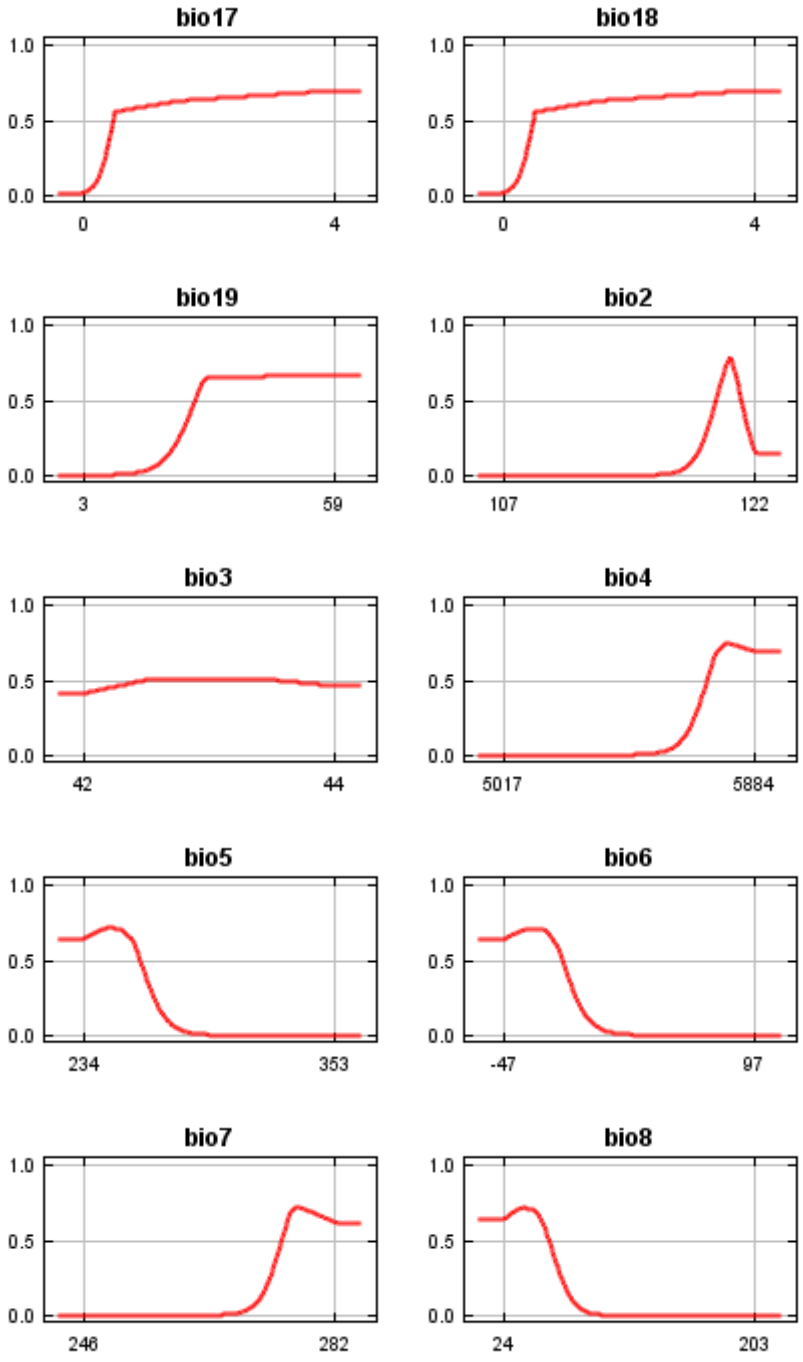
4792964

In contrast to the above marginal response curves, each of the following curves represents a different model, namely, a Maxent model created using only the corresponding variable. These plots reflect the dependence of predicted suitability both on the selected variable and on dependencies induced by correlations between the selected variable and other variables. They may be easier to interpret if there are strong correlations between variables.




bio17
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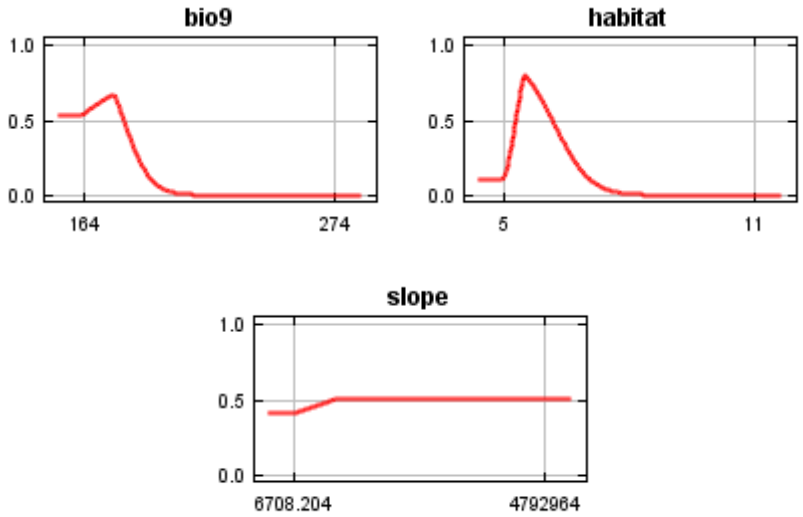
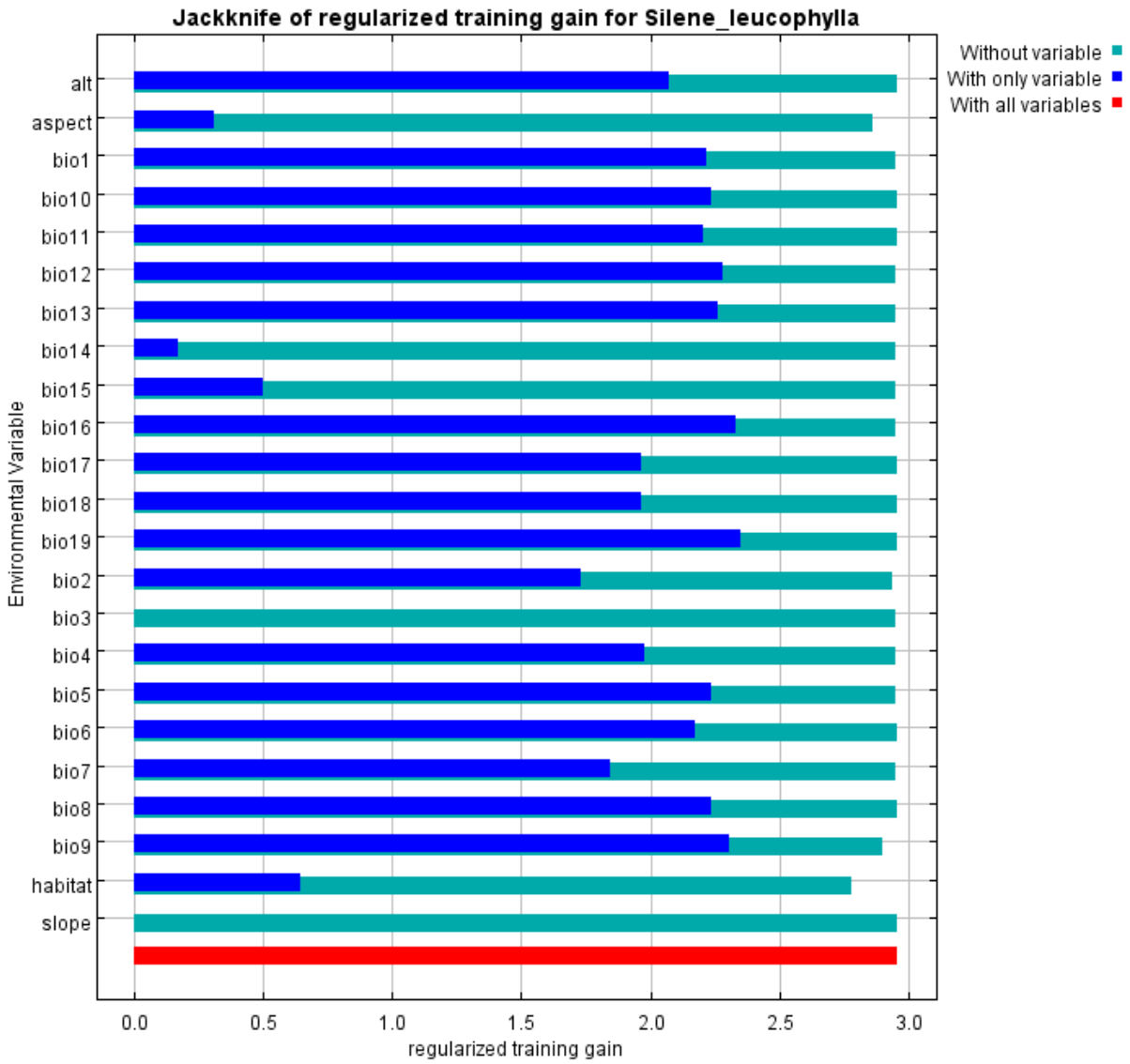


Analysis of variable contributions

The following table gives a heuristic estimate of relative contributions of the environmental variables to the Maxent model. To determine the estimate, in each iteration of the training algorithm, the increase in regularized gain is added to the contribution of the corresponding variable, or subtracted from it if the change to the absolute value of lambda is negative. As with the jackknife, variable contributions should be interpreted with caution when the predictor variables are correlated.

Variable	Percent contribution
bio17	58.9
bio19	17.8
habitat	11.1
aspect	4.9
bio9	3.9
bio13	1.7
bio2	1.1
bio12	0.2
bio16	0.1
bio3	0.1
bio7	0
bio14	0
slope	0
bio6	0
bio18	0
bio15	0
bio4	0
bio5	0
bio11	0
bio10	0
bio1	0
bio8	0
alt	0

The following picture shows the results of the jackknife test of variable importance. The environmental variable with highest gain when used in isolation is bio19, which therefore appears to have the most useful information by itself. The environmental variable that decreases the gain the most when it is omitted is habitat, which therefore appears to have the most information that isn't present in the other variables.



Part II
CONSERVATION MANAGEMENT AND ACTIONS

Management Plan

Previous work:

Management plan was developed in 2003 for St. Catherine PA. Some parts explain the action needed for the conservation of threatened flora as follow:

Flora (SKP Management Plan 2003)

It is estimated that about 1,285 species of higher plants occur in Sinai more than half the Egyptian flora with about 33 endemics and four endemic to Sinai and mainland Egypt. Around 135 species occur in South Sinai that do not occur elsewhere in Egypt. About 420 plant species exist in the high mountain region in and around St Catherine . Within the Protected Area 316 higher plants have been recorded to date. Of these 19 species are endemic, 10 are extremely endangered and 53 endangered. Flora surveys are far from complete especially in the high montane areas; recent surveys have revealed five new records for Sinai and it is anticipated that many new records and possibly new species will be recorded in the future. The mountains of South Sinai have been recognised as one of the important centres of plant diversity for the Saharo-Sindian (Irano-Turanian) [sic] region of the Middle East (IUCN, 1994).

The highest number of species has been recorded on Gebel Katherina (144) and Gebel Serbal (141); these two mountains contain the largest number of endemic species.

About 30 species of mosses are known from the St Catherine area; these are largely restricted to moister high altitude habitats and represent relicts of the alpine extension into the western part of Asia during the Pleistocene pluvial periods.

Status of plant communities: The dominant flora is that of montane vegetation thinly scattered over the better-watered mountain peak system and largely made up of Irano-Turanian elements. Twelve main plant communities are recognised dominated by various dwarf shrubs that reflect differences in habitat conditions such as altitude, slope, exposure, geology etc.

Artemisia herba-alba is the most prominent floral component of the higher altitude landscapes and is the dominant or co-dominant in almost all communities. Acacia is the physiognomically dominant species of lower altitude wadi communities.

Due to the low rainfall and poor soil development on the extensive bare rock surfaces plant life is largely restricted to the drainage channel (wadi) systems drainage network; as rainfall often results in torrential floods, plant life is more common on alluvium terraces bordering channels.

The main threats discerned for vegetation are localised overgrazing, uprooting of plants for fuel or camel fodder and over collection of medicinal and herbal plants for sale.

Threatened Plants: Acacia is a keystone species in South Sinai of vital ecological and cultural importance. In recent years Acacias have been subjected to overgrazing, cutting and other threats and recruitment to the population has been seriously compromised. A programme for the rehabilitation of this species was initiated in 1999 with the co-operation of local people. A two-phase strategy has been adopted, which involves the artificial propagation of seedlings and interventions to enhance natural regeneration. The programme has been proposed for continued support under the SSRDP.

Plants of conservation interest and recovery plans: Thymus decussates is near endemic and has a very limited and patchy distribution; the narrowly endemic Sinai Baton Blue

(Pseudophilotes sinaicus) with a total range of about 200km^2 is totally dependent on the Thymus as a host plant. Thymus is selectively browsed by domestic stock and patches can vanish and reappear within a lifetime. The relationship between these two endemics marks Thymus decussatus for special conservation management through recovery plans. Other candidate species include Moringa peregrina and Primula boveana.

Medicinal Plants: It is reported that the Bedouin use over 170 species of plants to treat various medical disorders from colds and digestive problems to bites and stings (Bailey and Danin, 1981); Cleome droserifolia is being investigated as a possible treatments for diabetes. The value of the medicinal plants and associated indigenous knowledge has been internationally recognised; in 1999 UNDP presented a proposal to the Global Environmental Facility (GEF) for the conservation and sustainable use of medicinal plants in the St Catherine Protected Area and this project will start in 2002.

Invasive species: The climatic conditions prevailing in the Protected Area limit opportunities for colonisation by invasive, exotic plant species. The use of exotic plants for landscaping is, however, cause for concern especially as plants commonly planted are toxic e.g. Oleander. The planting of exotic species must be proscribed inside the Protectorate.

General monitoring programmes
Purpose: The botanical survey and monitoring initiated in 1996 will be maintained. The main objectives of this programme are to identify priority areas for botanical conservation and to evaluate the impact of these conservation measures.
The general activities involved are to:
1. Identify and locate priority sites based on the botanical survey.
2. Design and install appropriate conservation measures for the priority sites.
3. Design and institute a practical and efficient vegetation monitoring programme.
4. Develop analytical tools appropriate to the interpretation of the assembled data.

Methods: The monitoring programme involves 37 enclosures where the following data are collected:
1. Total plant cover, height, and number of individuals of each species.
2. Phenology and vitality of each species estimated from number of reproductive organs and growth status.
3. Measuring the new growth of marked branches of shrubs and trees.
4. Estimating the impact of browsing and human interference on each species.

Permanent enclosure data to be recorded:
- GPS record.
- Elevation.
- Slope degree.
- Exposures.
- Total enclosure area
- Landform.

Monitoring timing: The monitoring is to be carried out annually between May and June for all the 37 enclosures to measure the changes after protection.

Future monitoring strategy: The botanical team will conduct the monitoring programme of the St Catherine high mountain region enclosures on an annual basis to determine plant response to protection.
The data to be gathered are:
1. Density: Density of species per unit area = total number of individuals of a species in all the sample plots / total number of sample plots studied.
2. Relative density of the species = total number of individual of a species/total number of individual of all species x 100.
3. Frequency: Total number of quadrats in which the species occur/total number of quadrats studied x 100
4. Relative frequency of a species = frequency of the species in stand x the sum of the frequencies for all species in stand x 100.
5. Abundance: Abundance of a species = total number of individuals of the species in all quadrats / total number of quadrats in which the species occurred.
6. Cover: The area covered or occupied by the leaves, stems and flowers, as viewed from above.
7. Relative cover of a species = total basal area of the species in all the quadrats/total basal area of all the species in all the quadrats x 100
8. Important value: The overall picture of the ecological importance of a species relative to the community structure can be obtained by adding the values of relative density, relative dominance, relative frequency and relative cover. This total value out of 400 is called the important value index (IVI) of the species.

All data are to be entered to the Twin Span computer program to help identify those species, which require a conservation (recovery) plan. As part of this programme, the PAMU herbarium will be expanded and properly curated.

Correlation with the grazing study:
The botanical monitoring programme is closely linked to the study on local grazing patterns and intensity in the mountain area around St Catherine Town.
1. The monitoring programme data are analysed to compare cover percentage of the protected and unprotected plant species in the study area.
2. The cover percentage gives a broad idea of the effect of grazing pressure on the range resource in the area and this will assist with the development of a sustainable grazing management programme for the high mountain area and for species recovery plans.
3. The grazing study and the monitoring of plant species will be extended to the other Protected Area sites.

Plant species recovery plans:
A recovery plan is already operational for Acacia with activities concentrated in southern wadis of the Protectorate. This recovery plan will be continued and extended under the SSRDP.

Recovery plans for Thymus decussatus (rare near-endemic), Moringa peregrina (rare tree) and Primula boveana (endangered endemic) will start during 2003.
The overall objective of the recovery plans will be:
1. Prepare and implement a long-term (five year) conservation plan for the species.

2. Ensure a viable population of the species by the end of the implementation plan.
3. Introduce measures for the sustainable utilisation of the species.

This will done by:

1. Mapping locations for occurrence of the species in the Protectorate.
2. Studying the natural regeneration of the species.
3. Quantifying threats and look for ways to combat them.
4. Designing a recovery plan involving all stakeholders.
5. Developing protocols for ex situ conservation of the species.

Grazing management monitoring and controls

Aim: To develop grazing management and grazing reserves to conserve plant communities and individual species and revive heilf and dakhl traditions where appropriate.

Purpose: The monitoring programme is to:

1. Quantify the impact of the free-ranging livestock of the Bedouin community.
2. Determine the consumed biomass of the different plant species, preferred diet composition and proportion of endemics consumed.
3. Determine the spatial properties (range and altitude profile) of livestock in the high altitude mountains of St Catherine .

Protocols to be used: The monitoring is to be continued for two years of continuous sampling. Four track logs a month are required from each settlement incorporated into the investigation, with two each for goats and sheep. About ten field observations are required a month. For the spatial analysis and range determination, GPS receivers equipped with track-log function are used. Direct observation is used for estimating the diet composition, utilised biomass and food preferences.

Track logs: The target is to record the position of the grazing animals at one-minute intervals. Track logs are to be downloaded using Mapsource then exported into .txt and imported into xls in Lat-Long and Old Egyptian datum and also in UTM-WGS 84.

Food preference and biomass estimates: Direct observation of palatable plant species utilised by sheep and goats. During observation, bite frequency and time spent biting each plant are to be recorded. A quantitative estimate of the consumed biomass of each species is logged with approximate bite size of each plant collected, oven dried and weighed.

CURRENT STATUS

GEOGRAPHICAL RANGE:

The five target plant species (*Silene leucophylla, Micromeria serbaliana, Ballota kaiseri, Euphorbia obovate,* and *Hyoscyamus boveanus*) are endemic to the St. Catherine Protected Area (SCPA) in southern Sinai, Egypt, recorded to have a narrow altitudinal range between 250 and 2,300 m asl (2050 m range), and presents about 23% of the total global attitudinal range (0-8848 m asl). The highest altitudinal range was recorded to *Hyoscyamus boveanus* (1550 m) and lowest was to *Micromeria serbaliana* (450 m) (Table 41).

Regarding to the Extent Of Occurrence (EOO), it ranged from 15.8 km^2 (*Ballota kaiseri*) to 3485 km^2 (*Hyoscyamus boveanus*), and their Area Of Occupancy (AOO) ranged from 12 km^2 (*Ballota kaiseri*) to 132 km^2 (*Hyoscyamus boveanus*) (Figure 21). In total, the distribution of all species cover about 4167 km^2 (EOO) and AOO about 232 km^2 (Map 23). These target species are clearly distributed in two locations (High Mountains Area and Serbal Mountain Area) (Table 41).

Table 41: Geographical distribution range of *Target species* inside St. Catherine Protected Area

Species	EOO	AOO	Alt. Range	Highest Frequency Sites	No. of locations
Micro.	65.8	44	1750-2200	Abu Mahshore, Shak Musa, Abu Hamman, and Elgabal Elahmar	2
Euph.	179	68	1000-2050	Farsh Elromana, El-Zawietin, Abu Walee, W. Elrahaba, Erheibet Nada	2
Hyosc.	3485	132	250-1800	Wadi Zaghraa, Wadi Soaal, Shag Telah, and Wadi Itlah	2
Silene	239.7	84	1600-2300	Shak Musa, Wadi Gebal, Gabal Mousa, Shak Abo-Hamman	2
Ballota	15.8	12	1600-2100	Wadi El-Arbaein, and Shak Abo-Hamman	2

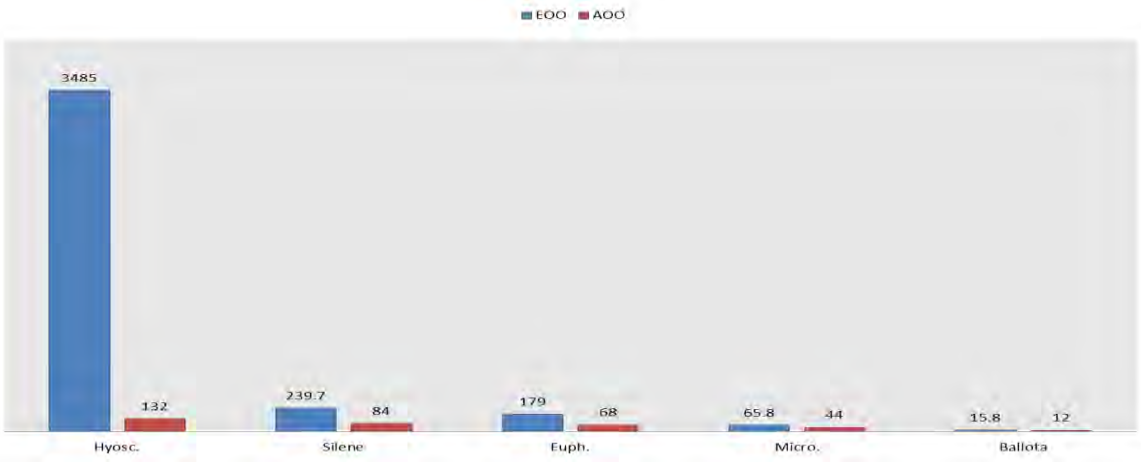
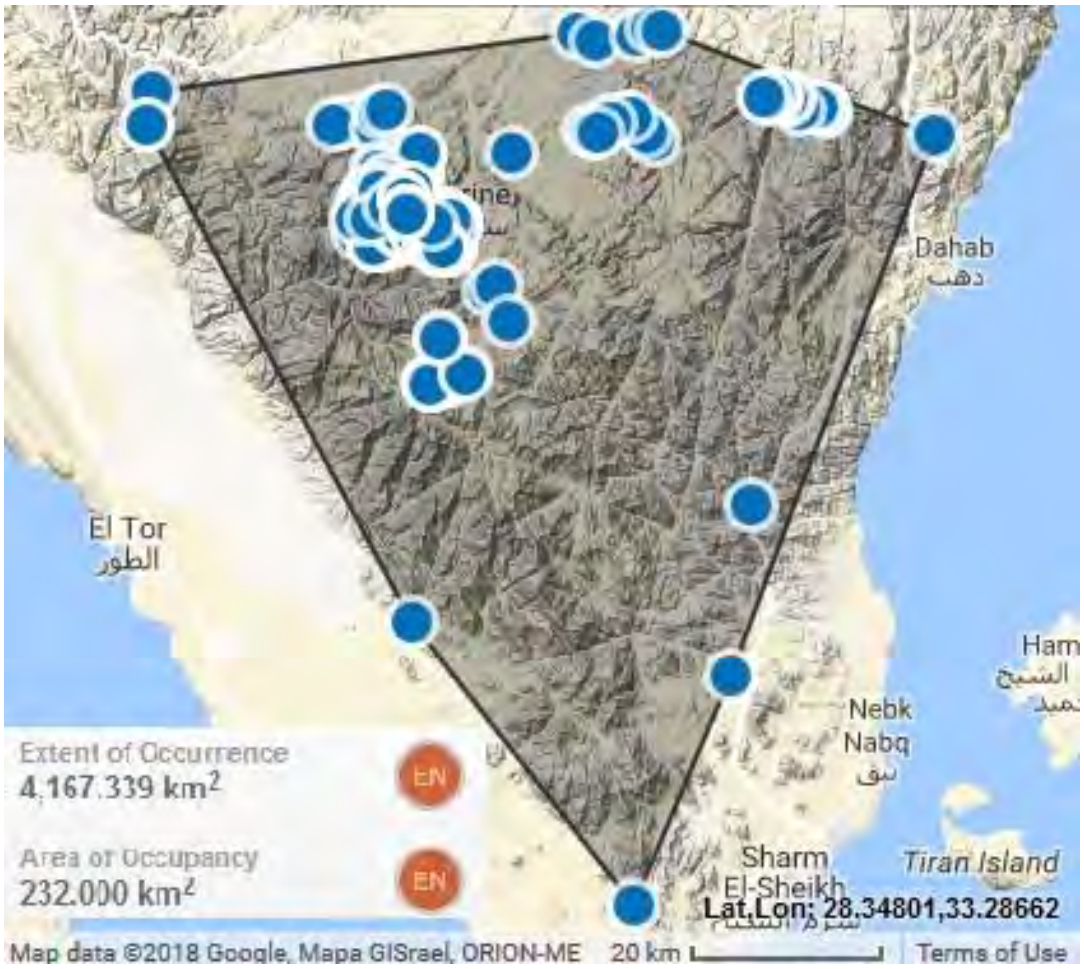
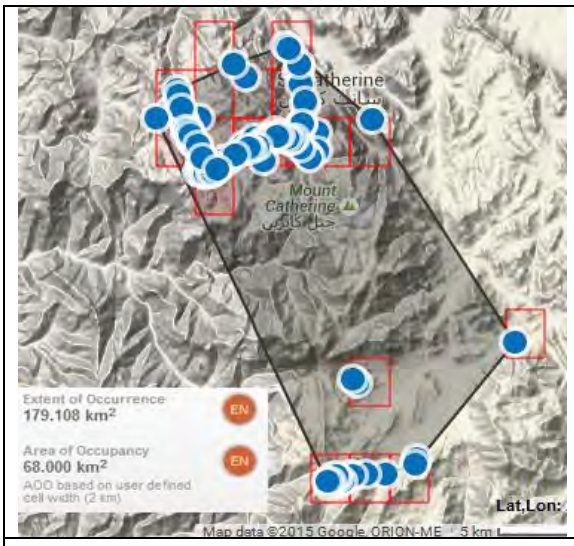
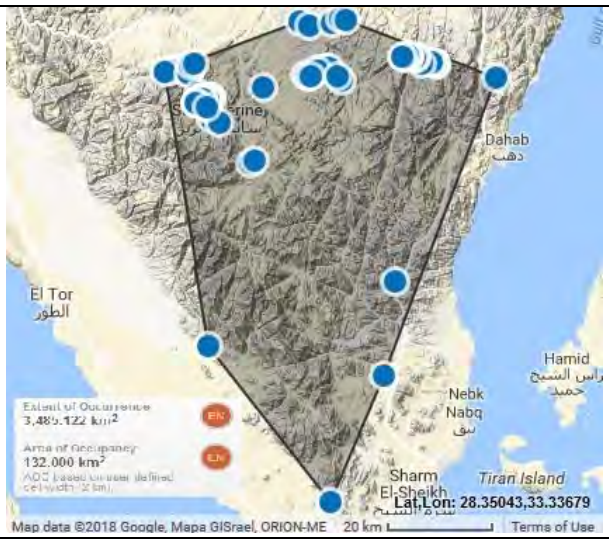
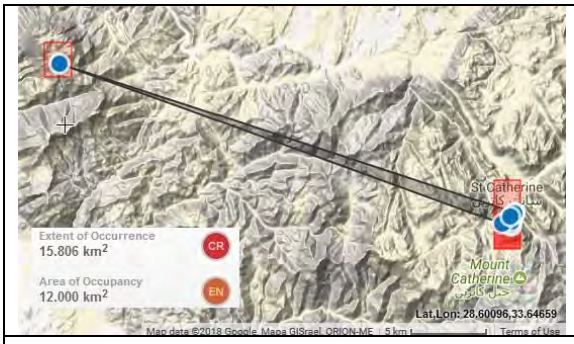


Figure 21. Extent Of Occourance and Area Of Ocubancy of target endemic species inside St. Catherine Protected Area

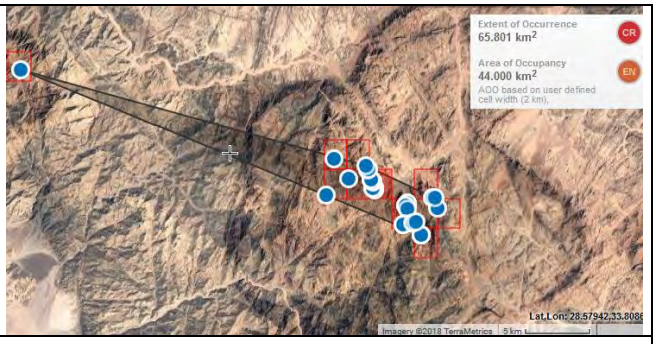


Map 23. Geographical Range map of *Target species* inside St. Catherine Protected Area

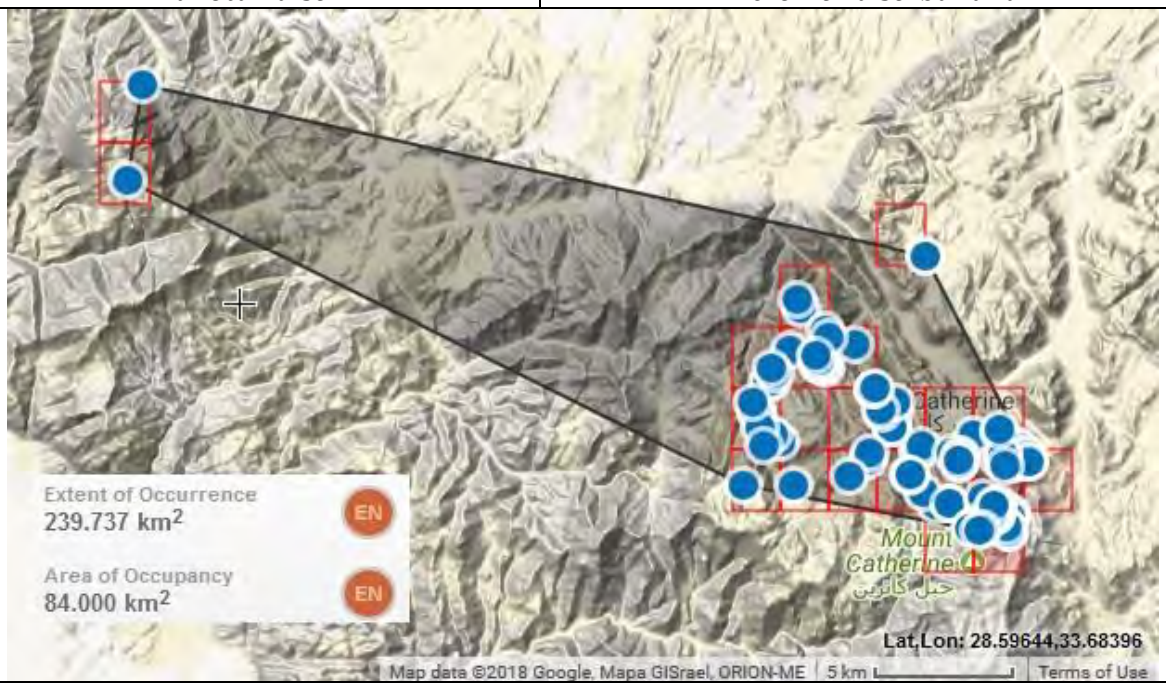
	
Euphorbia obovate	*Hyoscyamus boveanus*



Ballota kaiseri



Micromeria serbaliana



Silene leucophylla

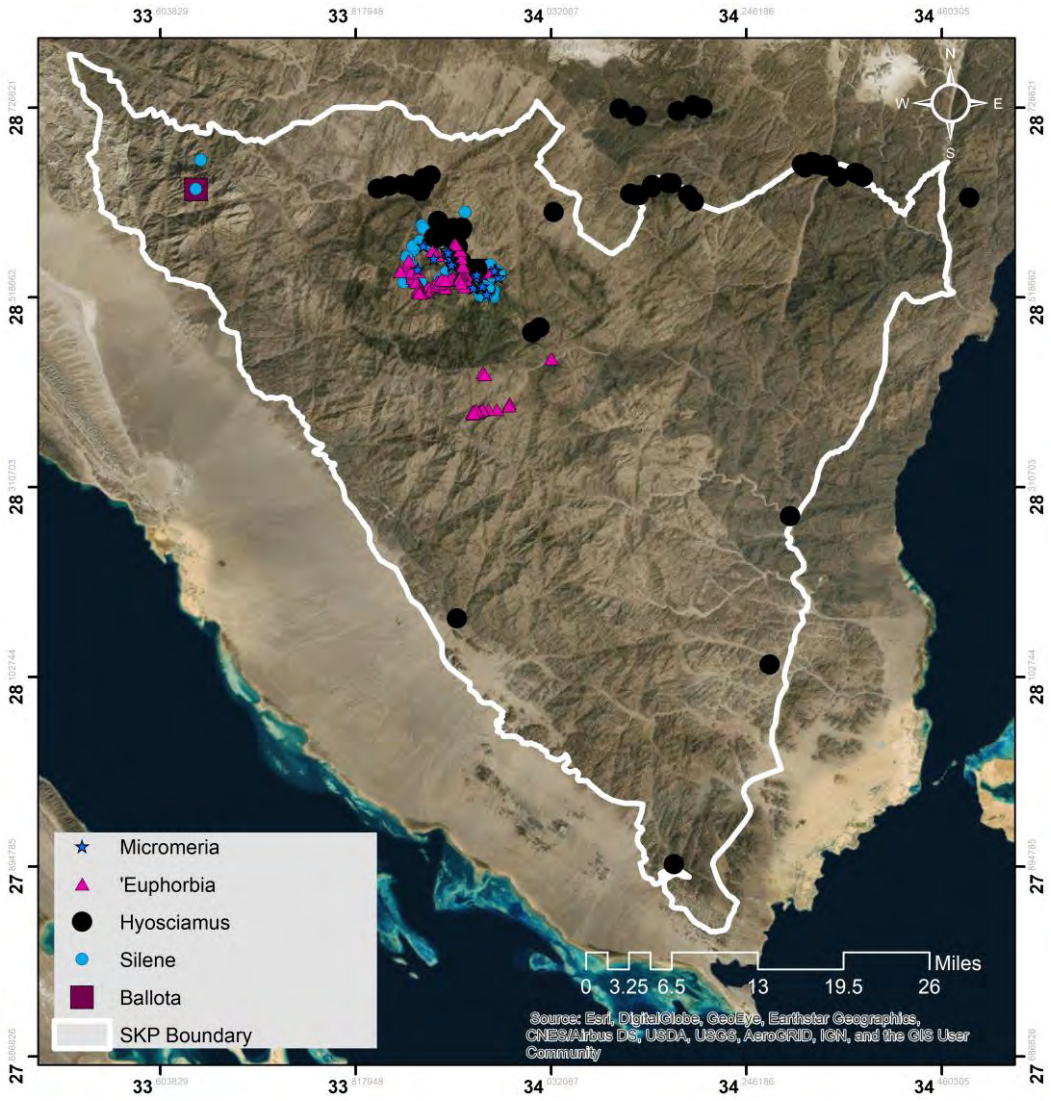
Map 24: Extent Of Occourance and Area Of Ocubancy of target endemic species inside St. Catherine Protected Area

POPULATION CHARACTERISTICS:

Most of the *Target species* subpopulations are small to very small, with individual plants occurring sporadically in space in little groups where the soil is gravelly and rocky (Map 25). The number of mature plants has been observed to decline as a result of several threats mainly, drought, over collection, over grazing, feral donkeys etc. The total global population size estimate for endemics ranged from 50 (*Ballota kaiseri*) to 3,000 mature individuals in case of *Hyoscyamus boveanus*. There are clearly separate subpopulations. During the last 10 years these subpopulations have been observed to have large changes in the total number of individuals, cover and density, due to over grazing by domestic and feral donkeys.

The populations of the target species are considered severely fragmented as the mountainous habitat acts as a barrier between the small subpopulations, and as many of these subpopulations have low viability due to destructive overgrazing causing loss of reproductive organs in case of *Silene leucophylla, Micromeria serbaliana,* and *Ballota*

kaiseri. Some work have been done by Mahmoud *et al.* (2008), Moursy (2010), Omar (2010, 2013), Shabana (2014) on the genetic variability of some endemic and near endemic species in the same area, these studies concluded that there are a great polymorphism between different subpopulations may come from the variation in topography and climatic conditions and confirm the presence of isolation between different subpopulations that cause the real fragmentation.



Map 25. Population structure of *target species* inside St. Catherine Protected Area

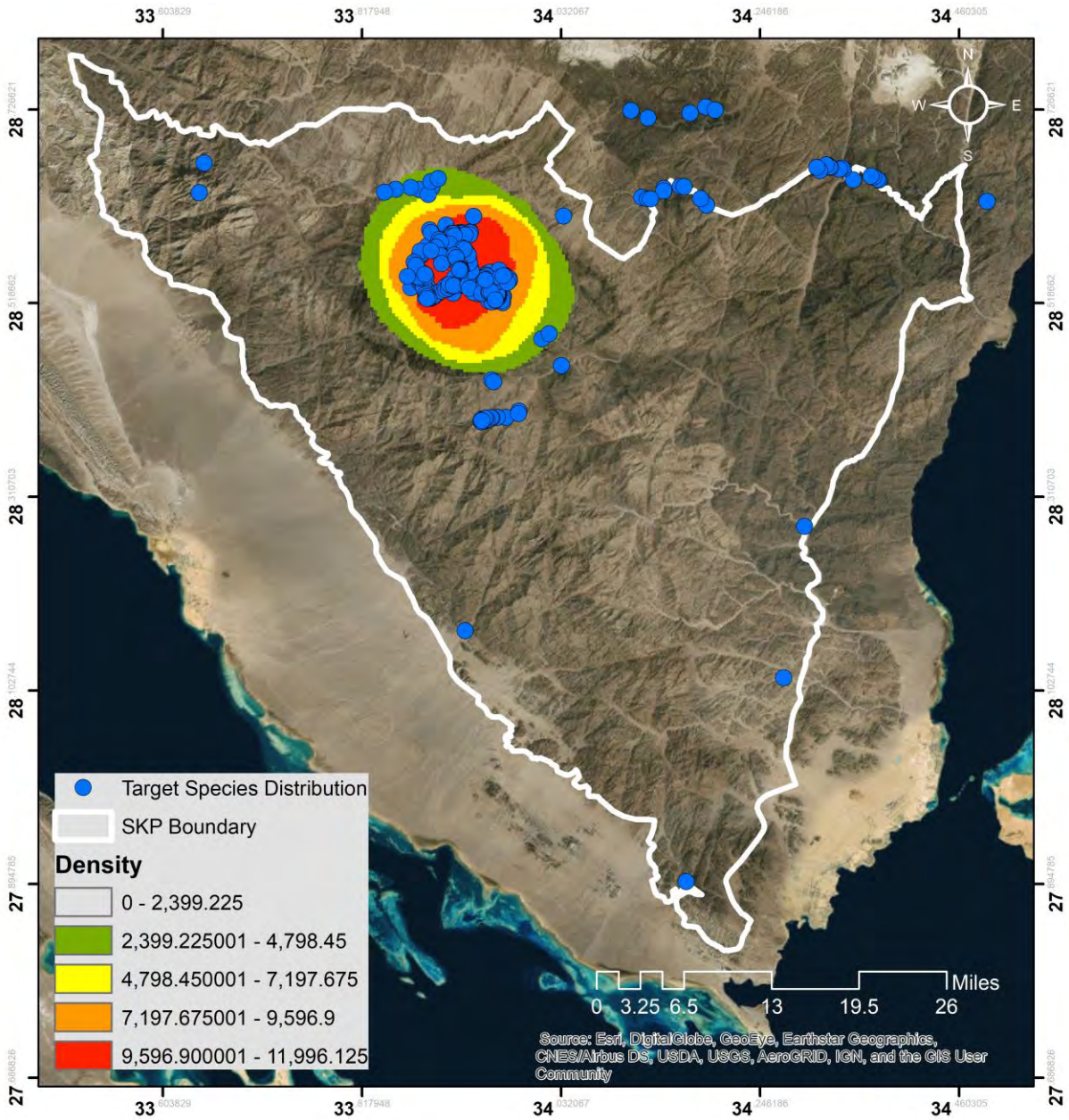
Table 42: Some facts about population characteristics of *the target species*

Species	Population Size	Largest subpopulation	Fragmentation	Connectivity
Microm.	500-1000	50	Yes - Mountains make barriers between different small subpopulations.	2
Euph.	2500-4000	600	Yes - Specific microhabitat and Mountains makes as barriers between different very small subpopulations.	2
Hyosc.	3000-5000	100	Yes - Distances to neighboring subpopulations, and mountains makes barriers between very small subpopulations.	3

Silene	1500-3000	50	Yes - The species suffers from destructive overgrazing that may reduce and terminate the process of producing reproductive organs.	2
Ballota	50-200	10	Yes - Mountains make barriers between different small subpopulations.	1

Note: Connectivity- 1 Very Weak and 5 Very strong

The species density varies from site to site based on target species but it's found that the highest density for all target species are concentrated in the high mountain areas especially Wady Gebal area, Elgabal Elahmar and Gabal Catherine area (Map 26). A total of three main locations were recorded (High Mountain area, Serbal Mountain area, and Elrahaba area). The effects of flooding (the most serious, plausible threat) will be felt separately in each area: thus these species are effectively in three clear locations.



Map 26. Density of all *target species* inside St. Catherine Protected Area

HABITAT AND ECOLOGY:

All target species are perennial herbs with a woody base. It has been observed that flowers mostly appear in late spring and reproduction is by seed in late summer. Target species are restricted to montane wadis with granite rocky ground of mountain areas especially at gorges, slope, wadi bed, and cliffs with steep slopes of up to 90° (Figure 22). Slope Aspect is another factor affecting the distribution dynamic of the target species, most of species were recorded in North, Northeast, Northwest, and West directions (Table 43). The cold winter climate (minimum temperature can reach -10°C) and cool summers (maximum temperature of c. 29°C) of the high elevations of Mt. St. Catherine are the coolest on the peninsula (Omar *et al.* 2013). The arid climate has a mean annual rainfall of about 37.5 mm (between 1971 to 2015), some in the form of snow, but there is great inter-annual variation with up to 300 mm in any one year, usually between October and May. Relative humidity is low, ranging from 10-35%.

Table 43. Preferable climatic, topographic, and edaphic conditions for target species

Species	Environmental Variables
Annual mini. Temp.	8.09-11.08
Annual max. Temp.	19.46-22.28
Precipitation	4.08-9.25
Soil texture	sandy, loamy sand, and sandy loam
water content%	0.23 - 32
pH	7.4 - 8.9
EC µs/ cm	18 - 673
Org.matter%	1.72 - 17.25
CaCO3%	12.5 - 47
Ca++meq/L	4 to 50
Mg++ meq/L	0.5 - 187.5
Na+ PPM	10.4 - 57.14
K+PPM	10.4- 163.82
HCO3- meq/L	4 to 19
Cl-meq/L	2.75 - 41
SO4-- meq/l	16.5 - 430

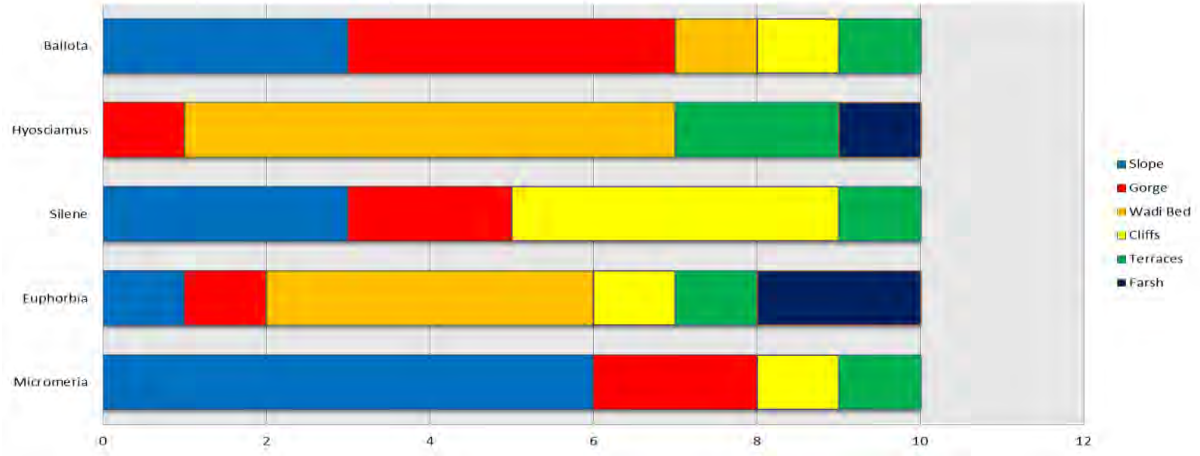


Figure 22. Percentage of each microhabitat for the distribution of target species.

As mention above and recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown, (1997) that soils of South Sinai are desert soils (Aridisols). This agrees with the observations of Kamh *et al.* (1989), Balba (1995), Moustafa and Zayed (1996) and Omar *et al.* (2013) that soils of the target area are gravelly in wadis and plains, rocky at mountains in the surface, sandy to loamy sand in texture, alkaline and non-saline to slightly saline. Its characterized by low content of essential nutrients and cation exchange capacity (CEC).

The optimum density and frequency for the target species were recorded at elevation between 1600 to 2000 m asl. This can be explained *as* the topography is a principal controlling factor in vegetation growth and the type of soils as recorded by O'Longhlin (1981); Wood et al. (1988) & Dawes and Short (1994). Elevation, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas (Titshall et al. 2000). Among these three factors, elevation is most important (Day and Monk 1974 & Busing et al. 1992). Elevation along with aspect and slope in many respects determines the microclimate and thus large-scale spatial distribution and patterns of vegetation (Day and Monk 1974; Allen and Peet 1990 and Busing et al. 1992).

THREATS:

Saint Catherine Protected Area is one of very few protected areas that have local communities work and live inside its boundaries. These interactions sometimes cause conflicts and threats on the natural resources of the PA. It was observed that donkey's distribution affected by vegetation cover (donkeys concentrated on areas with high vegetation cover) which actually affected by good water supply and showed negative relation with Bedouin community distribution (distributed away from human presence). It was recorded that hotspots areas for target species that located within elevations range from 1800 m to 2000 m such as Abu Tweita, Wadi Gebal, Farsh Elromana and Farsh Emsila showed the highest presence for feral donkeys. Grazing by these usually causes uprooting of the plants as indicated by Bedouins and field observations and this prevents plant regrowth. Soil compaction is associated with use by these animals and causes destruction to a variety of plant species through continuous trampling (Khafaja et al., 2006, Omar et al. 2013). *Silene leucophylla,* and *Hyoscyamus boveanus* are the most species negatively affected by this threat (Figure 23). However all these effects, much more research is needed on these Feral Donkeys especially regarding distribution dynamics, hotspots and direct and indirect effect on plant species distribution.

Sites like Abo Hebik, Elgalt Elazrak, Abu Tweita, Sherige, Shak Musa, Elmesirdi and W. Eltalaa are most targeted for plant collection. These sites are characterized by water supply and high plant biomass; however, plant collection increases with precipitation and is usually heavily between March and December each year (flowering season). It was observed that plants collection may be affected by economic factors. In other words, when tourism levels fall, Bedouin themselves start to collect plants for income. Local communities mentioned that women are the most common collectors of plants, and they collect 5 times per season. Although the reasons for collecting these plants are

always for trade or personal use as fuel, the use of plants as fuel has decreased sharply with the advent of butagaz (Assi, 2007, Omar et al. 2013).

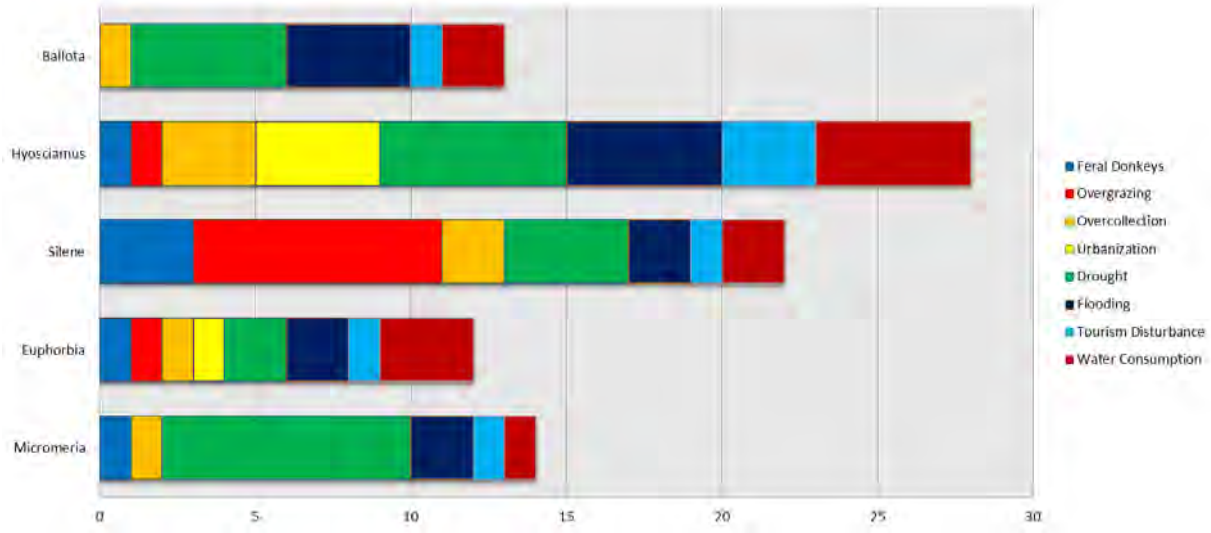


Figure 23. Threats levels on target species inside St. Catherine Protected Area

Gabal Musa, Gabal Catherine, Wadi Gebal, Farsh Elromana, Elgalt Elazrak, Abu Tweita, Wadi Tenia, W. Sherige and W. Eltalaa are the most sites presented the highest presence for tourism activities. About 3 million person from 51 nationalities visit SCPA from 2003 to 2011 with mean 335.000 people per year(SCPA Management), most of them focused on northern part of SCPA specially world heritage site. Many of the tourists do safari and camping in remote areas; usually safaris extend for many days using different camping points; the most camping points are in Farsh Elromana, W. Tenia and W. Gebal. Some of the negative impacts come from tourists in the way of collecting medicinal plants as a souvenir from the SCPA beside collection for fuel. Soil compaction of trespassing leads to poor vegetation cover comes from continuous walking. On other hand camping take place in shelter sites which give water source for tourists and this led to water consuming and direct effect on vegetation community. However all this the affect level for this activities are consider low, mush more researches are needed in this field.

Ungulates play a major role in regulating primary production (energy produced by photosynthesis) in grazing ecosystems (Huntly 1991). Defoliation can promote shoot growth and enhance light levels, soil moisture, and nutrient availability (Frank *et al.* 1998). Overgrazing, however, can significantly reduce biomass production. Grazing animals can decrease flower and seed production directly by consuming reproductive structures, or indirectly by stressing the plant and reducing energy available to develop seeds. Grazing animals can also disperse seeds by transporting seed in their coats (fur, fleece, or hair), feet, or digestive tracts (Wallander *et al.* 1995, Lacey *et al.* 1992). For some plant species, grazing ungulates may facilitate seed germination by trampling seed into the soil.

Regarding to grazing activities inside SCPA, Omar *et al.* (2013) found that Elmesirdi, Sheiage, Elgabal Elahmar and Shak Musa are the most sites represented the highest presence for goats which can explain by it are the closest sites to local communities' settlements. Elawitein, W. Gebal, W. Tenia, Abu Tweita and Farsh Elromana are the most

sites represented the highest presence for camels which can explained by the easily accessible and heavily used by tourists for camping which camel take place in transportation. Results showed that Tebook, Abo Twita, Ain Shekia, Shak Sakr and Elmesirdy represent the highest number of grazed individuals among the different locations, because these locations are stressed by tourism and human activity which are combined by the presence of camels and donkeys as transportation tools to and from historical sites, Bedouin communities are also settled beside these locations and this gives goats high presence in these locations. *Silene leucophylla* is the most target species negatively affected by grazing.

Table 44: Threats on *Target species* based on IUCN Threats Classification Scheme

Code	Threat	Timing	Scope	Severity	Impact Score
2.3.1.	Agriculture & aquaculture -> Livestock farming & ranching -> Nomadic grazing	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
5.2.1.	Biological resource use -> Gathering terrestrial plants -> Intentional use (species is the target)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
6.1.	Human intrusions & disturbance -> Recreational activities	Ongoing	Minority (<50%)	Causing/Could cause fluctuations	Low Impact: 5
6.3.	Human intrusions & disturbance -> Work & other activities	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
7.2.5.	Natural system modifications -> Dams & water management/use -> Abstraction of ground water (domestic use)	Ongoing	Minority (<50%)	Slow, Significant Declines	Low Impact: 5
8.1.2.	Invasive and other problematic species, genes & diseases -> Invasive non-native/alien species/diseases -> Equus asinus	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
11.2.	Climate change & severe weather -> Droughts	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.3.	Climate change & severe weather -> Temperature extremes	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9
11.4.	Climate change & severe weather -> Storms & flooding	Ongoing	Whole (>90%)	Very Rapid Declines	High Impact: 9

Very few sites were affected by collection for scientific researches (Herbarium, phytochemistry and genetics), the most affected research was the collection of specimen for herbarium because the collectors sometimes collect a big amount of plants with flowering parts and roots which may lead to decrease of future population. Also collection for phytochemistry requires more than kilo for good extraction. Results showed that the most affected sites were Kahf Elghola, Wadi Alarbein, Wadi Tennia, Abu Tweita, Elmesirdi, Abu Kasaba, Shak Musa, Shak Elgragenia, and Elgalt Elazrak. *Silene leucophylla, Micromeria serbaliana, Ballota kaiseri,* and *Hyoscyamus boveanus* are the most targets for this activity.

Due to climate change, the wild population of these species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the difficulties of some species to reproduce new generations as a result of overgrazing by herbivores that even eat the reproductive organs and decrease the chance for the possibility for creating new generation (observed- *Silene leucophylla*), the

very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (1-5% loss observed). Water is being relocated in some localities from elevated wadis which are rich in water to supply to low

Most of threats root cases comes from lack of awareness, weak law enforcement, lack of suitable strategies, weak financial support and lack of stakeholders cooperation. Since human activities have a strong effect on biodiversity, a population/community level approach is considered to be the level that can help in exploring the responses of the whole ecological system to various kinds of disturbance as reported by Hanski and Gilpin, (1991) and Barbault and Hochberg, (1992).

In general, these species are severely threatened by both natural (aridity of the area and climate change-flooding) and human factors (over-grazing by domestic animals and feral donkeys, over-collection, and unmanaged tourism activities). All these factors are pushing *Target species* to the brink of extinction. *Silene leucophylla, Micromeria serbaliana,* and *Hyoscyamus boveanus* are the most negatively affected species by these threats (Figure 24).

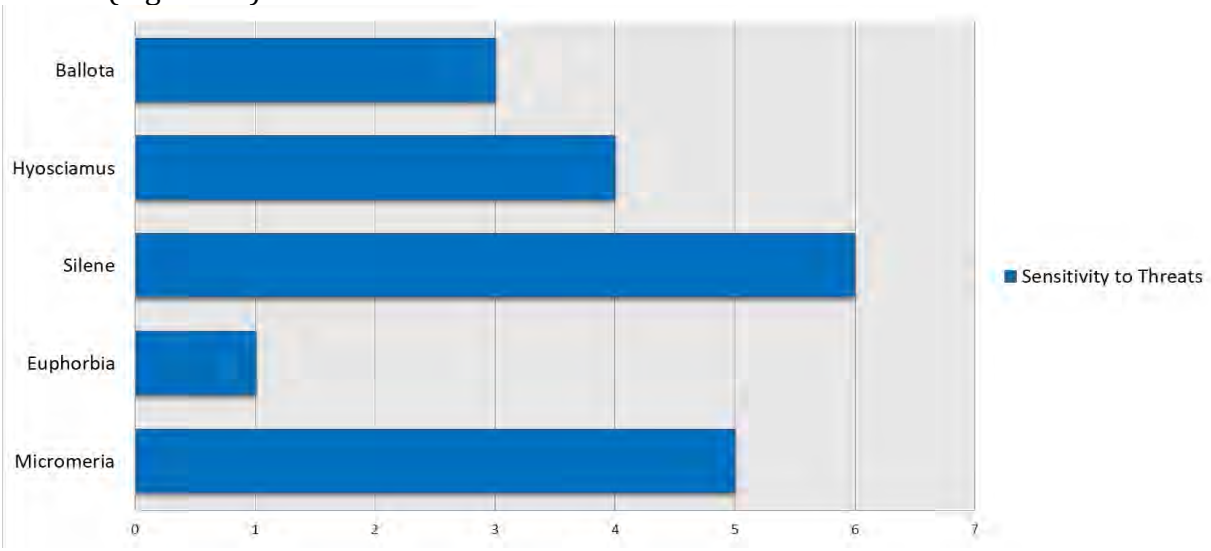


Figure 24. Target species sensitivity to different threats; 1=Very low and 10= Very high

Many studies (Assi, 2007 and Khafagi et al. 2012) were extracted the root causes of main threats and suggested solution to reduce them

Table 45: Main threats recorded within St. Catherin PA, root causes, barriers, and solutions

Threat	Root causes	Barriers	Solutions
Feral Donkeys:	• Bedouins, after recent settlement around SK City, have left the donkeys neglected in the mountains. • Those animals require high amount of feeding and were largely replaced by	• Lack of strategy to deal with invasive species. • Insufficient awareness on possible damages resulting from invasive species. • Loss of sufficient funding for addressing feral animal abundance.	• Use conventional methods of control including soft catch traps and hunting. • Increase awareness of Bedouins about the impacts (and potential impacts) of feral species on their environment and their culture emphasizing the importance of eradication

	camels. • The recent use of trucks for water transport.		and management. • Establish a comprehensive strategy, using a participatory approach with the local Bedouins, to deal with possible future colonization. • Establish a strategy to prevent and control invasive species.
Over collection:	• Quick economic gain. • Increased market demand for medicinal plants at the national level. • Firewood gathering for heating and cooking. • Bedouins recent settlements in "Wadis" around SK increased over collection around those settlements. • Poverty encourages intensive use of natural resources including medicinal plants. • Cheap prices offered per bag in the absence of added value and proper market linkages. • It's away for money gain when tourism falls down.	• Week enforcement of regulations. • Lack of awareness on plant values, endemism, and ecological role. • Most collectors are not organized in an association or cooperatives, etc. • Limited accessibility to firewood alternatives in remote settlements. • Land tenure: "Open access" system. • Inadequate alternative sources of income. • Cultivation areas insufficient to meet demand. • Cultivation programmers do not involve the wild collectors. • Lack of fund source to encourage local community to use other methods for gaining money.	• Develop species-specific regulations regarding harvesting quotas, rotation of collecting areas, etc. • Cultivation reduces the pressure on Medicinal Plants (MP) wild population and decreases overharvesting. The project should continue the cultivation program; however, there should be a focus to involve wild collectors in cultivation of MPs. • Increase awareness and capacities for the law enforcement cycle. • Enhance MP association (Association located at SK City) capacities for marketing of conservation friendly MP products. • Strengthen technical and capacities of the MP association for value-added process and product improvement. • Conduct extensive trainings for local collectors on time of harvesting, suitable manners of transporting, and storing of medicinal plants to avoid loss in quality and quantity. • Increase consumer sensitivity towards biodiversity friendly MP-derived products. • Promote regeneration or reinforcement of populations by re-seeding or other ways of propagation as appropriate for each species. • Rehaplitation proses must take place for rare species affected by over collection. • Finding continues source

			for money to those who haven't any source for living except collection of medicinal plants.
Tourist Intrusions:	*Trespassing beyond trails borders:* • Negligence and saving time. *Collection of firewood during camping:* • Negligence. • Guide saving money (instead of buying the firewood from the city).	• Week enforcement of regulations. • Low level of awareness among tourists on plant values, endemism, and ecological role. • Insufficient awareness among tour operators and tour guides with respect to Protectorate's regulations. • Insufficient number of protectorate's staffing.	• Increase awareness regarding the regulations on firewood among stakeholders engaged in tourism businesses. • Increase awareness among tourists on plant values, endemism, and ecological role. • Produce awareness materials on the threat of firewood collection on biodiversity including MPs to be distributed in the Protected Area visitor's center. • The appointment of people to work in order to monitor the activities of park visitors and provide environmental services and information to them.
Overgrazing:	• Bedouins recent settlements in "Wadis" around SK resulted in limited land available for grazing around those settlements. • Collapse of the traditional grazing system (Hilf).	• Lack of efficient and sustainable implementation of alternatives to grazing. • Limited access of the Bedouins to, and high cost, of supplementary animal feed. • Land tenure: "Open access" system. • Lack of extension and veterinary services for herds. • The Agricultural unit in SK is not active.	• Investigate local Feed block Unit feasibility. Promoting feed blocks as supplemental feeding may be a sustainable solution that could be investigated. Feed blocks make use of non-conventional local feed resources including olive and fruit remnants, etc. This is a cheap alternative and can alleviate some pressure on grazing resources. • Continue efforts in reviving the traditional grazing system "Hilf". • Increase the public awareness about the importance of MPs and endemism and the way they can select the most appropriate places for grazing.
Collection for Scient Research:	• Increased interest at the national and international levels in studying the active ingredients and other characteristics of MPs species (particularly endemic and rare species). • Researchers	• Week enforcement of regulations. • Low level of awareness on Good Harvesting Practices. • Insufficient number of rangers. • Most laboratories are using	• Increase awareness in universities and research institutions on good harvesting practices when collecting for research studies. • Enforce regulations concerning collection permits signed by EEAA and universities and

	are interested in conducting their studies on sources obtained from the wild rather than from cultivation. • Low of researcher awareness about the importance of MPs and the actual quantities they want.	old equipment which requires large amount of plant material for extraction and detection of active ingredients. • Lack of communication between SCPA and universities. • Low levels of trust between SK Protected Area and universities which lead some researchers to collect plants without permission from SCPA.	research institutes within and outside Egypt. • The appointment of new researchers to work within SCPA in order to monitor the activities of park visitors and provide environmental services and information to them.
Urbanization and Settlements Expansion:	• More Bedouins are involved in tourism activities concentrated around SK City. • Expanding population. • Access to schools and other modern facilities. • Recently advices to reconstruction of Sinai by government to encourage youth to migrate to Sinai.	• Institutional planning deficiencies. • Lack of socio-economic development and adequate/essential services in remote areas. • Lack of cooperation between SCPA and city council and the lack of trust between two organizations. • Encroachment of land by force from Bedouins.	• Increase the public awareness about how they can choose the places for gardens, dams, wells and houses. • Strength the cooperation between SCPA and city council in planning and site management by sharing data about places and its importance.
Quarries:	• Meet high demand for construction in South Sinai. • Lucrative trade in granite, cement, limestone and sandstone inside and outside Egypt. • Part of Sinai re-construction by encourages peoples to work in this rich field.	• Institutional planning deficiencies. • Weak law enforcements.	• Increase public awareness about the importance of MPs and historical sites. • Select suitable sites far from valuable sites. • Raising the price of quarrying to reduce demand by Bedouins and people who interest in business.

Natural resource policies aim to provide people the opportunity to enjoy and benefit from natural environments evolving by natural processes with minimal influence by human actions. The National Park Service (NPS) will ensure that lands are protected within park boundaries. Where parks contain nonfederal lands, the NPS uses cost-effective protection methods. Preservation of character and resources of wilderness areas designated within a park, while providing for appropriate use, represent the primary management responsibility. The National Parks and Conservation Association

is a national nonprofit membership organization dedicated to defending, promoting, and enhancing our national parks, and educating the public about the NPS.

The results of evaluation of monitoring data will help to pinpoint where, and how, a plan should be remodeled. Restructuring or redesign of plan elements based on the results of this study, will contribute to adaptive management, i.e. management which is responsive to changing conditions and project objectives. The plan should set out the time intervals (mid-term, terminal) between evaluations and should state who (individual, organization, or agency) will carry out evaluations and who will be the recipients of reports. For the evaluation to have some practical effect in improving conservation management there should be specific mechanisms for feeding the results of evaluation back into the management process, and assigned responsibilities for follow-up. As with monitoring, evaluation should be an ongoing part of biodiversity conservation management, rather than a project-based activity.

FINANCIAL SUPPORT:

Funding is the lifeblood of Protected Area management. Without adequate funding and proper financial planning, the sustainable management of the St Catherine Protected Area would be seriously compromised. Protected areas of Egypt are facing a great challenge effect negatively on the achievement of their goal. Weak financial support by time led to great deterioration in the effectiveness of managing and conserving the biodiversity values. Funding is required for both capital investments, i.e. infrastructure and equipment replacement and for operational expenses like salaries, maintenance and management activities. Funding for Protected Area management comes from central Government disbursements; these raise by revenue generated from entrance fees, etc. However, St. Catherine PA not gets the total entrance fees and most of the budget is spent on workers' salaries in the cleanliness of Mount Mousa. Probably there are no budget for surveys and conservation assessments and actions.

The conservation of threatened plants is costly and need alternative body for funding beside the government. The Protectorate's annual budget requirements must be determine annually on the basis of the Annual Operational Plan and should be varied according to planned and completed activities. Population size, distribution & trends, threats, species action/recovery plan, area-based management plan, population trends, habitat trends, etc. must be done within the next few years to ensure the conservation of threatened plants in St. Catherine PA.

SUGGESTED CONSERVATION PLAN:

The entire world distribution for the target species is inside the St. Catherine Protected Area (SCPA) except *Hyoscyamus boveanus*. Regular monitoring by SCPA rangers takes place every two years to detect the effect of this protection on population trends (Shabana *et al.* 2011). On average 20 checks are made every year to keep a watch on the current situation for the plant and its habitat, and to record any detrimental activities.

Undertaken by the United Nations Development Program (UNDP), the Global Environment Facility (GEF) and the Egyptian Environmental Affairs Agency (EEAA), the Medicinal Plants Conservation Project (MPCP) tried to conserve some important species, target species were among of them, using cultivation inside greenhouses, rehabilitation, as well as collecting and storing their seeds for future use. The Medicinal Plants Conservation Project was launched in January 2003 and ended in 2013. It is a national project that aims at examining and eliminating the root causes to the loss in biodiversity and addressing the threats to the conservation and sustainable use of medicinal plants in Egypt through a number of interventions, while at the same time empowering the Bedouin community to use and manage its resources in a sustainable manner. It aims at conserving the medicinal plant species within the ecosystem (in situ) through the development of sustainable management practices, including the protection of hotspots and individual plants or populations wherever it is not possible to utilise the resources sustainably. Ex situ conservation measures will be applied when the threat to a species is considered severe and warrant such measures (MPCPEgypt, 2010). Great work have been done in this scope but unfortunately, there is no continuity for such activities after the finish of this project resulting from the absence of clear future plan for managing such activities as well as the financial abilities become unstable for step forward.

However all these activities and efforts the situation of the target species is threatened. This may come from the weak financial support to PA management, insufficient staff numbers to do the main role of monitoring and conservation efficiently in the large protected area (4350 km^2), and the weak linkage between PA Management and higher decision makers in EEAA.

Several legislations were set to protect natural resources and regulate its uses such as Law 102/1983. Ministerial Decree 1067/1983, Prime Ministerial Decree 264/1994, Law 4/1994, Prime Ministerial Decree 613/1986. Law 2/1973. Law 117/1983. Ministerial Decree 66/1983, Presidential Decree 374/1991, Ministerial Decree 1611/1989 (Ministry of Justice), Ministerial Decree 1353/1996, etc. Although of all these laws and regulations, the species is still in extreme danger and one of the most important threats that may lead to extinction is collecting. Theirs urgent needs to held specific Critically Endangered species conservation convention, Influencing legislations appropriations, harsher punishment for endangered plant species assembly without clear permission from the main authorities (Table 46).

Table 46. Important Conservation Actions Needed for *Target species* conservation.

Action Needed	Status
1 Land/water protection	
1.1 Site/area protection	Done
1.2 Resource & habitat protection	Need active enforcement
2 Land/water management	
2.1 Site/area management	Maintenance of habitat, maintenance of enclosures, area hands off, training staff
2.2 Invasive/problematic species control	Not applicable
2.3 Habitat & natural process restoration	Habitat restoration, water rights, to reduce of stop species collecting.
3 Species management	
3.1 Species management	

3.1.1 Harvest management	Highly needed - *Hyoscyamus boveanus*
3.1.2 Trade management	Highly needed – *Hyoscyamus boveanus*
3.1.3 Limiting population growth	Not applicable
3.2 Species recovery	
3.3 Species re-introduction	Highly needed
3.3.1 Reintroduction	Highly needed
3.3.2 Benign introduction	Highly needed
3.4 Ex-situ conservation	Highly needed
3.4.1 Captive breeding/artificial propagation	Seed collection, artificial propagation from seeds, botanical garden, seed storage, tissue culture, Cultivation
3.4.2 Genome resource bank	Seed bank, freezing cuts from the plant, or stocking the seeds, Tissue bank, Cryobank, Pollen bank, Field gene bank
4 Education & awareness	
4.1 Formal education	Universities, Scientific Research Centers, School student
4.2 Training	Enhance knowledge about conservation importance to species for staff and stakeholders.
4.3 Awareness & communications	Media, web blogs, journal articles
5 Law & policy	
5.1 Legislation	
5.1.1 International level	Endangered species conservation convention
5.1.2 National level	Influencing legislations appropriations
5.1.3 Sub-national level	Harsher punishment for endangered plant species assembly without clear permission from the main authorities

Based on the information extracted from this study about the conservation status of some endemic and near endemic species we can conclude and recommend the following actions:

- There is an urgent need to integrate the knowledge derived from ecological, demographic and geographical approaches extracted from this study to species conservation in order to be able to formulate management strategies that take into account all different considerations.
- *Silene leucophylla, Micromeria serbaliana,* and *Ballota kaiseri* have the first priority when species recovery take place through rehabilitation, restoration, reintroduction, and benign introduction in areas that have similar environmental conditions extracted from this study.
- There is an urgent need to conserve the target species outside its habitat (Ex situ) though seed collection, artificial propagation from seeds, botanical garden, seed storage, tissue culture, cultivation, seed bank, freezing cuts from the plant, or stocking the seeds, Tissue bank, Cryobank, Pollen bank, and Field gene bank by planting plants for the conservation of genes.
- There are urgent needs to work fast in two directions to keep these species save; 1) Ex-situ conservation through a seed bank, genome resource bank, and artificial propagation, 2) In-situ conservation through rehabilitation and restoration, and fenced enclosures. It's important to carry out a wide range of educational and awareness activities in universities, and scientific research centers about the sensitivity of this important threatened species.
- There is an urgent need to carry out annual monitoring on species population trend, habitat trend, fluctuations, and reduction probability to fellow up its situation.

- Further scientific studies are needed to achieve the maximum accuracy for the best conservation practices for the target species (Table 47); this include population and habitat trend, threats direct and indirect effect, threat management, species genetics, increasing productivity of medicinal plants, etc.

Table 47: Important Research needed for *target species*

Code	Research Needed	Specification
1.2.	Research	Population size, distribution & trends
1.5.	Research	Threats
2.1.	Conservation Planning	Species Action/Recovery Plan
2.2.	Conservation Planning	Area-based Management Plan
3.1.	Monitoring	Population trends
3.4.	Monitoring	Habitat trends

- Regarding to threats on the target species, solutions were set by Assi (2007) and Omar *et al* (2013) and confirmed by this study; these solutions can be summarized as follow:
    - Developing a management plan for the control of feral donkeys in the area.
    - Establish a comprehensive strategy, using a participatory approach with the local Bedouins, to deal with possible future colonization.
    - It was found that drought is the major factor controlling the distribution of feral donkeys and with simple management plan this threat can be reduce.
    - Regulating of grazing activities and intensity through the Bedouin's tradition "El-Hilf".
    - Develop species-specific regulations regarding harvesting quotas, rotation of collecting areas, etc.
    - Cultivation reduces the pressure on Medicinal Plants wild population and decreases overharvesting.
    - Increase awareness and capacities for the law enforcement cycle.
    - Conduct extensive trainings for local collectors on time of harvesting, suitable manners of transporting, and storing of medicinal plants to avoid loss in quality and quantity.
    - Promote regeneration or reinforcement of populations by re-seeding or other ways of propagation as appropriate for each species.
    - Rehabilitation process must take place for such threatened species affected by over collection.
    - Increase awareness regarding the regulations on firewood among stakeholders engaged in tourism businesses.
    - Increase awareness among tourists on plant values, endemism, and ecological role.
    - Increase awareness in universities and research institutions on good harvesting practices when collecting for research studies.
    - Enforce regulations concerning collection permits signed by EEAA and universities and research institutes within and outside Egypt.
    - Increase the public awareness about how they can choose the places for gardens, dams, wells and houses.

- Strength the cooperation between SCPA and city council in planning and site management by sharing data about places and its importance.

- St. Catherine Protected Area need to sufficient financial resources and increasingly efficient management to equal global levels, and to provide permanent tributaries of funding to modernize the scientific methods of protection systems. Without such funding and without qualified trained staff all this study will be ink on paper.
- It's highly recommended to use the information extracted from this study (Tables, figures, maps) when conservation process take place trough In-situ or Ex-situ techniques.
- It is recommend using this study specially these species as a base line to detect the effect of global warming on species distribution by annual monitoring.

Many other species are threatened inside the protected area boundaries, conservation actions should be directed to the following species:

Table 48: Priority taxa for conservation inside St. Catherine Protected Area

No	Species	RL Category
1	Allium crameri Asch. & Boiss.	NE
2	Anarrhinum pubescens Fresen.	NE
3	Astragalus fresenii Decne.	NE
4	Ballota kaiseri Tackh.	NE
5	Bufonia multiceps Decne.	NE
6	Colchicum comigerum (Schweinf. ex Sickenb.) Tackh. & Drar	NE
7	Euphorbia obovata Decne.	NE
8	Hyoscyamus boveanus (Dunal) Asch. & Schweinf.	NE
9	Micromeria serbaliana Danin & Hedge	NE
10	Muscari salah-eidii (Tackh. & Boulos) Hosni	NE
11	Origanum syriacum L. subsp. sinaicum (Boiss.) Greuter & Burdet	NE (Species draft of NT)
12	Phagnalon nitidum Fresen.	NE
13	Phlomis aurea Decne.	NE
14	Plantago sinaica (Barn.) Decne.	NE
15	Polygala sinaica Botsch. var. sinaica	NE
16	Primula boveana Decne. ex Duby	CR (2014)
17	Pterocephalus arabicus Boiss.	NE
18	Rorippa integrifolia Boulos	NE
19	Rosa arabica Crep.	NE
20	Scorzonera drarii Tackh.	NE
21	Silene leucophylla Boiss.	NE
22	Silene odontopetala Fenzl var. congesta Boiss.	NE (Species also NE)
23	Silene oreosinaica Chowdhuri.	NE
24	Silene schimperiana Boiss.	NE
25	Veronica kaiseri Tackh.	Draft – DD
26	Vicia sinaica Boulos	NE

Seed Collection & Storage

Methodology:

Seed Collection:

PLANNING SEED COLLECTING EXPEDITIONS:

- The team made contact with St. Catherine Protected Area Management staff the main responsible body for protecting the target species for arranging the seed collecting.
- Target species were checked that are not listed under international agreements or directives that give them special status.
- The team had studied maps of the area and developed a rough timetable for the collecting trip.

SEED COLLECTION (Sampling):

- In our case (restricted plants), there are a few populations ranges from one to 2 population in the whole Egypt.
- Basic vegetation survey (Eco geography) was done to determine the distribution of the target species and the geography of subpopulations of the target species in order to determine the collection sites (Part I).
- In order to minimize risks to the future survival of plant populations, and particularly in the case of threatened species in small populations, the team collected no more than 20% of the total mature seeds available on the day of collection.
- Two replicates were done from each accession. The number of the accessions were determined based on the species distribution and current conservation status and threat level (ranged from 2 to 3 accession for each species)
- Number of seeds per accession was varied based on the target species phenology and fruit size.
- Where the number of plants sampled is less than 20, we kept seeds from different plants separate.

SEED COLLECTION:

- Old, empty or immature seeds prior to collecting were checked
- The seeds were collected in paper, plastic bags based on the target species.
- Based on vegetation analysis and conservation priorities, number of sampling were 14 sites.

PLANT IDENTIFICATION AND DOCUMENTATION:

Passport data:

- Data about species and target area full description (topography, flora, threats, soil, climate, etc.) were collected and presented in this work in the form of tables, figures, and maps.

SEED DRAYING AND CLEANING:

- After collection of seeds we left it in paper bags on trays in a dry, airy place with no drafts or direct sunlight for three to four days or until seeds appear visibly dry.
- Shacked daily to speed up this phase and make sure the seeds don't go moldy.
- Collections were cleaned to remove empty, poorly developed and insect-infested seeds and debris

SEED STORAGE:

SEED BANK:

- The team were willing to submit the collected seeds to places where they will be save and useful for future work in cultivation and research.
- After cleaning the seeds we had submitted it to St. Catherine Protected Area Management for partly storage for very near future use in germination (stored under -15 C). It's not long term conservation but it will help to reduce the stress of collecting these plants from wild.
- In case of St. Catherine PA the storage will be for short time (Maximum 2 years) until the use for cultivation or research.
- The team mot able to submit this collection to Desert Research Center or Agriculture Research Center in Egypt because of the administrative obstacles.

Saint Catherine Protected Area in South Sinai

Date of Announcement: 1988
Area: 4250 Km^2
Type:World cultural and Natural heritage protected area
Distance from Cairo: 500 Km

The Area is characterized by the highest mountain tops in Egypt. These tops were the result of that great tectonic movement called the Great African Rift that occurred 24 Million years ago and led to the creation of the Red Sea and the Aqaba Gulf, which became the attraction of tourists from all over the world. St. Catherine Protected Area has abundant natural riches and cultural heritage. It has a natural habitat for several plants and animals.

For example:

- **Wild Life:** Mammals like the Nubian Ibex, Drocas - Gazalla Egyptian deer, hyrax, Sinai tiger, wolf, hyena, fox, lizard, hedgehog, echinate rat, and jerboa etc. There are 27 species of reptiles like serpents, vipro dab lizards, monitor lizards, and snakes etc.

- **Plant Life:** The Area also has 22-28 species that are exist only in Sinai like , samm, Habaq, sorrel wood, thyme, worm wood, buck thorn, tarfa, sakaraan, Ba'ataran and other medical and poisonous plants.
- **Ancient Heritage:** There are a lot of churches and monasteries like St. Katherine Monastery, and relics from the Byzantine, Pharaonic and later eras.
- **Scenery:** The Area is very high and has the highest mountains in Egypt like St. Katherine, Serbal, Um Shomer, Thabet, mountainous scenery, oases around water springs and wells that are unique attractions worldwide.

Contact details:

Website: http://www.eeaa.gov.eg/en-us/topics/nature/protectorates.aspx
Email: ibrahim_abdelrafee@yahoo.com

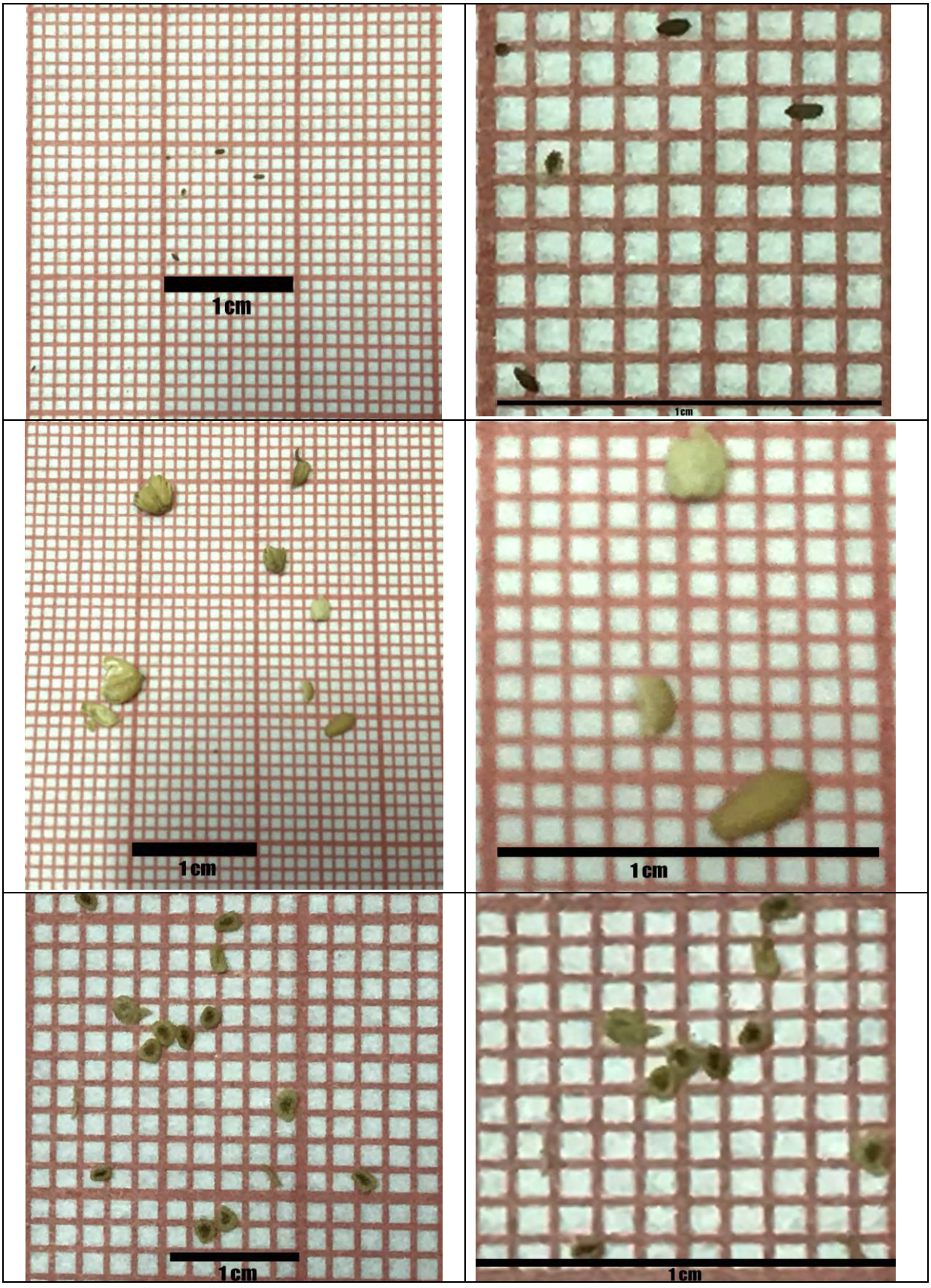
Results:

- A total of 3 accessions were collected from 3 species located in 5 sites.
- One accession was collected from *Micromeria serbaliana, Euphorbia obovate, and Hyoscyamus boveanus.*
- As a result from extensive threats on the study area the team didn't found any seeds in *Silene leucophylla,* and *Ballota kaiseri.*
- Number of seeds and total seed weight for each accession presented in Table 49.

Table 49: Target species accessions with details about Number of seeds and Total Seed Weight for each replicate of each accession

No	*Species*	No. of seeds	Total Seed Weight
1	*Micromeria serbaliana*	20	0.0008
2	*Euphorbia obovate*	35	0.0073
3	*Hyoscyamus boveanus*	60	0.009

Here are some photos for the target 3 species seed samples, with scale and zoom. Species from up to down as follow: *Micromeria serbaliana, Euphorbia obovate,* and *Hyoscyamus boveanus.*



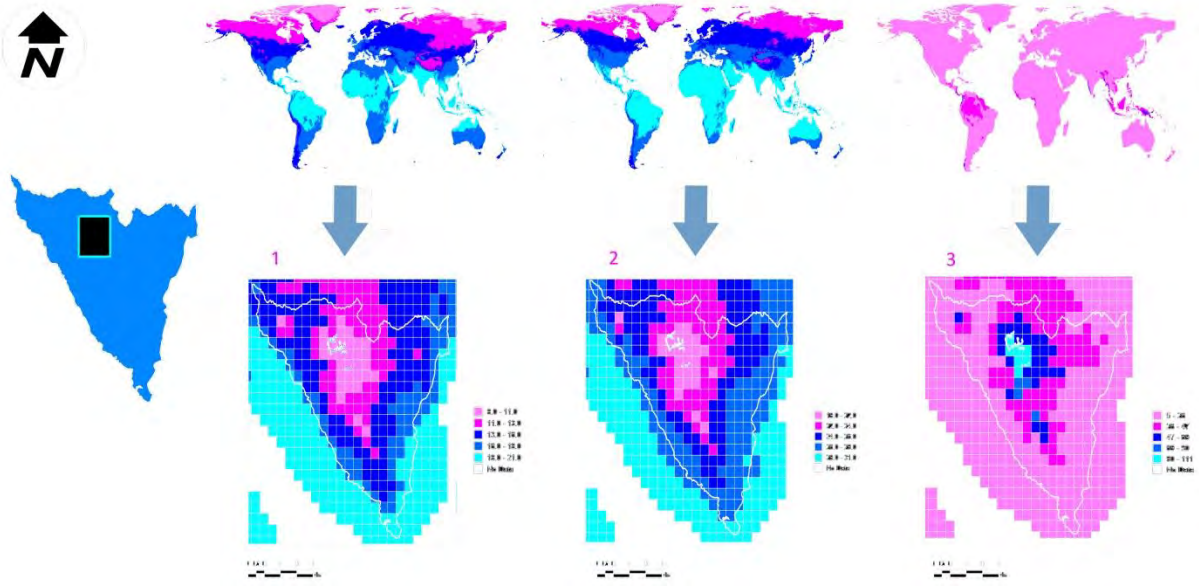
Environmental factors including edaphic and climatic features were then extracted for each accession and presented in Tables 50 and 51.

Table 50: Main edaphic factors for each accession

Code	W.C	pH	EC µs/ cm	T.D.S PPm	Org.	$CaCO_3$	Ca ++meq/L	Mg^{++} meq/L	Na^{+} ppm	K^{+}	HCO_3^{-} meq/L	Cl^{-} meq/L	SO_4^{-} meq/l
Micro.	0.34	8	153.85	320	3.45	25	32.5	2.5	10.4	10.4	8	11.5	87.5
Eupho.	0.7	8.3	168	84	0.23	19	2	4	15.81	15.81	8	7.25	35
Hyos.	0.78	8.7	104	47	11.42	7.5	1.5	4.5	21.3	26	4.5	2.25	3

Table 51: Bioclimatic Conspectus for *Target species* habitats

Bioclimatic factors	Minimum	Maximum	Range	Mean
Annual minimum temp.	8.09	11.08	2.99	9.35
Annual maximum temp.	19.46	22.28	2.83	20.64
Precipitation	4.08	9.25	5.17	6.85
Annual Mean Temperature	13.78	16.68	2.91	15.00
Mean Monthly Temperature Range	11.18	11.37	0.19	11.29
Isothermality	39.96	40.42	0.46	40.15
Temperature Seasonality	601.59	618.85	17.26	611.56
Max Temperature of Warmest Month	27.70	30.30	2.60	28.81
Min Temperature of Coldest Month	-0.60	2.50	3.10	0.69
Temperature Annual Range	27.80	28.40	0.60	28.12
Mean Temperature of Wettest Quarter	5.83	8.95	3.12	7.15
Mean Temperature of Driest Quarter	19.65	22.37	2.72	20.81
Mean Temperature of Warmest Quarter	20.68	23.42	2.73	21.84
Mean Temperature of Coldest Quarter	5.83	8.95	3.12	7.15
Annual Precipitation	49.00	111.00	62.00	82.25
Precipitation of Wettest Month	15.00	32.00	17.00	24.67
Precipitation of Driest Month	0.00	0.00	0.00	0.00
Precipitation Seasonality (CV)	114.98	125.37	10.39	119.48
Precipitation of Wettest Quarter	32.00	73.00	41.00	54.73
Precipitation of Driest Quarter	0.00	2.00	2.00	0.56
Precipitation of Warmest Quarter	0.00	3.00	3.00	1.77
Precipitation of Coldest Quarter	32.00	73.00	41.00	54.73



Map 27: Climatic variables within St. Catherine PA, 1- Annual Minimum Temperature, 2- Annual Maximum and 3- Annual Precipitation.

SEED STORAGE:

As mention above:

- All the pervious activities were done with the help of St. Catherine PA management staff and seed collected by local community.
- The team were submitted the collected seeds to St. Catherine PA where they will be save and useful for future work in cultivation and research.
- After cleaning the seeds we had submitted it to St. Catherine Protected Area Management for partly storage for very near future use in germination (stored under -15 C). It's not long term conservation but it will help to reduce the stress of collecting these plants from wild.
- In case of St. Catherine PA the storage will be for short time (Maximum 2 years) until the use for cultivation or research.
- The team not able to submit this collection to Desert Research Center or Agriculture Research Center in Egypt because of the governmental administrative obstacles. But they will be supported by information about these species through report.

Here are some photos describe the field activities.

Part III

CAPACITY BUILDING, AWARENESS & COMMUNITY INVOLVEMENT

Introduction

"The capacity to manage is the product of willingness, competence, skills, capability, and adequate resources". Qualified, competent and committed staff are central to the success of protected areas. It is therefore not surprising that strengthening the capacity of protected area agencies and the individuals working in them has become one of the priorities in the development of PA systems over the last decade. The CBD Programme of Work on Protected Areas called on its Parties to "complete national protected-area capacity needs assessments and establish capacity building programmes" (Activity 3.2.1). Responding to their obligations, most of the countries of the world have included training initiatives in their national CBD implementation processes.

Managers and staff are operating in a challenging world. If they want to prosper, they have to adapt to changes quickly. It is very hard to find a PA manager who is competent in all these issues at the beginning of his/her professional development. Their entire career should be a lifelong training to become real experts. Formal university education today (with very rare exceptions) is not tailored to the needs of in-the-field PA professionals. Compared to other careers, not many universities have special faculties or departments for PA staff. In most countries there is no institution where one can obtain a M.Sc. or Ph.D. in PA management. For such regions, short-term courses give the only possibility for PA staff to acquire the competences needed.

Local community: Community involvement is a very important aspect of real conservation for any community, no matter what size. Without community buy-in, a project may never get off the ground or will not be accepted once it is completed. Community involvement should be used to generate not only ideas for conservation projects and their implementation, but also ideas to further improve existing project features. Conservation can be facilitated and enhanced by finding out what the community needs, what will benefit the community, what has been tried in the past, and what could be done to improve past ideas.

Community members, when given an opportunity to be informed and involved in the process, are or can be a critical factor to a project's success. Community members may have special issues or concerns that, if incorporated into a project at the outset, may help to reduce the likelihood of challenges to risk assessment results, and potential remediation or revitalization plans. Successful community involvement is based upon information and dialogue. Only an informed community can be part of the decision-making process, which then will lead to a sustainable project. Community members who contribute to the planning process will better understand the process and will be more likely to support a project they had input in.

Local communities within St. Catherine PA[2]*:* Today, Sinai's fifty thousand Bedouins are divided into fourteen tribes or sub-tribes, which evolved as different groups arrived and merged with each other. The Bedouins living in north and central Sinai consist of four

[2] SCPA Management Plan 2003

large tribes and a number of lesser tribes and clans. In South Sinai the Bedouin population and tribal territories are smaller than in the north. However, like their brethren in the north the seven tribes of the south have varied origins but are collectively referred to as Towaras, or Arabs of El Tur, formerly a major port and now South Sinai's regional capital. Although the Aleiqat and various clans of the Suwalha were the first Bedouin tribes to settle in Sinai at the time of the Islamic conquest of Egypt, the largest tribe now is the Muzeina, who occupy the most southern part of Sinai along the coastal areas from Sharm El Sheikh to Nuweiba. Each tribe has one or more traditional territories (dirha), which are still recognised, although nowadays different tribes live together, e.g. in Feiran.

Within the study area, one tribe, the Gebeliya, comprised of about 1,500 persons, has played an integral part in the life of the Monastery since its beginning. The Gebeliya are not of Arab descent but are descendants of Macedonian people sent by the Emperor Justinian to build, protect and serve the Monastery in the sixth century A.D. Over the years the monks and the Gebeliya have established a symbiotic relationship. During the Israeli occupation of Sinai, beginning in 1967, the traditional nomadic lifestyle of the Bedouin changed and this caused a gradual move away from the traditional tent settlements to more permanent stone housing. It is this that is mostly seen in the Sinai now.

The Bedouin are a conservative people with a rich culture, a reputation for hospitality and a profound knowledge of their land. Wild plants and animals have traditionally supplemented their diet, health, income and material culture. Many Bedouin men work in non-traditional activities, mainly in tourism enterprises as guides or cameleers, although some continue to cultivate mountain gardens. The women herd the livestock and produce traditional craft items.

The traditional conservation ethic is deep-rooted, with the tribal system of el hilf (the agreement) to control seasonal use of pasture or personal action, dakhl (essence), normally to protect trees. These systems were enforced by tribal law (‘urf) so when a person pledges to uphold a principle that all tribes people regard as just, acting against it violates both his personal honour and ‘urf itself. Although traditional conservation systems are now largely vestiges of the past, ‘urf still applies and during the inception mission several Bedouin claimed a traditional responsibility for wildlife protection in some areas.

The local Bedouin communities are the traditional users of the natural resource base and as such are among the main stakeholders in the Protected Area; their understanding and support of the Protected Area’s objectives and close involvement in planning and implementing management interventions are critical. Local communities should be enabled to manage their own resources locally but as local communities may have to restrict their activities and so pay the opportunity costs for conservation, they should be

entitled to share tangible benefits from the management of the Protected Area to offset such costs and ensure their support.

Since the first moment of the declaration of the St. Catherine Protected Area the local community encouraged and assisted to undertake local conservation initiatives and community development projects through self-help projects. More than 50 direct persons from the locals are working with the protected area as local community guard and their primary functions ate to extend monitoring and regulatory activities to the more remote parts of the Protected Area. They report to Rangers. The community guards carry identification cards and wear a National Park badge. The community guards assist the Ranger force in the execution of their duties by:

- Reporting any hunting, killing, disturbance or collection of wild species (including plants) in or around the Protected Area and monitoring and reporting on wildlife populations particularly of large mammals species.
- Reporting any developments such as building or quarrying in their area and monitoring development activities.
- Guiding and assisting Rangers, orientating visitors within their area of responsibility and assisting with mountain rescue and other emergency responses.
- Liaising with Rangers working on activities associated with the Bedouin Support Programme particularly with regard to informing local communities of scheduled visits by doctors and veterinarians.
- Reporting on the condition of trails and paths and undertaking or arranging necessary maintenance.
- Looking after any established monitoring sites and equipment, wildlife watering points and manning established satellite centers or other Protected Area property.
- Promoting any Protected Area regulations regarding resource conservation, e.g. grazing exclusion areas etc. within the local communities.
- Monitoring tourism activities within the area (i.e. recording visitor numbers, tour companies, dates etc.) and checking on and regulating visitor behavior to prevent visitors from cutting vegetation, discarding rubbish, writing graffiti etc.
- Cleaning visitor campsites of refuse and removing graffiti.
- Promoting local community conservation and development initiatives, e.g. establishing local conservation areas, waste management, social programmes etc.

Current situation:

One of the aims that the Protected Area established to bring benefits to and to contribute to the welfare of the local community through the provision of natural products (such as medicinal plants) and services (such as income derived from sustainable forms of tourism). Regarding to weak financial support to the St. Catherine Protected Area, in addition to lack of qualified staff and educational and awareness activities the previous

and other activities for supporting the community needs deactivated by time and the linkage between the Protected Area and the community deteriorated and the trust gap increased. By time the challenge increased and community needs duplicated with limited budget for support. All these push the locals to break the rules of conservation as a result from:

- High incidence of child malnutrition.
- Limited access to, and high cost, of supplementary animal feed.
- Acculturation and loss of traditional knowledge and skills.
- Few benefits from commercial exploitation of indigenous knowledge, e.g. medicinal plants.

The following are reasons why community involvement is important:

- Community members may have useful information about the site's history, past land uses and associated threats
- Community members may have special issues or concerns that, if incorporated into a project at the outset, may help to reduce the likelihood of challenges to risk assessment results, and potential remediation or revitalization plans
- Community members who contribute to the revitalization planning process will better understand the process and will be more likely to support a project they had input in, thus creating a sustainable project.
- Community involvement provides a forum for residents to become informed about conservation of their natural resources and actively involved in making decisions that ultimately impact their community.

GIS: Biodiversity information initiatives are making large quantities of data readily available to the scientific community. These data open exciting opportunities for exploring, documenting, and understanding biodiversity worldwide. Data come from diverse sources and are heterogeneous in content, quality, and format. As a result, careful data preparation and quality control is an important step prior to any analysis. This two-part course covers two critical steps in the process: how to prepare a biodiversity data set for analysis and open sharing, and how to 'publish' data for global open access.

"Truly effective biodiversity conservation demands inventory, evaluation, planning and management at scales ranging from the local and regional to national, continental and global" Nix et al. (2010). Geographical Information System (GIS) has the ability to store, analyse, and integrate data of different themes over different regions, and at different scales. The use of GIS/RS in protected area development and management will allow protected areas to be viewed as integrated parts of an overall landscape.

Previously, protected area managers combined printed maps of topography and land ownership with their knowledge of local climate, species distributions, topography, environmental law, and land use to define management zones and strategies. Today, all this data can be analysed in digital databases to provide for more efficient, accurate and informed decision-making. Once protected areas were viewed and managed in isolation

from surrounding landscapes and were often designated as non-development areas. Exploitative development sectors, such as mining, forestry, roads and energy, were viewed as a direct threat to the integrity of PAs. Now, it is understood that, unless PAs are planned and managed as an integral part of the wider development landscape, their benefits to socioeconomic development will not be recognised and they will remain under siege. The information needs of PA managers have also changed. GIS can be a critical part of expressing PAs as part of a mosaic of land tenure and uses, where conservation and development are mutually reinforcing.

The evolution of GIS and its application to protected area development and management follows a progression from small-scale or limited theme data to regional issues using multiple data sources:

- Hard-copy maps allow managers to clearly identify zoning in and around protected areas that reflects the varying intensities of conservation and use and the consequent management arrangements to be enforced. Maps display limited themes, however, and cover a specific region.
- Databases of environmental policies (i.e., laws and regulations) or species statistics can be used to determine management regimes in different zones or to help identify biodiversity regions. Databases contain factual data but do not necessarily provide a spatial context for it.
- The development and use of Geographic Information Systems (GIS) over the last decade has provided the ability to combine multiple data sources with land-use and species statistics. These tools provide a method of combining spatial data with attribute (descriptive) data that is often stored in databases, and allow multiple data themes to be viewed at both local and regional scales.
- The internet provides access to data from all over the world, and spatial data can increasingly be viewed at international scales: for example, to analyse the natural system connections across national boundaries, or for the basin of a river. The progression of information from simple maps and documents to Decision Support Systems (DSS) has allowed conservation areas to be viewed in a regional, integrated context. The rapid development of internet technology has allowed the expansion of data analysis from local to regional or global coverage. Protected areas can be treated as multiple-use zones that involve economic, conservation, and community values, instead of being considered in isolation from the surrounding landscape and economy.

IUCN Red List: Extinction and declines in plant diversity are due to a range of factors, including population growth, high rates of habitat modification and deforestation, over-exploitation, the spread of invasive alien species, pollution and climate change. The Millennium Ecosystem Assessment noted that approximately 60% of the ecosystem services evaluated are being degraded or used unsustainably (www.milleniumassessment.org). The degradation of ecosystem services often causes significant harm to human well-being and represents a loss of a natural asset or wealth of a country.

The IUCN Red List of Threatened Species (henceforth 'Red List'), produced by the Species Survival Commission (SSC) of the World Conservation Union (IUCN; http://www.iucn.org), highlights species that are at the greatest risk of extinction and promotes their conservation by 'concentrating minds on true priorities' (Collar and

Andrew 1988). The dominant method for assessment, particularly at the global level, has been the IUCN Red List process. However, it is unlikely that the target can be reached using this process alone, and hence it should be stressed that it is a preliminary assessment that is called for, and that this need not be a full Red List assessment. In the last decade, there has been a gradual increase in the number of species included in the IUCN Red List at a global level. However, given an estimate of approximately 370,000 flowering plants, the global assessments still only include 3-4% of plant species. More encouraging progress has occurred at a national level. During the consultation on this target, 52% of countries indicated that they had completed some form of Red List assessment[3].

The utility of the Red List as a conservation tool derives not only from the classification of each species into a category of threat, but also for the wealth of data, collected to support these assessments, that are published online in a searchable format. Submissions to the Red List now require the rationale for listing, supported by data on range size, population size and trend, distribution, habitat preferences, altitude, threats and conservation actions in place or needed. Many of these parameters are coded in standardized 'authority files' that enable comparative analyses across taxa[4]. The Red List data are a source of information that is essential to guide conservation efforts focused on species. Threat categorizations themselves are key to guiding priorities for conservation investment among species (Collar, 1996), albeit necessarily along with other information, such as cost and feasibility (Mace and Lande 1991, Possingham, 2002). The assessments also produce a series of recommendations for conservation action (BirdLife International, 2004).

Aim:

- Enhance the knowledge about importance of conservation of threatened plants in the study area
- Enhance the knowledge about IUCN Red List Assessment
- Enhance the linkage and reduce the conflicts between the local community and the Protected Area through a series of educational and awareness activities about Target species conservation
- Capacity building for local communities (guards), and PA staff about conservation planning and technics
- To train and develop human resources at professional level.
- To provide exposure to the participants about the application of Satellite Imagery, extraction of thematic inputs and their applications in Geographical Information System (GIS).
- To provide exposure on advanced mapping techniques.
- Raise the awareness about threatened plants conservation for local community children.

[3] CBD, 2009
[4] IUCN, 2004

Methodology:

- During this study we tried to assess the training and capacity needs of the target protected area staff, and as possible strengthen the fieldwork capacities in the area of monitoring threatened species within PA. To some extent we succeeded to train some researchers on the modern monitoring programs in accordance with the standards of the IUCN as well as training on data collection and analysis of modern and sophisticated programs.
- A series of workshops, meetings, training, and fieldwork activities were held inside St. Catherine PA in the presence of its entire staff including local community. The subjects were threat analysis, threat effect, problem tree analysis, geographical attribute analysis (GIS), and fieldwork methodology for IUCN Red List.
- Regarding to threats, a series of questions were asked to the PAs staff in order to determine the current threats to biodiversity and trying to rank them as well as mapping its distribution within the PA boundaries
- Problem tree analysis is considered the core of the strategic planning process. As many places in Egypt PA face many difficult problem that has to be dealt with in a peculiar manner since most of the problems are complex and interrelated and sometimes irreversible. One important result of using this method is the agreement that percolate in the mind of the stakeholders as this is their own ideas and thoughts. Stirring agreement between all of the stakeholder facilities the problem solving mechanism and create a sense of responsibility and commitment between them while in the same time consider their view and aspiration towards the problem. Therefore by the end of the workshop the problem is objectively assessed with all the logical views and consideration and objective and activities to solve the problems is identified.
- Workshops were held inside the target PA with presence of its entire staff including local community. A series of questions were asked to the staff in order to detect the main problem and try to analysis it in order to determine the objectives and opportunities.
- Regarding to Geographical Attribute analysis (GIS), threat level analysis was trained to one of researchers of South Sinai Protected Areas (4 PAs), the training aimed to creating hotspots maps for threats level inside PAs boundaries. This training aimed to: introduce the use of GIS as well as to develop understanding of some topics beyond the basic courses or most standard texts. However much more are highly needed.

In order to strengthen the capacities and enhance and raise the educational and awareness levels about our work and to ensure the participation and involvement of local communities within the conservation practices we did the following activities:

1. Community Involvement

Community assessment answers the basic questions: Who is the community? Where do they live and work? Who will most directly be impacted by the conservation project? We set a series of items for this assessment like:

a. Identify stakeholders and categorize them according to their influence
b. Establish realistic expectations for the community input
c. Identify community goals and aspects for the future of the community
d. Educate residents on the process of project development
e. Identify specific aspects of the project that can accommodate some of the community goals
f. Start the communication process by fostering a dialogue, seeking community interest and support, and sharing information, remediation, and redevelopment issues

With a total support from St. Catherine PA management team Invitations were sent to the target stakeholders to attend the following events:

- A total of 3 workshops with PA management staff, rangers, community guards, plant collectors, decision makers to discuss:
  - Background knowledge about species and its distribution and importance
  - Threats on target species,
  - Threats root causes and solutions (problem tree analysis, treat reduction assessment)
  - Suggests action plans for facing such threats.

2. Educational and Awareness Activities

Target audience for our project:

- Local community:
  - Plant collectors
  - Community guards
  - Children
- Decision makers (PA management team)
- Researchers

Reason for choice:

- *Plant collectors*: To reduce the over collection threats on the target species
- *Community guards*: to enhance and strengthen the treats observation abilities
- *Decision makers* (PA management team): improve the knowledge and facilitate the decision making

- *Researchers*: building the capacities of the young researchers, and increase the linkage between pure science and applied one
- *School children*: Instill the principle of conservation inside the minds of the protectors of the future

Activities:

- A total of 2 training course on IUCN Red List Assessment, threat mapping and GIS for researchers, in Sharm Elshikh (South Sinai Protected Areas). the course structure involves several modules:
  - Introduction to the IUCN Red List.
  - IUCN Red List Assessments.
  - Introduction to GIS
  - Data collection, cleaning, and analysis
  - Hot spots using GIS.
  - Questioner after and before the activity to measure the level of enhancement.
- A total of 2 fieldwork training (researchers, community guards) on data collection (Taba PA, Ras Mohamed PA)
  - Pre-field work review and planning
  - Fieldwork skills and threat observations
  - Data collection based on IUCN red list scheme
  - Data needed for analysis
  - Questioner after and before the activity to measure the level of enhancement.
- Field trip for children from local community about seed collection and importance of plants (St. Catherine PA)

As a way of cooperation to ensure sustainability these workshops and trainings were technically, administratively, and partly financed by Ministry of Environment (Nature Conservation Sector), and Strengthening Protected Area Financing and Managements Systems Project. This support comes in the form of administration arrangements and approvals to held this events inside the target PA as well as partly arrange the places and logistics of the events

Results:

- A total of 45 persons (Local community, decision makers (PA management team), NGOs, researchers, children) were participated in these activities.
- A total of 15 persons were trained on GIS and IUCN Red List in Sharm Elsheikh (South Sinai Protected Areas).
- A total of 12 persons were trained on IUCN field Data Collection in field in Sharm Elsheikh (South Sinai Protected Areas).
- A total of 6 Children (local community) were trained on field in seed collection.
- Awareness of 30 school children were raise in the field about plants, and threats using stories, drawing and gams.
- Using problem tree analysis, conflict analysis, threat reduction assessment and problem solving we succeeded to extract the main data required for the conservation of this species.
- Data extracted from these discussions are presented in the threat analysis part.
- Knowledge about the importance of conservation of the target species and the threats and its root causes were enhanced
- Problem tree analysis was one of the best interactive method for extracting the main problem from different stakeholders
- Conflicts between the different stakeholders were reduced partly in the part of managing human use for the sustainability of the target species.
- Local community feels happy that they participate actively to solve a main problem in their area.
- Solutions and action plans were extracted from these discussions and presented in the threat analysis part.
- The level of knowledge gained by target stakeholders from the different discussions can be summarized as follow:

Aspect	Local community (Plant collectors, Community guards)		Decision makers (PA management team)		Researchers		Children	
	Before	After	Before	After	Before	After	Before	After
Threats on target species,	6	8	7	8	4	8	3	6
Threats root causes and solutions (problem tree analysis, treat reduction assessment)	6	8	7	8	4	7	3	7
Suggests action plans for facing such threats.	6	8	8	9	4	5	4	9
Target species importance and conservation efforts	4	8	7	9	2	6	2	5
IUCN Red List	0	4	4	7	3	7	0	2
GIS	-	-	2	5	3	7	-	-
PA s	9	4	5	7	5	7	0	2

Note; 1= lowest degree and 10= the highest

Here are some photos summarize these activities:

Workshops:

St. Catherine PA

Taba Protected Area

Training (South Sinai Protected Areas)

Fieldwork training (Ras Mohammed)

Field training for local community children (St. Catherine PA)

FUTURE TRAINING NEEDS ASSESSMENT:

From meetings and discussions with PAs staff, we found some gabs need to covered by suitable focus training. The most urgently needed for researchers were fieldwork survey, monitoring methodology, data entry and analysis, GIS applied to management of natural resources, Tools for the conservation of vegetation, Threat analysis, Environmental Impact Assessment, Ecological bases for the management of Protected Areas, and English language.

In 2011, the IUCN published a book under the title of: *Protected Area Staff Training: Guidelines for Planning and Management" edited by* Kopylova, and Danilina (2011). This book discus the guidelines for Planning and Management Protected Area Staff Training. However the situation of protected areas in the whole world are not the same but they tried to collect the maximum needed training suitable and useful for all. Generally they found that the most needed training for PAs management staff is:

- Fundraising
- Sustainable development Outreach & partnerships
- Natural resource management Leadership & decision-making
- Planning Information systems
- Administration Scientific knowledge & research
- Visitor management Traditional knowledge
- Facility management
- Conflict management
- Economics, natural resources and the environment

Specific needs:

Table 52. Specific training needs for Protected Areas staff

No.	Target	Training Needed
1	For PA management	○ Strategic planning and operational management of a PA ○ HR and motivation for a PA ○ Social marketing ○ Conflict management ○ Private sector and the PA ○ PA and governmental structures – ways of interaction ○ Cooperation with NGO sector ○ PA and local communities ○ Work with cultural and religious leaders ○ Participatory management ○ PA management in the face of global changes ○ Management planning and business planning ○ Institutional setting/arrangements ○ Financial management ○ Legal aspects of PA system management ○ Monitoring and evaluation of PA management effectiveness
2	Environmental education and public awareness	○ How to organize a public awareness campaign ○ How to organize environmental education campaigns in schools ○ How to prepare good awareness-raising material ○ How best to market a PA ○ How to work with mass media

		○ Visitor centers and nature museums ○ Work with visitors at eco-trails ○ Groups of Friends of PA and how to organize their work ○ Volunteering for a PA
3	Eco-tourism development	○ Basic principles of the organization of a tourist industry, types of tourists ○ Specificity of ecological tourism ○ Visitor planning and management ○ Limits of acceptable change: different approaches to calculation ○ Legal framework of eco-tourism development in a PA ○ How to develop a tour ○ How to create and certificate ecological paths in a PA ○ Tourism infrastructure development ○ Monitoring of the impact of recreational activity on a PA ○ Marketing and development of the ecotourism product ○ Interaction between a PA and tourist companies
4	Alternative livelihood programs, relations with indigenous populations and community conservation areas	○ Evaluating PA impact on regional socio-economic development ○ Alternative livelihood programs at a PA: methodology, best practices ○ Integrating local communities into ecotourism development at a PA ○ Developing micro-credit funds and PA-based micro- credit programs for local communities
5	Ecological monitoring and research	○ Innovative methods of data accumulation and processing (GIS etc.) ○ Ecological monitoring and data interpretation ○ Complex research at a PA and interaction with scientific organizations ○ Application of scientific data in PA management practice
6	Training for rangers	o Legislation and law enforcement o Prevention and documentation of law violations (protocols etc.) o Environmental interpretation in the work of rangers o Evaluating the effectiveness of the PA ranger service

General Notes:

- However all the mentioned training topics, some protected areas have a specific needs and priorities resulting from several factors that control the management aspects in these areas.
- It's very important to take into consideration the mentioned training topics when capacity building will provide to PAs staff.
- Starting with basics is the most preferable way for ensuring the best benefits for PAs management staff.

Achievements and Impacts:

From June 2017 to date the team success to determain the following:

1. Geographical distributions of the 5 target species (Number of locations, distribution range, extent of occurrence, area of occupancy) were determined and distribution maps were produced.
2. Population characteristics of the 5 target species (Number of populations, number of subpopulations, population dynamics, population size, Number of mature individual, fluctuation and decline status were determined.
3. Eco geographical characteristics (topographic, ecological, and climatic attributes) that control the distribution of our target species were extracted and analyzed.
4. Preferable suitable habitat and microhabitat for growth of these species were extracted.
5. Morphological and reproductive characteristics of these species were recorded.
6. With the help of local community field experiences and our field observations the major threats on target species were Identified and ranked based on the score of threat timing, severity, scope, and urgency, and their underlying root causes and barriers to solutions were also identified.
7. Former conservation actions for these species were recorded and future needed actions, and researches were suggested.

- Local community, park rangers, and decision makers were involved directly in the project preparation and implementation stages and better awareness towards plant conservation were strengthened.
- Th project had a powerful positive impact especially within the implementation stage (fieldwork, training, and workshops) on participants (local community, park rangers, undergraduate students, and decision makers) in the form of raising awareness, conflict solving, management modifications, and capacity building.

    - A total of 60 sites have been visited during the field work in order to determine the distributions of the target plant species.
    - More than 2000 points (GPS coordinates) have been collected from field work and previous studies in the same area for all plant endemics.
    - Data needed for vegetation, topographic, climatic, eco-geographic, threat density, and hotspots have been collected within these visits.
    - The team succeeded to record a small population for *Micromeria serbaliana*. This species was not recorded since 1998.
    - A total of 7 threats were extracted from the review of the previous studies, fieldwork, and from the discussions with SCPA staff, and local community.
    - Feral Donkeys, over collection, and overgrazing are the most ranked threats. And from deep discussion we conclude that that most root causes of threats come from lack of awareness, weak law enforcement, and lack of suitable strategies, weak financial support and lack of stakeholder's cooperation.
    - Distributions of each threat were recorded and maps for hotspots are in the analysis process.
    - A total of 3 workshops, 3 meeting, and 3 training on threat reduction assessment, data collection and analysis were held with participation of SCPA staff, adjacent 5 protected areas researchers, local communities, and plant collectors.

- Training on plant survey and data collection for IUCN Red List Assessment for 30 researchers and 10 members of local community were done within the fieldwork.
- IUCN Red List Assessment for the target species done and proposal prepared to be submitted to the IUCN Red List Unit for publication soon.

SECTION III:

Conclusion:

1. Most of the Target species subpopulations are small to very small, with individual plants occurring sporadically in space in little groups where the soil is gravelly and rocky. The number of mature plants has been observed to decline as a result of several threats mainly, drought, over collection, over grazing, feral donkeys etc. The total global population size estimate for endemics was very small. There are clearly separate subpopulations. During the last 10 years these subpopulations have been observed to have large changes in the total number of individuals, cover and density, due to over grazing by domestic and feral donkeys.
2. The population of the target species is considered severely fragmented as the mountainous habitat acts as a barrier between the small subpopulations, and as many of these subpopulations have low viability due to destructive overgrazing causing loss of reproductive organs in some cases. Several studies on the genetic variability of some endemic and near endemic species in the same area concluded that there are a great polymorphism between different subpopulations may come from the variation in topography and climatic conditions and confirm the presence of isolation between different subpopulations that cause the real fragmentation.
3. Due to climate change, the wild population of these species could be in extreme danger in the relatively near future. The most important natural threats are the long-lasting droughts, the difficulties of some species to reproduce new generations as a result of overgrazing by herbivores that even eat the reproductive organs and decrease the chance for the possibility for creating new generation, the very scarce irregular precipitation during the year, the fragmentation inherent to its habitat, and the possibility that rare floods may cause harm such as uprooting (1-5% loss observed). Water is being relocated in some localities from elevated wadis which are rich in water to supply to low wadis. This activity leads to consumption of water from wells and results in habitat deterioration and declines in population size.
4. Most of threats root cases comes from lack of awareness, weak law enforcement, lack of suitable strategies, weak financial support and lack of stakeholders cooperation.
5. In general, the target species are severely threatened by both natural (aridity of the area and climate change-flooding) and human factors (over-grazing by domestic animals and feral donkeys, over-collection, and unmanaged tourism activities). All these factors are pushing Target species to the brink of extinction.
6. The distribution, population size, demography, reproduction, and threats of restricted plant species like target species seems to be highly affected by environmental variation like topography, climate, and soil properties. In the regions

characterized by topographic and physiographic heterogeneity, like the mountainous region in Saint Katharine, the variation in microclimate plays the major role in governing the natural vegetation and irregularity of rainfall may lead to fluctuations in all species aspects.

7. Target species have the first priority when species recovery takes place through rehabilitation, restoration, reintroduction, and benign introduction in areas that have similar environmental conditions extracted from this study.
8. Although the target species are mostly covered by protected area and partly conserved through in situ and ex situ technics in the past within the regulations and policies of the park, much more however is urgently needed.
9. IUCN Red List assessment is a simple and effective tool for conservation status determination especially for restricted range species. With small accurate data about your target species focused on its geographical range, population, habitat, and threats it's easy to rank your species in suitable level as a first point for complete conservation process.
10. It's not needed to collect all data required for IUCN assessment; for example you can list your species as Critically Endangered species if you have only data about its geographical range. However it's preferable to collect data as you can to cover all criteria to reflect a good detailed picture about the species situation on land in order to start a perfect conservation planning and design suitable actions.
11. The outcome of the undertaken study; A general model is presented describing ecosystem degradation to help decide when restoration, rehabilitation, or reallocation should be the preferred response.

Problems encountered and lessons learnt:

Actually, the team faced some minor problems regards to Military restrictions: Some target sites became under the supervision of military and not be allowed for visiting but we made contact with local authorities for getting permissions.

Which project activities and outcomes went well and why?

All project activities went very well as a result from fruitful cooperation between the team and stakeholders and local community.

Which project activities and outcomes have been problematic and in what way, and how has this been overcome?

- Up to this point we have never had any real problems in the implementation of the objectives and activities of the project. Incorporating of many stakeholders in the implementation stage and discussion process (workshops and meetings) was sometimes difficult in terms of arrangement, timing and simplicity of dialogue resulting from the conflicts between different parties especially between local community (land owners) and management team of St. Catherine Protected area. By the end of these events we got a good impression and feedback from all parties as a

result of our use of simple ways and clear methodology to explain the problem and its causes and impediments solutions. Which persuaded many of them.

- Given the current conditions in Egypt, especially Sinai (the study area) that cause activities restrictions (especially outreach activities), the team work had set strategies to address these limitations as follow:
  - We divided the activities into several small parts
  - We've integrated some of the activities in subsidiaries of nature reserves activities in South Sinai
  - We used every available opportunity to present the goals and results of our project to stakeholders in the study area

Please state important lessons which have been learnt through the course of the project so far.

- Team work is the main tool for project success; team should include members from different aspects with many capacities to achieve the main goal. All members should work as one.
- In the project preparation stage, problems should be presented clearly and several plans and strategies (A, B, and C) for solution should be extracting.
- The greater the number and diversity of stakeholders involved in the implementations and discussions process whenever it grew evidence and got an accurate results.
- Different methodologies should be ready in your pocket in case if you find obstacles with one you can use another.
- Simplicity and honesty is the direct way to solve the conflict between different parties.

Future planned activities:

Recommendations:

1- Focus on human resource development in the first and concerning by updating their abilities in order to achieve sustainable development.
2- Strengthening the scientific aspects of PA rangers in the field of Assessing extinction risk using IUCN Red List Categories and criteria, species conservation prioritization, genetic preservation and mapping.
3- There is an urgent need to integrate the knowledge derived from ecological, demographic and genetic approaches to species conservation in order to be able to formulate management strategies that take into account all different considerations.
4- It’s highly recommended to use the presented information about the target species requirements when conservation actions take place.
5- Species recovery is highly recommended through rehabilitation, restoration, reintroduction, and benign introduction in areas that have similar environmental conditions.
6- There is an urgent need to conserve the target species outside its habitat (Ex situ) though seed collection, artificial propagation from seeds, botanical garden, seed

storage, tissue culture, cultivation, seed bank, freezing cuts from the plant, or stocking the seeds, Tissue bank, Cryobank, Pollen bank, and Field gene bank.

7- Regarding to threats levels and urgency of taking an rapid action to stop or reduce the negative impacts of these threats on the biodiversity inside the target Pas.
8- Raising awareness through biodiversity information: Effective educational programmes with special focus on children need to be implemented in order to raise awareness about the importance of threatened species, their habitats' conservation and the threats increasingly faced by this biome. Moreover, educational projects oriented to all the population levels about the value of species and conservation and the need of more efficient techniques for the utilization of this resource are needed (Highly recommended by IUCN).
9- Data deficiency and research: Research efforts focusing on species for which there is currently little knowledge must be dramatically increased. A Data Deficient listing does not mean that species are not threatened. In fact, as knowledge improves, such species are often found to be amongst the most threatened (or suspected as such from available evidence). It is therefore essential to direct research efforts and funding towards these species as well as those in threatened (Highly recommended by IUCN).
10- There is an urgent need to carry out annual monitoring on species population and habitat trend, habitat trend, fluctuations, and reduction probability to fellow up its situation.
11- It is recommend using this study specially this species as a base line to detect the effect of global warming on species distribution by annual monitoring.
12- It's very urgent to carry out detailed study about endemic species in such PA to clearly identify their distributions, interactions, dynamics, threats level and mapping as well as conservation assessment in order to have a clear vision about the situation in such place for complete conservation program.
13- It is essential to carry out such study to cover all threatened species and all Protected Areas of Egypt and the priority must be directed to the most threatening PAs.
14- Ensure staff has access to training programs that will enable them to effectively carry out their duties. Researchers are one of the most important circles inside the conservation process and capacity building for PAs management staff is an urgent step towards best conservation practices and suggested training topics within the study should be considered when actions take place.
15- Encourage popular participation by raising awareness through the dissemination of information and to provide access.

References:

- Allen, R.B. and Peet, R.K. (1990): Gradient analysis of forests of the Sangre de Cristo Range, Colorado. Canadian Journal of Botany, 68: 193-201.
- Assi, R. (2007): MP Threat Analysis and Threat Reduction Assessment Report. Conservation and sustainable use of medicinal plants in arid and semi-arid ecosystems project, 61 pp.
- Balba, A.M. (1995): Management of problem soils in arid ecosystems. Lewis Publishers, New York.
- Barbault, R. and Hochberg, M.E. (1992): Population and community level approaches to studying biodiversity in international research programs. Acta Oecol., 13: 137-146.
- Benito, B.M., Martınez-Ortega, M.M., Munoz, L.M., Lorite, J., Penas, J., 2009. Assessing extinction-risk of endangered plants using species distribution models: a case study of habitat depletion caused by the spread of greenhouses. Biodiv. Conserv. doi: 10.1007/s10531-009-9604-8.
- BirdLife International, (2004): Threatened Birds of the World 2004, CDROM BirdLife International (http://www.birdlife.org/datazone/ species/index.html).
- Boulos, L. (1999): Flora of Egypt. Al hadara publishing, Cairo, Egypt, Vol. 1: 419 pp.
- Boulos, L. (2000): Flora of Egypt. Al hadara publishing, Cairo, Egypt, Vol. 2: 392 pp.
- Boulos, L. (2002): Flora of Egypt. Al hadara publishing, Cairo, Egypt, Vol. 3: 373 pp.
- Boulos, L. (2003): Flora of Egypt. Al hadara publishing, Cairo, Egypt, Vol. 4: 617 pp.
- Busing, R. T., White, P. S., and MacKende, M. D. (1992): Gradient analysis of old spruce-fir forest of the Great Smokey Mountains circa 1935. Canadian Journal of Botany, 71: 951-958.
- Collar, N.J., (1996): The reasons for Red Data Books. *Oryx* 30, 121–130.
- Dawes, W.R., and Short, D. (1994): The significance of topology for modelling the Surface hydrology of fluvial landscapes. Water Resources Research, 30: 1045- 1055.
- Day, F.P., and Monk, C.D. (1974): Vegetation patterns on a Southern Appalachian watershed. Ecology, 55: 1064-1074.
- Durnkerley, D.L., and K.J. Brown. (1997): Desert soils. In D.S. Thomas, (ed.) Arid zonegeomorphology: Process, form and change in drylands, second edition. John Wiley and SonsLimited. 55-68 pp.
- El-Alqamy, H.M. (2002): Developing and Assessing a Population Monitoring Program for Dorcas Gazelle (Gazella dorcas) Using Distance Sampling in Southern Sinai, Egypt. M.Sc. thesis, School of Biology, Division of Environmental and Evolutionary Biology, University of St. Andrews, Scotland. 118 pp.
- Elith, J., Graham, C.H., Anderson, R.P., Dudik, M., Ferrier, S., Guisan, A., Hijmans, R.J., Huettmann, F., Leathwick, J.R., Lehmann, A., Li, J., Lohmann, L.G., Loiselle, B.A., Manion, G., Moritz, C., Nakamura, M., Nakazawa, Y., Overton, J.M., Peterson, A.T., Phillips, S.J., Richardson, K., Scachetti- Pereira, R., Schapire, R.E., Soberon, J., Williams, S., Wisz, M.S., Zimmermann, N.E. 2006. Novel methods improve prediction of species' distributions from occurrence data. Ecography 29: 129-151.
- Fayed, A. and Shaltout, K. (2004): Conservation and sustainable use of Medicinal plants in arid and semi-arid eco-systems project, Egypt (GEF, UNDP) (project no: 12347/12348), Flora of Saint Catherine protectorate, final report. And Floristic Survey of the Mountainous Southern Sinai: St. Catherine Protected Area, final report.
- Fielding, A.H., Bell, J.F., 1997. A review of methods for the assessment of prediction errors in conservation presence/absence models. Environ. Conserv. 24: 38-49.
- Frank, D.A.; McNaughton. S.J.; Tracy, B.F. (1998): The Ecology of the Earth's Grazing Ecosystems. *BioScience*, Vol. 48, No. 7., pp. 513-521.

- Guisan, A., Graham, C.H., Elith, J., Huettmann, F., the NCEAS Species Distribution Modelling Group,. 2007a. Sensitivity of predictive species distribution models to change in grain size. Divers. Distrib. 13: 332- 340.
- Guisan, A., Zimmermann, N.E., Elith, J., Graham, C.H., Phillips, S., Peterson, A.T., 2007b. What matters for predicting the occurrences of trees: techniques, data or species' characteristics? Ecol. Monogr. 77: 615- 630.
- Hanski, I. and Gilpin, M. (1991): Metapopulation dynamics: brief history and conceptual domain. *Biological J. Linean Soc*. 42:3-16.
- Hatab, E.E. (2009): Ecological studies on the Acacia Species and Ecosystem Restoration in the St. Catherine Protected Area, South Sinai, Egypt. Ph.D., Thesis, Fac. Sci., Al-Azhar Univ 227pp.
- Hernandez, P.A., Graham, C.H., Master, L.L., Albert, D.L., 2006. The effect of sample size and species characteristics on performance of different species distribution modeling methods. Ecography 29: 773-785.
- Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., Jarvis, A., 2005. Very high resolution interpolated climate surfaces for global land areas. Int. J. Climatol. 25: 1965-1978.
- Huntly. N. (1991): Herbivores and the dynamics of communities and ecosystems. *Annual Review of Ecology and Systematics* 22: 477-503.
- IUCN, (1994): IUCN Redlist Categories. Prepared by the Special Survival Commission. IUCN, Gland, Switzerland.
- IUCN. (2014): Guidelines for Using the IUCN Red List Categories and Criteria. Version 11. Prepared by the Standards and Petitions Subcommittee. Downloadable from http://www.iucnredlist.org/documents/RedListGuidelines.pdf
- Kamh, R.N., El-Kadi, M.A., El-Kadi, A.H., and Dahdoh, M.S.A. (1989): Evaluation of Mn forms in selected soils of Sinai. Desert Institute Bulletin, A.R.E. 39(1):183-197.
- Khafagi, O., Hatab, E.E., Omar, K. (2012): Challenges towards Hypericum sinaicum conservation in south Sinai, Egypt. Jordan Journal of Biological Sciences. 6(2): 116-126.
- Kopylova, S.L. and Danilina, N.R. (Editors) (2011). Protected Area Staff Training : Guidelines for Planning and Management. Gland, Switzerland: IUCN. xiv + 102 pp
- Kumar, S., Stohlgren, T.J., Chong, G.W., 2006. Spatial heterogeneity influences native and nonnative plant species richness. Ecol. 87: 3186- 3199.
- Lacey, J.R., R. Wallander, and K. Olson-Rutz. (1992): Recovery, germinability, and viability of leafy spurge (*Euphorbia esula*) seeds ingested by sheep and goats. Weed Technology 6:599-602.
- Mace, G.M. and Lande, R. (1991): Assessing extinction threats toward a reevaluation of IUCN Threatened Species Categories. *Conserv. Biol.* 5, 148–157.
- Mosallam, H.A.M. (2007): Assessment of target species in St. Catherine Protected Area, Sinai, Egypt. J Appl Sci Res., 3(6): 456-469.
- Moursy, M.M., (2010): Ecophysiological studies on the endemic plant *Euphorbia sanctae-catharinae* Fayed, in Saint Katherine Protectorate, South Sinai, Egypt. *M.Sc., Thesis*, Fac. Sci., Al-Azhar Univ 350 pp.
- Moustafa, A.M., and Zayed, A.M. (1996): Effect of environmental factors on the flora of alluvial fans in southern Sinai. Journal of Arid Environments, 32: 431-443.
- MPCPEgypt, 2010. The Medicinal Plants Conservation Project website, http://www.mpcpegypt.org/English/Global/Page.aspx?PageID=1

- Murienne, J., Guilbert, E., Grandcolas, P., 2009. Species' diversity in the New Caledonian endemic genera *Cephalidiosus* and *Nobarnus* Insecta: Heteroptera: Tingidae, an approach using phylogeny and species' distribution modelling. Bot. J. Linn. Soc. 97:177-184.
- O'Loughlin, E. M., (1981): Saturation regions in catchments and their relations to soil and topographic properties. Journal of Hydrology, 53: 229-246.
- Omar, K. (2010): Eco-geographical study on *Nepeta septemcrenata* in Saint Katherine protectorate, South Sinai, Egypt. *M.Sc., Thesis*, Fac. Sci., Al-Azhar Univ., 350 pp.
- Ortega-Huerta, M.A., Peterson, A.T., (2008): Modeling ecological niches and predicting geographic distributions: a test of six presence-only methods. Revista Mexicana De Biodiversidad 79: 205-216.
- Papes, M., Gaubert, P., 2007. Modelling ecological niches from low numbers of occurrences: assessment of the conservation status of poorly known viverrids Mammalia, Carnivora across two continents. Divers. Distrib. 13: 890-902.
- Pearson, R.G., 2007. Species' distribution modeling for conservation educators and practitioners. Synthesis. American Museum of Natural History. Available at http://ncep.amnh.org.
- Pearson, R.G., 2007. Species' distribution modeling for conservation educators and practitioners. Synthesis. American Museum of Natural History. Available at http://ncep.amnh.org.
- Phillips, S.J., Anderson, R.P., Schapire, R.E., 2006. Maximum entropy modeling of species geographic distributions. Ecol. Modell. 190: 231- 259.
- Possingham, H.P., (2002): Limits to the use of threatened species lists. Trends Ecol. *Evol*. 17, 503–507.
- Radford, E.A., Catullo, G. and Montmollin, B. de. (eds.) (2011). Important Plant Areas of the south and east Mediterranean region: priority sites for conservation. IUCN, Gland, Switzerland and Malaga, Spain. Gland, Switzerland and Malaga, Spain: IUCN. VIII + 108 pp.
- Saker, M., El-Demerdash, M., Allam (2011): In vitro propagation and genetic characterization as effective tools for conservation of Silene leucophylla, grown in St. Katherine Protected Area, Sinai, Egypt. Journal of Genetic Engineering and Biotechnology. Volume 9, Issue 1, 2011, Pages 21-27.
- Schlesinger, W.H., Raikes, J.A., Hartley, A.E. and A.F. Cross (1996): On the spatial pattern of soil nutrients in desert ecosystems. Ecology 77: 364-374.
- SCPA Management Plan 2003. The management and development plan for St. Catherine Protectorate, Full reference edition, 148 pp.
- Täckholm V. (1974), Students Flora of Egypt. Cairo University, Cooperative printing Co., Beirut, 2nd. Ed., pp. 482-483.
- Titshall, L.W., O'Connor, T.G., and Morris, C.D., (2000): Effect of long-term exclusion of fire and herbivory on the soils and vegetation of sour grassland. African Journal of Range and Forage Science, 17: 70–80.
- Wallander, R.T., B.E. Olson, and J.R. Lacey. (1995): Spotted knapweed seed viability after PAsing through sheep and mule deer J. J. Range Manage. 48:145-149.
- Wisz, M.S., Hijmans, R.J., Li, J., Peterson, A.T., Graham, C.H., Guisan, A., NCEAS Predicting Species Distributions Working Group., 2008. Effects of sample size on the performance of species distribution models. Divers. Distrib. 14: 763-773
- Wood, E. F., Sinpalan, M., Beven K., and Band L., (1988): Effects of spatial variability and scale with implications to hydrological modelling. Journal of Hydrology, 102: 29-47

PHOTOS:


إدارة المنطقة الطبيعية
Landscape Management
الحفاظ على البيئة النباتية ورصدها
Flora Conservation and Monitoring