The Rufford Foundation
www.rufford.org

2017 Final Report

Project ID: 21271-2

Community-based conservation of threatened plants Silene schimperiana, and Polygala sinaica in South Sinai, Egypt

CREDIT

Fieldwork Team:
Dr. Karim A. Omar
Mr. Ibraheim Elgamal
Mr. Amir Shalof
Mr. Seleim Mehana
Mrs: Fatma Abdelbaset

Data Entry:
Dr. Karim A. Omar
Mr. Ibraheim Elgamal

Charts, Maps, and Analysis:
Dr. Karim A. Omar

Design and Layout:
Dr. Karim A. Omar

Report Photos:
Mr. Ibraheim Elgamal
Dr. Karim A. Omar

Cover picture:
Dr. Karim A. Omar (Design)

Financial Support:
The Rufford Foundation

ACKNOWLEDGEMENT

This study consumed huge amount of work, research and dedication. Still, implementation would not have been possible if we did not have a support of many individuals and organizations. Therefore we would like to extend our sincere gratitude to all of them.

It was our great honors to get this valuable grant, the team is very thankful to **Rufford Foundation Management Team** for their financial and logistical support and for providing necessary guidance concerning study implementation we really appreciate.

Special thanks to Mr. Mohamed Hemeid manager of St. Catherine Protected Area, and Mr. Mohammed Mahmoud for his honest fruitful support during the field work activities.

Special thanks are due to my great honest team; Mr Ibraheim Elgamal, Mr. Amir Shalouf, and Mrs. Fatma Abdelbaset. The team, whose bearing the difficulties of more than superhuman to complete the study in time. I would like to thank with all the love our professional Bedouin guide Seleim Mehana for his hard work and professionalism within our fieldwork in St. Catherine Protected Area.

Nevertheless, we express our gratitude toward our families and colleagues for their kind co-operation and encouragement which help us in completion of this Study.

Dr. Karim A. Omar

BACKGROUND

In order to develop an efficient and effective conservation strategy using complementary in situ and ex situ techniques, we must have a clear understanding of target species geographical distribution, its habitat preferences and requirements, its population characteristics, threats and taxonomy. The details of the localities where Plant collection have been made, the so-called Passport data, associated with herbarium and germplasm collections, are a key source of information to guide future conservation activities. The ecological, geographic, genetic, reproductive biology and taxonomic data are collectively referred to as eco-geographic data and their analysis is a necessary prerequisite for efficient conservation. Good nature-conservation management requires a basic understanding of ecological science at all levels, especially focusing on the landscape ecological aspects. Species and community ecology can easily be dealt with at a local level. If, however, an attempt is made to develop an understanding of ecological infrastructure, the ability to document information and develop models over large areas is vital. This is where geographical information systems (GIS) and their power and potential come into play (Bridgewater, 1993).

It can be difficult to determine which areas to restore, what species and/or vegetation communities to target in restoration programs, and what threatening processes need to be mitigated. According to De la Cruz- Rot (2001), focusing on the community level can help fill the gap between species and ecosystem approaches to plant conservation. Plant communities are in fact basic components of the landscape and their extent and arrangement has consequences both for species survival and for ecosystem processes1.

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.

Traditionally, protected areas have been seen as the cornerstone of in-situ conservation. Conservation approaches that are more adaptable to individual situations and applicable beyond protected areas, are being increasingly applied . Protected areas are the cornerstone of in-situ conservation, as is outlined in Article 8 of the CBD. A protected area network may contribute to conservation targets through the maintenance of target species and their habitats, as well as the conservation of natural or semi-natural ecosystems. There is a however growing awareness of the importance of extending in-situ conservation beyond protected areas (Newmark, 2008, Primack, 2012). Some conservationists believe that efforts to expand and strengthen the global system of protected areas should be redoubled and at the same time dismiss the whole concept of sustainable development of resources as a misguided effort (Brandon, 1997; Kramer et al., 1997; Soule´ and Sanjayan, 1998).

Based on to the distribution of the local communities (Main Target) in South Sinai, we will make educational and awareness activities in SCPA and the four neighbor protected areas (Taba PA, Napq PA, Abu Galoum PA, and Ras Mohammed PA). The project main site will be SCPA which located in the southern part of Sinai, which located in the northeast part of Egypt. The SCPA is terrestrial and

not connected to any sea. The study site exactly situated in the central part of the southern Sinai that include the highest mountains allover Egypt. Site coordinates; Latitude: 28.54596 and Longitude: 33.94934 all in decimal.

South Sinai area is one of the most floristically diverse spots in the Middle East with 30% of Egypt's endemic plant species. *Silene schimperiana*, and *Polygala sinaica* are perennial herbs endemic to SCPA. Both have economic importance as fodder for domestic animal beside the medical significance. These plants grown in very narrow microhabitats inside SCPA (the only site for these species all over the world) with estimated EOO less than 300 km2. 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. The conservation and ecological status of these plants are not known. In addition, the conservation requirements for these plants are inadequate and their situation in wild are not well known, so there is an urgent need to improve these knowledge about its conservation status in order to take the right decision when practical conservation start. The aim of this project is to assess the conservation status of these species with the help of local community, and to generate long-term conservation plans through a multidisciplinary approach that integrates demography and ecology.

The overall objectives of the project:

Conservation and ecological status of these plants are not known, so there is an urgent need to improve this knowledge about its conservation status in order to take the right decision when practical conservation starts. The aim of this project is to assess the conservation status with the help of local community to generate a long-term conservation plan that integrates demography and ecology.

The objectives of this project are:

The project will take 10 months to achieve its objectives. Practical fieldwork like vegetation analysis, soil analysis, morphological analysis, reproductive analysis, geographical analysis, demographic study, topographic analysis, and threat analysis, will take about 6 months. Data analysis stage will include macroclimate analysis, ecological attributes analysis, Eco geographical analysis mapping, predicting and analyzing the geographic data, and Species Prediction model and this will consume 2 months. Educational and awareness activities will consume one month and reporting and data publishing will consume one month also.

Activities and Timescale

The project will take 10 months to achieve the following activities:

1. To assess the conservation status of the target species within SCPA boundaries using IUCN Red List guidelines.
2. To carry out a morphological, reproductive, and demographic for variation detection.

3. Identify and rank threats that affect the distribution of these species, and try to identify their underlying root causes and barriers to solutions.
4. Clearly identify conservation priorities, suitable habitats for growth and suggest appropriate strategies for the target species conservation by in situ and ex situ techniques.
5. Predict suitable habitat distribution for the target species.
6. Clearly identify the socio-cultural environment interaction, conflicts and participation.
7. Improve the capacity of rangers and researchers of PA about extinction risk assessment.
8. To raise the public awareness about species importance and conservation programs.
9. Setting strategies and management plans for the conservation of target species accepted from different parties.

Study Area:

Sinai Peninsula has the geographical importance and uniqueness of being the meeting place of Asia and Africa. For this reason its flora combines elements from these two continents, Saharo-Arabian, Irano-Turanian, Mediterranean and Sudanian elements (McGinnies *et. al*., 1968).

The Saint Katherine region is situated in the southern part of Sinai and is a part of the upper Sinai massif. It is located between 33˚ 55' to 34˚ 30' East and *28°* 30' to *28°* 35' North. The soil is formed mainly from mountains weathering, thus it is mainly granitic in origin. The soil layer is generally shallow were the bed rock is close to the surface. Annual rainfall is less than 50 mm. However, rainfall is not of annual character, rather 2 to 3 consecutive years without rainfall is common. Rain takes the form of sporadic flash floods or limited local showers, thus highly spatial heterogeneity in received moisture is also common.

A number of stands within SCPA were surveyed ranging throw different microhabitats. The diversity of both landforms and geologic structures of SCPA leads to the differentiation of a number of microhabitats. Each of them has its peculiar environmental conditions and unique flora which is rich in medicinal, rare and endemic plants. The diversity in geomorphological and geological structures of SCPA resulted in a unique landscape. Six landform types are identified in this landscape namely: Wadis (valleys), Terraces, Slopes, Gorges, Farsh (basins) and Caves (Khedr, 2007).

- **Wadis** are one of the most important and clearly defined ecosystems in SCPA. They act as drainage systems collecting water from catchment areas and form favorable habitats for plant growth. The wadis in SCPA are very narrow, have very steep slopes, short in length and occur at higher elevations ranging from 1190m to 1900m. Floristically, these wadis are relatively diverse and characterized by the presence of many medicinal plants e.g. *Seriphidium herba-album*, and some endemic plants e.g. *Ballota kaiseri*, *Phlomis aurea* and *Euphorbia sanctae-catharinae*. Also, these wadis are characterized by having many springs flow in narrow shallow channels or form little ponds in the rocks at the side of the wadi bed. These springs supports the growth of some aquatic and freshwater marsh communities with vegetation cover varying between 5 and 25%.
- **Terraces** are platforms of bedrock mantled with a sheet of gravel and sand, or rocky surface. This microhabitat is dominated by perennial species (lithophytes) that grow on the surface of hard granitic rock covered with very thin deposits. The most important medicinal plants are *Stachys aegyptiaca*, *Teucrium polium* and some endemic species e.g. *Silene leucophylla*, *Nepeta septemcrenata* and *Bufonia multiceps*. It occurs at higher elevations ranging from 1453m to 1928m.
- **Slopes** represent all land surfaces ranging from horizontal to vertical. Slope habitat dominates in Mount Katherine. It appears at different elevations ranging from 1634 m to 2300m. It is also characterized by different moisture availability. Annual plant species are restricted to pockets of soil in gentle slopes.
- **Gorges** originate from joints or faults. It is one of the most important microhabitats in Mount Katherine, Mount Musa, and Mount El-Ahmar. The gorge microhabitats are characterized by gravel and sand between the boulders and pockets of soil. In

addition, some gorges have dykes that trap water resulting in significant plant cover. It occurs at higher elevations ranging from 1594m to 2037m.

- **Farsh** (basin) microhabitats are restricted to higher elevations 2025-2233m. It occurs as depressions between the peaks of high mountains. This microhabitat is characterized by the presence of pockets of soil, open with the gentle slope. This microhabitat supports dense growth of the endemic species *Thymus decussates*, *Nepeta septemcrenata* and many other medicinal plants with vegetation cover varying between 50 and 75%.
- **Caves** are very important microhabitats in the north-facing slopes of SCPA Mountains. It is usually found at an elevation above 1750 m, and is usually found near springs and in cracks of red granite, where water is available almost all over the year. The endemic species which is restricted to cave microhabitat is *Primula boveana*. It is associated with *Adiantum capillus-veneris* and *Funaria* sp.

Vegetation of these locations is rich in herbs and few shrubs. Grasses are not abundant, but a few species do occur after rainfall. The dominant species are *Achillea fragrantissima, Seriphidium herba-album* and *Tanacetum sinaicum* while a very low proportion of other species like *Foeniculum vulgare* may be recorded.

Geology

Sinai Peninsula is a triangle plateau occupying the northeastern corner of Egypt. With its position at the northeast corner of Africa, Egypt forms a bridge between Asia and Africa. Sinai Peninsula is part of Asia; the rest of the country is part of Africa. It is also part of the Mediterranean Basin. Its base, is in the north along the Mediterranean Sea. The area of the Sinai Peninsula (61,000 km^2) is about 6% of that of Egypt (Migahid *et. al.* 1959). It is triangular in shape and is separated from the mainland of Egypt by the Suez Canal and the Gulf of Suez. It is continuous with the Asiatic continent for a distance of over 200 Km between Rafah on the Mediterranean Sea and Taba at the head of the Gulf of Aqaba.

It is conventionally divided into two main parts. The southern part is one third of the Peninsula. The northern part is almost entirely covered by sedimentary rocks that are mostly composed of limestone, while in the southern part the basement rocks occupy more than 80% of the area and are mainly of granitic composition. The St. Catherine Protected Area is located between 33^o 30' to 34^o 30' E, and 28^o 50' to 29^o 50' N. The protectorate area is described as predominantly smooth-faced granite outcrops forming mountains such as Gebel Serbal, Ras Safsafa and Gebel El-Rabah. Black mountains consisting of old volcanic rocks are rather common.

Geologically, a complex of ancient crystalline rocks forms the St. Catherine Protected Area with some rocks, such as the Feiran gneiss, dating back 1,100 million years. Grey granites dating back to 850 million years are among the oldest rocks while the more common rose granites are younger at about 600 million years old. Ancient pink, white and yellow sandstones, dating from the Permian to the Cretaceous period, skirt the crystalline rocks to the north and west of the Protectorate (Hatab, 2009).

The Protectorate contains some of the highest peaks in Egypt, including Gebel Katherina (Mount Saint Katherine) the country's highest summit at 2,642m, Gebel Umm Shaumar

(2,586m), Gebel El Thabt (2,439m), Mt. Sinai (Gebel Musa) (2,2,80m) and Gebel Serbal (2,070m). These mountains are composed of rocks of various types, colors and ages; for instance Gebel Katherina is made of andesite porphyry, a volcanic rock about ten million years old. Neighboring mountains of Gebel Ferrah, Gebel Safsafa and Mount Sinai are formed from pink granite, a 580 million year old basement rock. However, Mount Sinai's summit is made of more recent volcanic rock, again only about ten million years old.

Until about 25 million years ago, the Sinai Peninsula, like the Arabian Peninsula, was attached to Africa as part of the African Shield. Sinai was split off as the great African Rift gradually widened to form the Red Sea. This movement continues at about 2cm a year; the Sinai is still an active seismic zone and small earth tremors occur occasionally.

Over millions of years, massive tectonic forces have tilted and shattered the country rock causing volcanic eruptions. The dark veins, or dykes, which cut across mountains, sometimes running for several kilometers, are the intrusions of basalt (volcanic) rock into rock fractures and along lines of weakness. Particularly impressive dyke swarms can be seen along Wadi Feiran. The Bedouin often dig their wells in these dykes, as they tend to trap underground water. Some of the rocks, particularly the grey, rose and red granites have value as ornamental stone and are quarried in parts of the Protectorate together with building aggregate (Hatab, 2009).

Hydrology

A complex network of deeply-cut wadis intersects the mountain massif and drains it eastwards to the Gulf of Aqaba and westward to the Gulf of Suez. The most important wadis are Wadi Feiran (Sheikh), Wadi Hibran, Wadi Isla, Wadi Nasb and Wadi Zaghra. In general, water supplies are very limited for both people and wildlife. In the crystalline mass it is available in small quantities in suspended shallow aquifers of wadi alluvium or in shattered dyke structures. These supplies were traditionally exploited by Bedouins digging wells and require local precipitation for replenishment. Recent tourism development has resulted in a serious depletion of this limited groundwater.

There are no permanent watercourses in the Protectorate; wadis may run for short periods following heavy rainfall and floods can be destructive. In certain wadis, e.g. Wadi Isla, water may flow above ground for short distances throughout the year following good rain. Natural springs occur where rocks are highly fractured or jointed. The springs may form small oases and are often tapped by Bedouins to irrigate gardens; they are also the only water sources available for wildlife.Aquifers in wadi alluvium are traditionally exploited by Bedouin digging wells, often located upstream of dikes that cross the wadi. Wells may function only seasonally depending on rainfall and can be destroyed by flooding.

The main water bearing formations in South Sinai include: (1) the basement complex occupying the southern part of Sinai specially the highly fissured igneous rocks (Saint Catherine area, Wadi El-Sheik and Wadi Feiran) and (2) the alluvial deposits occupying the alluvial plains which are parallel to the Gulf of Suez and the Gulf of Aqaba (Hammad, 1980).

Issar and Gilad (1982) studied the regional groundwater flow pattern in South Sinai. Kassem (1981) concluded that the fractured granites, grandiosities of wadi Feiran are the most important basement water-bearing zones while the metamorphic rocks have not any

Hydrogeologic importance. El-Rayes (1992) classified the basement rocks of Saint Catherine area hydro- geologically into three units: major aquifer, leaky aquitared and local aquifer units. The depths to water table ranged from 4 to 8m in basement rocks, and up to 40m in alluvial deposits.

Prime Ministerial Decree No. 613 established St Katherine 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 Katherine Protectorate; full protected-area status was given to approximately 4,350km² 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 Katherine 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 Katherine Protectorate 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] (SKP Management Plan 2003)

MATERIALS AND METHODS

Data Collection:

- The present study was carried out in the period between January 2017 to date.
- Data used for analysis in this study were collected from the fieldwork survey, 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 these species we collected sufficient data about the following:

- Distribution of *target species* within the target PA during the field survey was recorded. 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 these species.

2- Population Characteristics

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

- Number of *species* populations, subpopulations, and number of total individuals were recorded within field survey.

- 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 based on 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 these 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 were recorded within each site.
- Plant species in each given quadrant has been 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 200 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, previous work and local community and St. Catherine PA staff discussions, we used a systematic sampling approach to capture local environmental gradients, placing more than 200 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, (2005); 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 2015, 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).
- We have collect 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 extracted and suggested. Researches needed according to IUCN Scheme were recommended (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 (Graham and Hijmans 2006; Murienne et al., 2009), 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 (Pearson et al., 2007). 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 (Pearson et al., 2007). 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

Red List Assessment:

Polygala sinaica Botsch. POLYGALACEAE

Figure 1. *Polygala sinaica* Botsch.

Table 1: Taxonomic notes on *Polygala sinaica* Botsch.

Taxonomic Notes	Justification
Full Name	*Polygala sinaica*
Level	Species
Parent	*Polygala*
Taxonomic Authority	Botsch.
Status	Accepted
Taxonomy	PLANTAE- TRACHEOPHYTA- MAGNOLIOPSIDA- FABALES- POLYGALACEAE- Polygala- sinaica
Hybrid	No
Invasive	No
Feral	No
Synonyms	*Polygala decaisnei* Steud. *Polygala spinescens* Decne.
Common Names	* Seir - Haykal (Arabic)
Taxonomic Sources	Hassler M. (2015). World Plants: Synonymic Checklists of the Vascular Plants of the World (version Sep 2015). In: Species 2000 & ITIS Catalogue of Life, 20th November 2015 (Roskov Y., Abucay L., Orrell

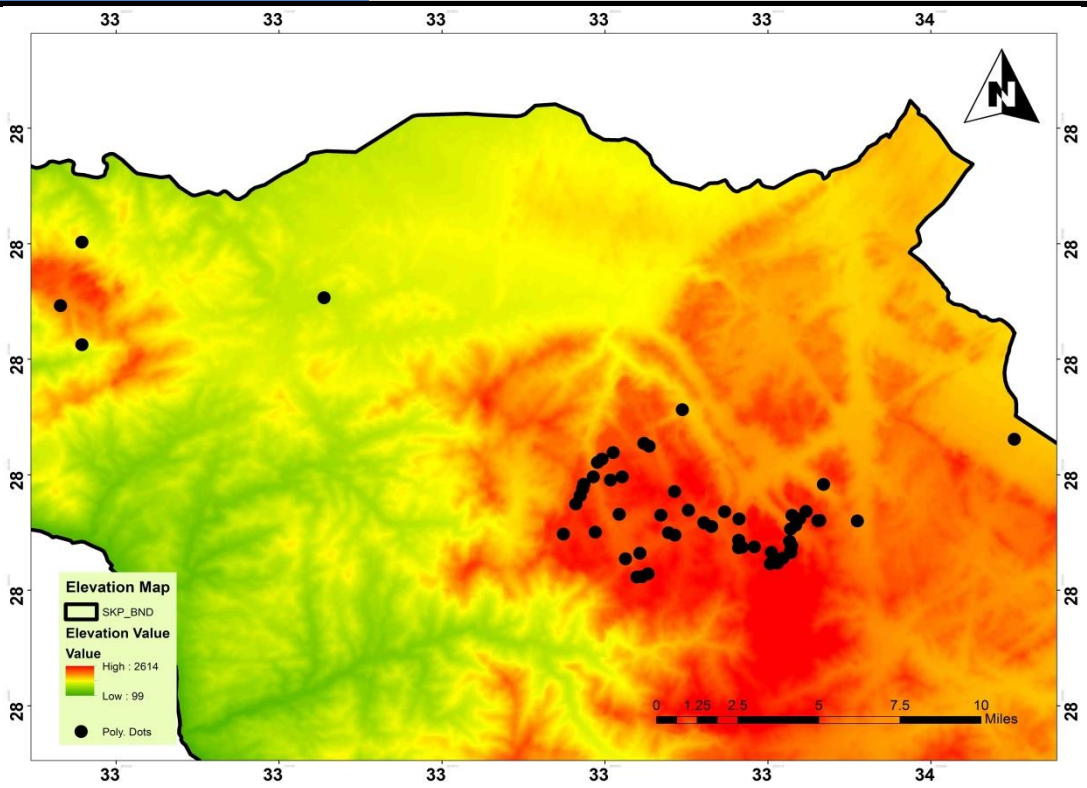
	T., Nicolson D., Kunze T., Flann C., Bailly N., Kirk P., Bourgoin T., DeWalt R.E., Decock W., De Wever A., eds). Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.

GEOGRAPHIC RANGE:

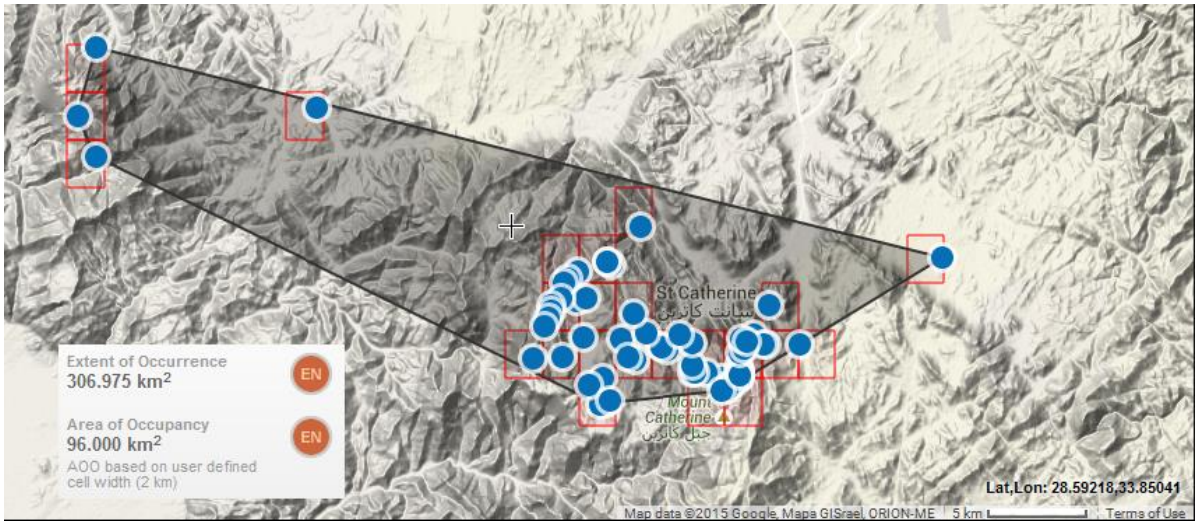
Polygala sinaica is an endemic plant species to the St. Catherine Protected Area (SCPA) in southern Sinai, Egypt with a narrow altitudinal range in Egypt between 1000 and 2300 m asl (Map 1). Its extent of occurrence (EOO) is c. 307 km^2, and its area of occupancy (AOO) is 96 km^2 (Table 2, Map 2). This species is clearly distributed in two locations (High Mountains Area, and Serbal Mountain Area). Wadi Gebal, Elgabal Elahmar, and Catherine Mountain are the most important places for this species within the area of SCPA.

Table 2: Geographical distribution range of *Polygala sinaica inside St. Catherine Protected Area*

Geographical Aspects	Justification
EOO	307 km^2
AOO	96 km^2
Elevation Lower Limit (in metres above sea level)	1000
Elevation Upper Limit (in metres above sea level)	2300
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic



Map 1. Elevation map of *Polygala sinaica inside St. Catherine Protected Area*



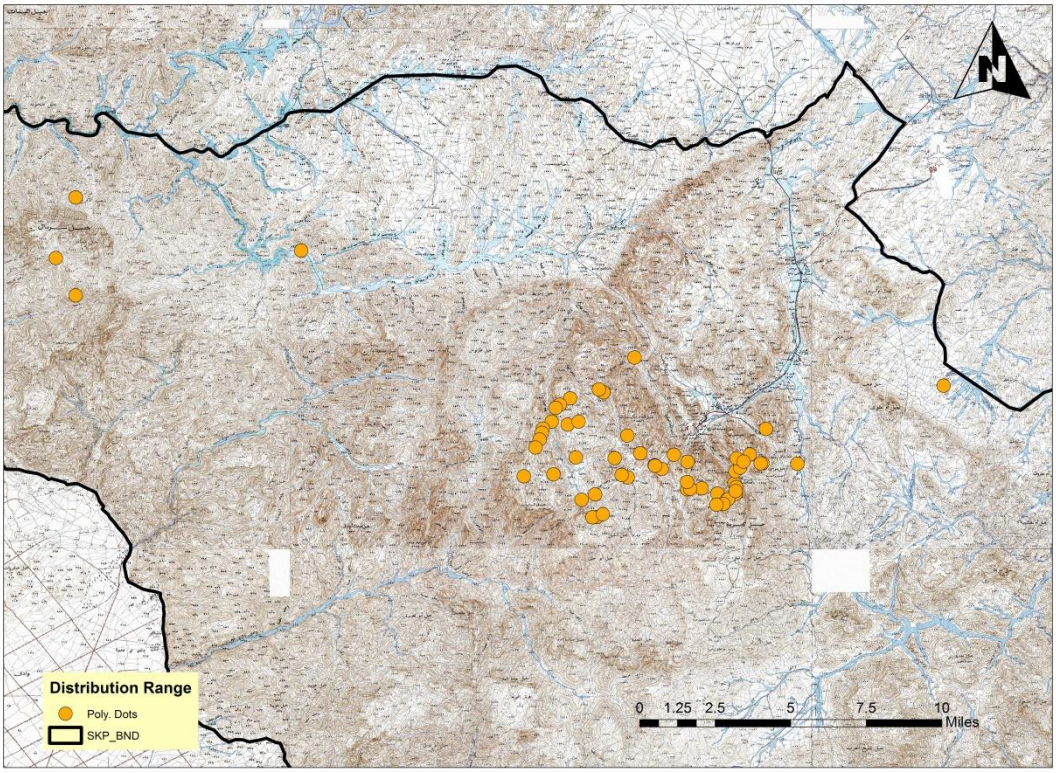
Map 2. Geographical Range map of *Polygala sinaica inside St. Catherine Protected Area*

POPULATION INFORMATIONS:

Most of the *Polygala sinaica* subpopulations are very small, with individual plants occurring sporadically in space in little groups where the soil is rocky (Map 3). The number of mature plants has been observed to decline as a result of drought and overgrazing. The total national population size estimate ranges from 300 to 1,000 mature individuals (Table 3). There are clearly separate subpopulations. The number of mature individuals in each subpopulation ranges from 1-50 in the largest subpopulation (the exact number in the largest subpopulation is unknown). 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 overgrazing. The population is considered severely fragmented as the mountainous habitat acts as a barrier between the small subpopulations, as well as many of these subpopulations have low viability due to destructive overgrazing causing loss of reproductive organs.

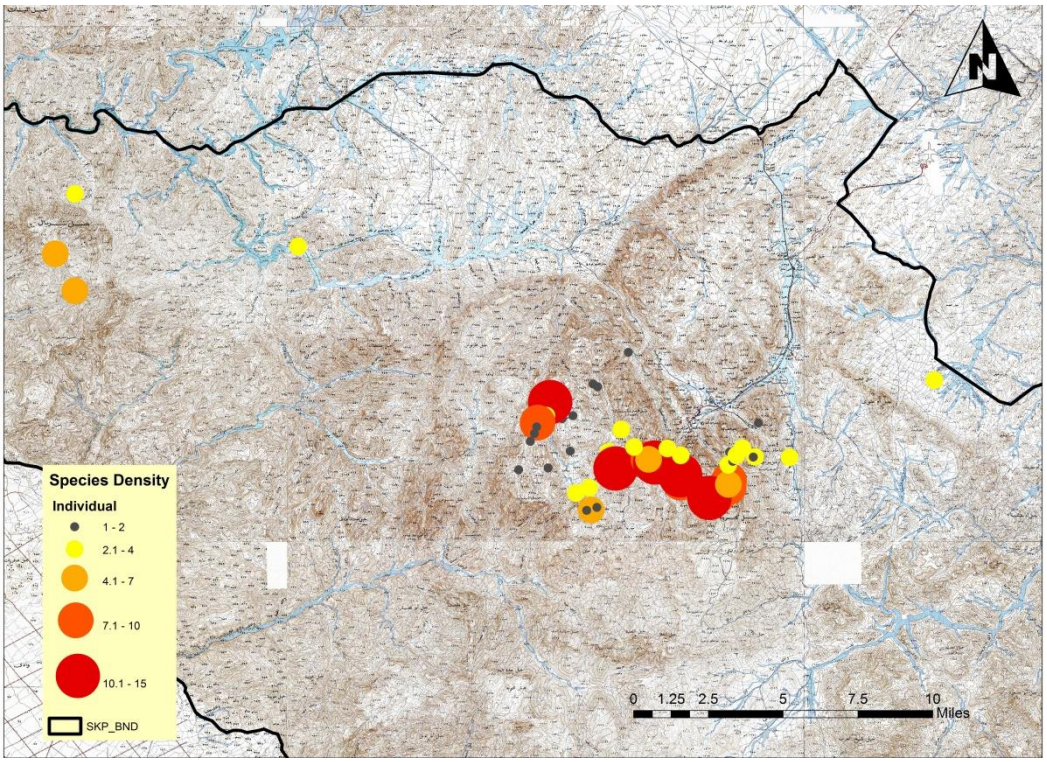
Table 3: Some facts about population characteristics of *Polygala sinaica*

Population Information	Justification
Locations	2 locations- High Mountains Area and Serbal Mountain Area
Current Population Trend	Decreasing
Number of mature individuals (=population size	300-1000 Estimated
Severely fragmented?	Yes – the mountainous habitat acts as a barrier between the small subpopulations, as well as many of these subpopulations have low viability due to destructive overgrazing causing loss of reproductive organs.
Continuing decline in mature individuals?	Yes - Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	50- Estimated



Map 3. Population structure of *Polygala sinaica inside St. Catherine Protected Area*

The plant is distributed within two restricted areas (High Mountains Area and Serbal Mountain Area). Wadi Gebal, Elgabal Elahmar, and Gabal Katherine are are the higest sites for species density (Map 4). Gabal Katherin, Elgabal Elahmar, and Zeaater are the higest sites for species frequency (Figure 2).



Map 4. Density of *Polygala sinaica inside St. Catherine Protected Area*

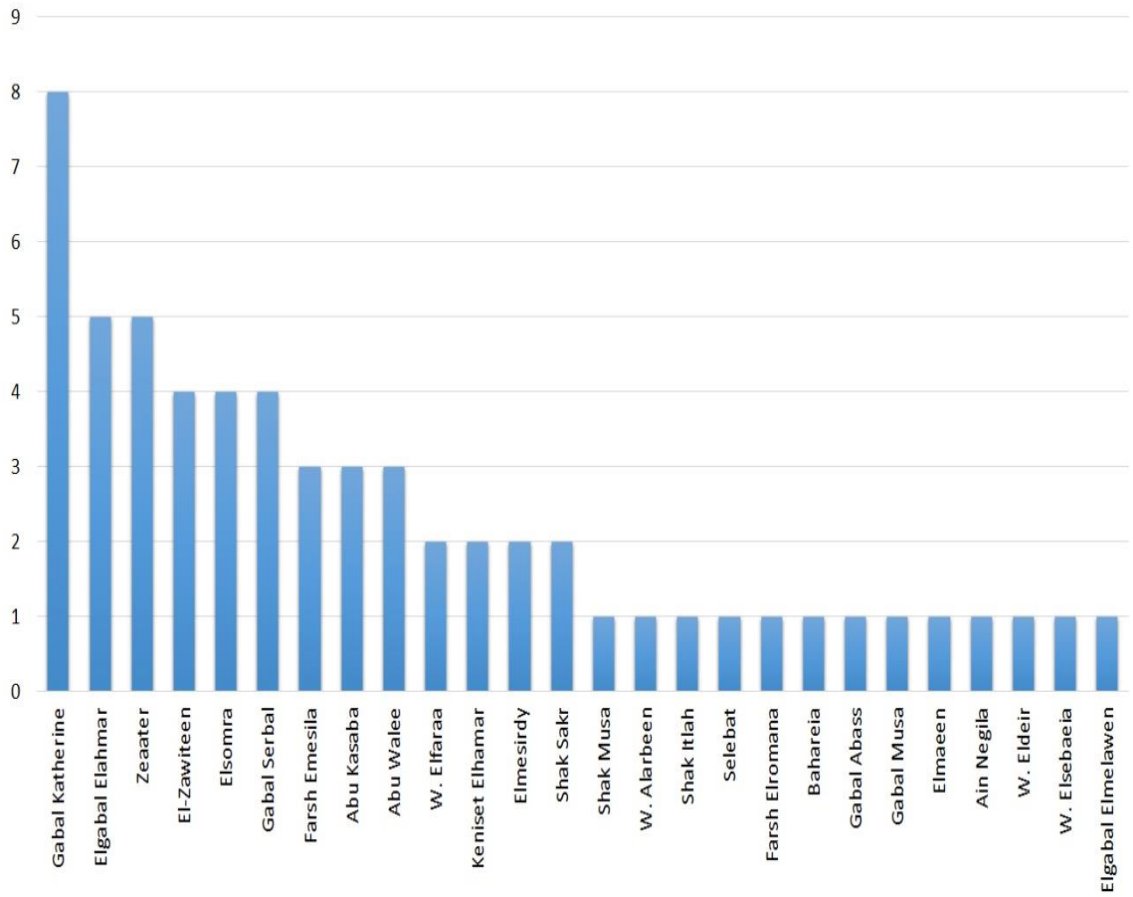
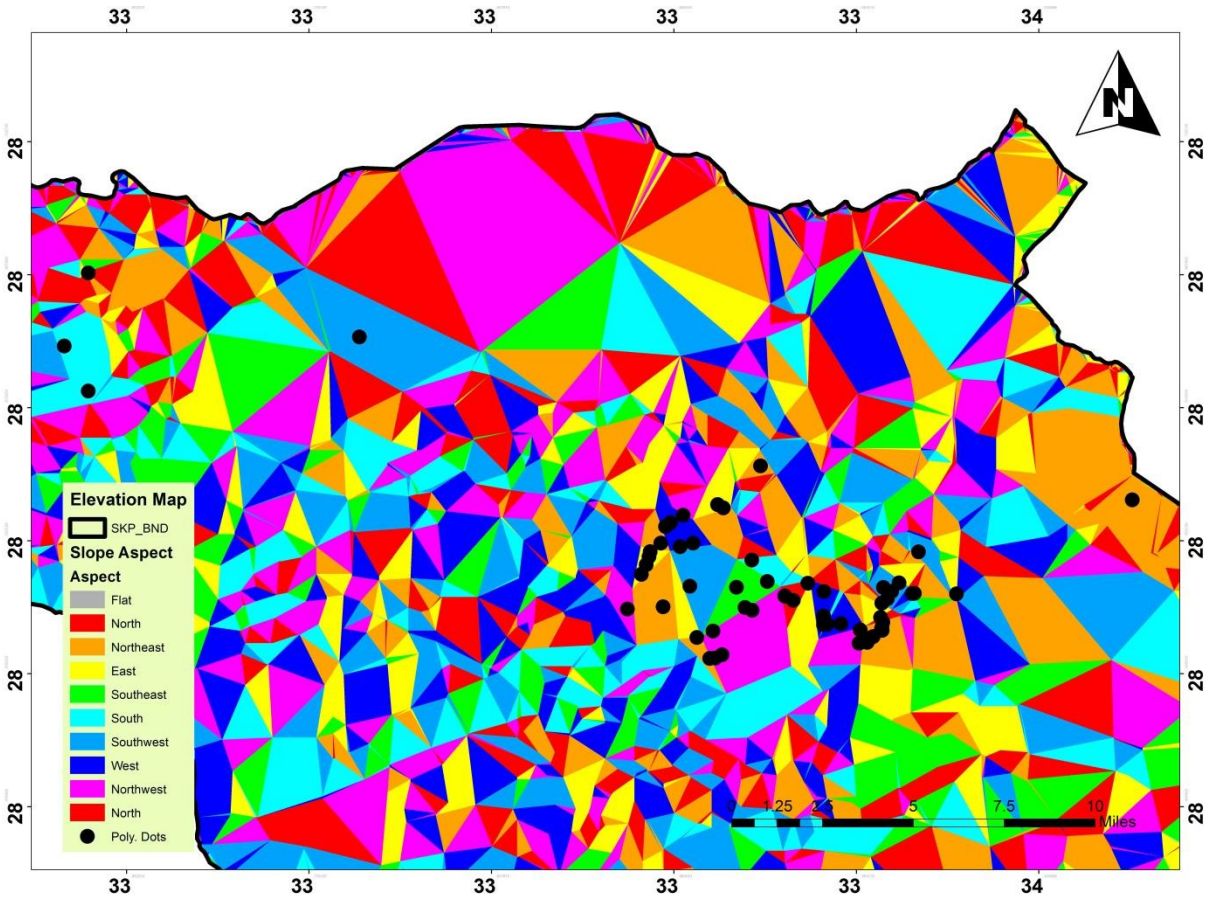


Figure 2. Frequency of *Polygala sinaica* among different sites in St. Catherine Protected Area

HABITATS AND ECOLOGY:

Polygala sinaica is perennial herb. The plant in the seedling stage was observed from 1 of March to 1 of May or in early vegetative stage, the late vegetative stage at the beginning of spring and flowering stage were observed in late spring. The plant completed fruiting stage maturation stage at in summer, and finally the plant reached to dryness state to finish their life cycle and the seeds in soil may be grow at the next spring to give a new individual The survey showed that *Polygala sinaica* populations are located in very specific micro-habitats**.** Most of *Polygala sinaica* sites were recorded at cliffs (65%) and gorges (30%). It is restricted to montane wadis with granite rocky cliffs of mountain areas (Table 4), with sharp slopes of up to 90°. Regarding to slope aspect it was recorded at West (30%), North East, South West (15.5%), and North West (7%) (Map 5). Optimum frequency were recorded between elevations 1600 to 2200 m (Figure 3).



Map 5. Slope Aspect map of *Polygala sinaica inside St. Catherine Protected Area*

Annual precipitation and species distribution indicate that *Polygala sinaica* naturally occurs in the low-rainfall zones (less than 150 mm), A well distributed rainfall within the range of 50–84 mm is best suited for *P. sinaica* growth. The annual rainfall in all the collection sites ranged from 49 to 111 mm. The superimposed map of BIOCLIM annual Min-temperature, Max-Temperature and species distribution indicate that *P. sinaica* naturally occurs in the low-temperature zones range from 8.09 – 11.08 C° at winter and from 19.4 - 22.28 C° at summer season.

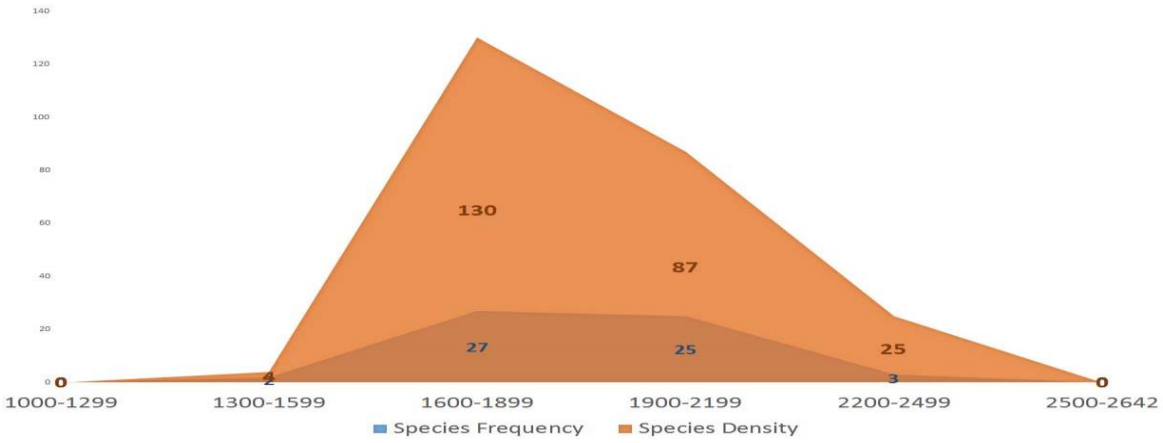


Figure 3. Relation between elevation and *Polygala sinaica* density and frequency

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that the 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 *P. sinaica* distribution area are 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).

It is recorded that *P. sinaica* showed high rate of overlap with *Mentha longifolia*, *Chiliadenus montanus* and *Tanacetum sinaicum*.

Table 4: Habitat of *Polygala sinaica* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6.	Rocky areas (eg. inland cliffs, mountain peaks)	resident	Suitable	Yes
8.2.	Desert -> Desert - Temperate	resident	Suitable	Yes

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

TRADE AND USES:

The species has economic importance in grazing processes as a PAtoral plant (Khafagi *et al.* 2012, Omar *et al.* 2013).

THREATS:

Drought is the major threat affecting the distribution of *P. sinaica* within the study area. With drought the effect of overgrazing will be most harmful and may be led to decrease the population size with time. 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. It was recorded that there is a massive grazing pressure observed on *P. sinaica* especially by camels and donkeys (Table 5). In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (over-grazing by domestic animals and feral donkeys). All these factors are pushing *P. sinaica* to the brink of extinction.

Table 5: Threats on *Polygala sinaica* 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 ->	Ongoing	Minority	Slow,	Low

	Work & other activities		(<50%)	Significant Declines	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	Whole (>90%)	Very Rapid Declines	High Impact: 9
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

CONSERVATION ACTIONS:

The entire national distribution of *P. sinaica* in Egypt is inside the St. Catherine Protected Area (SCPA). Parts of some subpopulations (Elgabal Elahmar, Wadi Eldeir, Wadi Esbaiea) are already protected by five fenced enclosures, and 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 (Table 6). Education and awareness activities are implemented by SCPA Management and supporting projects. Much more is needed, however (Tables 7, 8).

Table 6: Conservation Actions In-Place for *Polygala sinaica* 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 Global Scale: Unknown
4	Ex-situ Conservation	Yes – inactivated
5	Monitoring	Partly Yes

Table 7: Important Conservation Actions Needed for *Polygala sinaica*

Code	Conservation Actions In-Place	Justification
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
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 *Polygala sinaica*

Code	Research Scope	Research Aspects Needed
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

IUCN RED LIST ASSESSMENT RATIONALE:

Polygala sinaica qualifies as Endangered at national scale because it is near endemic to a tiny area, with an extent of occurrence (EOO) is c. 307 km^2, and its area of occupancy (AOO) is 96 km^2, of the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations and the population is severely fragmented. There is a continuing decline in habitat quality for this species, with evidence of declines in subpopulation numbers and numbers of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

Silene schimperiana Boiss. CARYOPHYLLACEAE

Figure 4. *Silene schimperiana* Boiss.

Table 9: Taxonomic notes on *Silene schimperiana* Boiss.

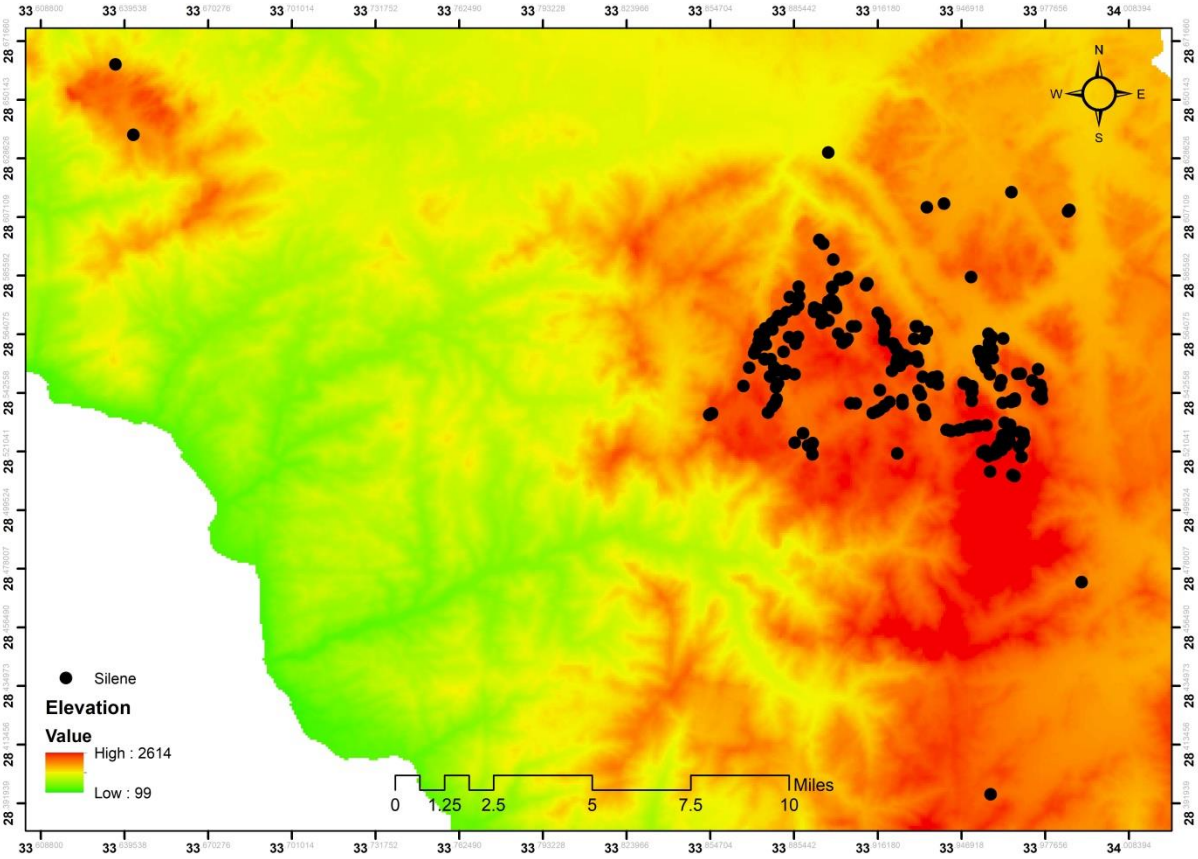
Taxonomic Notes	Justification
Full Name	*Silene schimperiana*
Level	Species
Parent	*Silene*
Taxonomic Authority	Boiss.
Status	Accepted
Taxonomy	PLANTAE- TRACHEOPHYTA- MAGNOLIOPSIDA- CARYOPHYLLALES - CARYOPHYLLACEAE - *Silene* - *schimperiana*
Hybrid	No
Invasive	No
Feral	No
Synonyms	-
Common Names	Loseik (Arabic)
Taxonomic Sources	Hassler M. (2017). World Plants: Synonymic Checklists of the Vascular Plants of the World (version Nov 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. (2017). Species 2000 & ITIS Catalogue of Life, 28th November 2017. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.

GEOGRAPHIC RANGE:

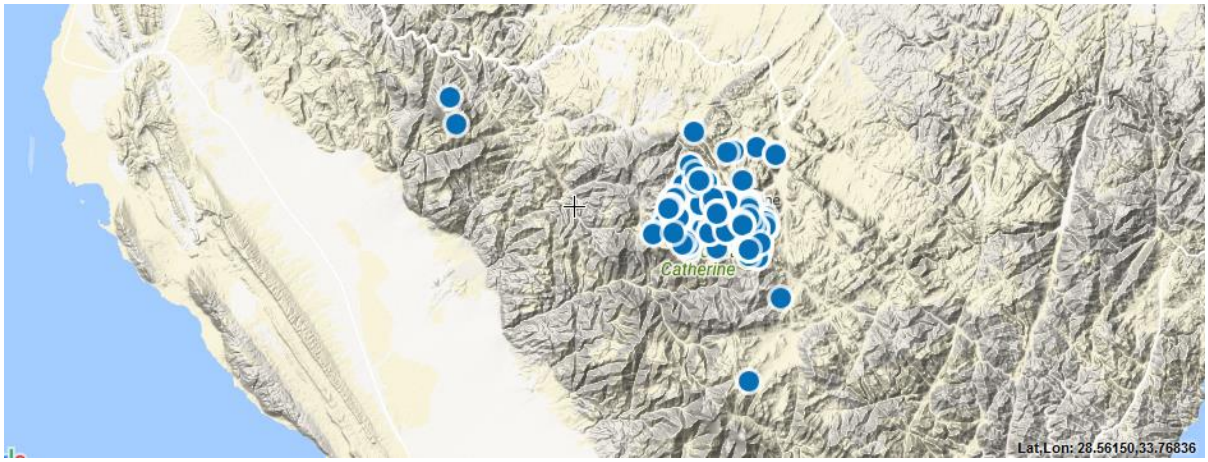
Silene schimperiana is an endemic plant species to the St. Catherine Protected Area (SCPA) in southern Sinai, Egypt with a narrow altitudinal range in Egypt between 1100 and 2330 m asl (Map 6). Its extent of occurrence (EOO) is c. 494.5 km^2, and its area of occupancy (AOO) is 132 km^2 (Table 10, Maps 7 and 8). This species is clearly distributed in two locations (High Mountains Area, and Serbal Mountain Area). Wadi Gebal, Elgabal Elahmar, and Shak Musa, Shak Elgragenia are the most important places for this species within the area of SCPA.

Table 10: Geographical distribution range of *Silene schimperiana inside St. Catherine Protected Area*

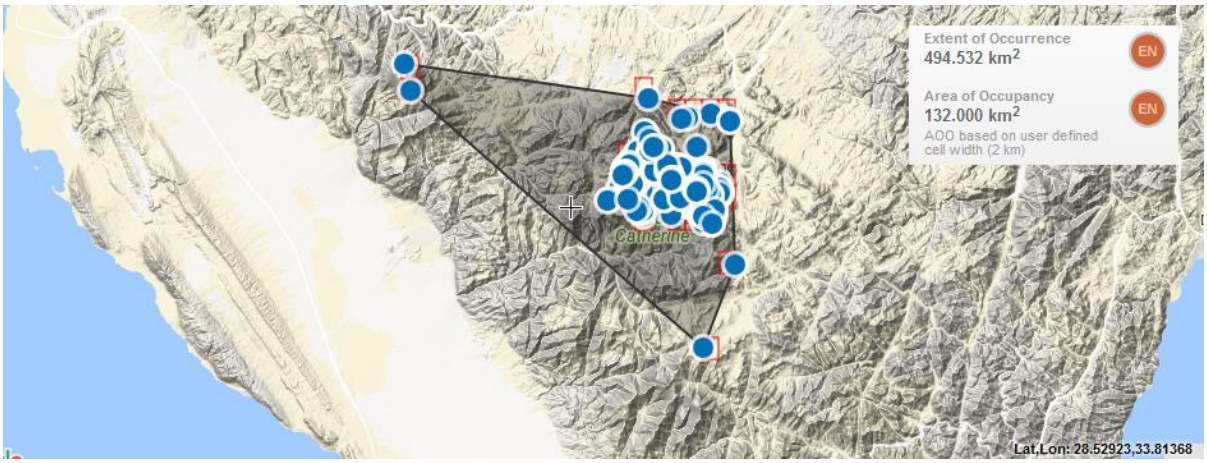
Geographical Aspects	Justification
EOO	494.5 km^2
AOO	132 km^2
Elevation Lower Limit (in metres above sea level)	1150
Elevation Upper Limit (in metres above sea level)	2330
Countries of Occurrence	Egypt -> Sinai
Presence	Extant
Origin	Native
Seasonality	Resident
Biogeographic Realm	Palearctic



Map 6. Elevation map of *Silene schimperiana inside St. Catherine Protected Area*



Map 7. Geographical Range map of *Silene schimperiana inside St. Catherine Protected Area*



Map 8. Extent Of Occurrence and Area Of Occupancy for *Silene schimperiana inside St. Catherine Protected Area*

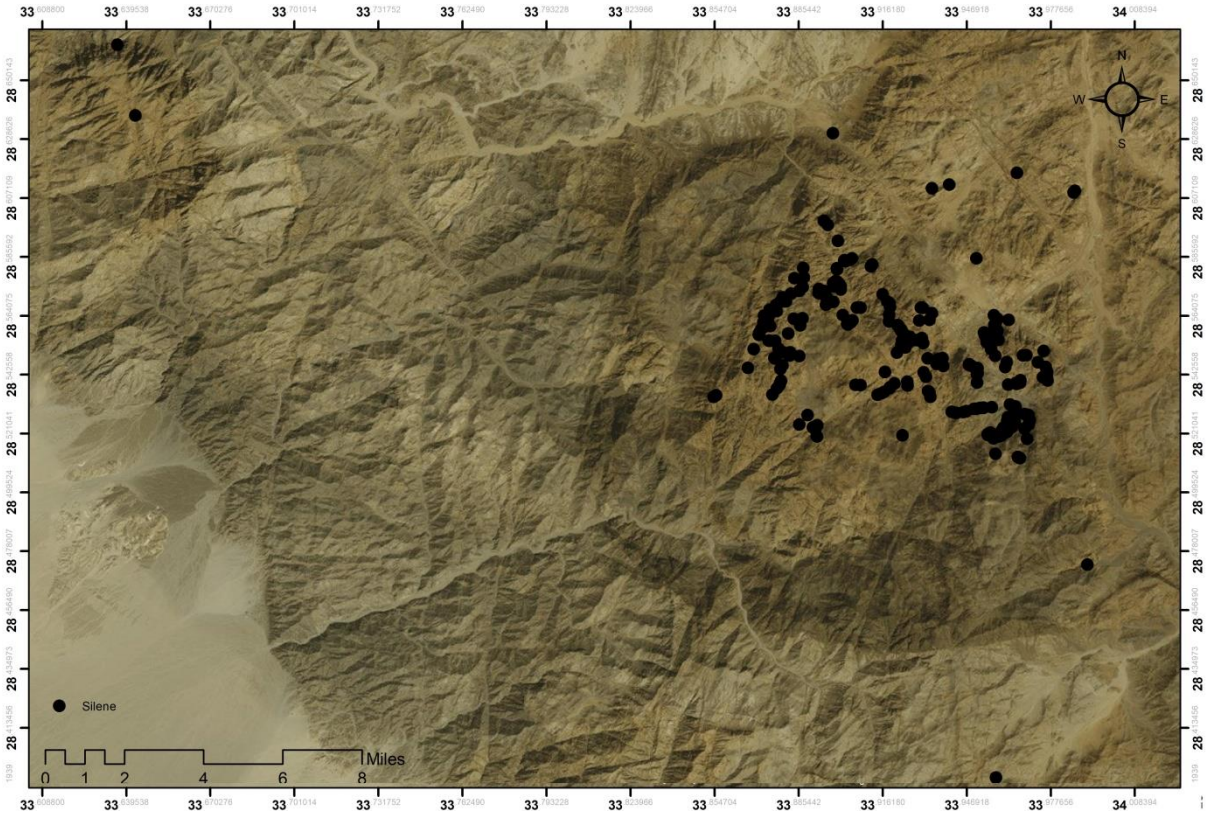
POPULATION INFORMATIONS:

Most of the *Silene schimperiana* subpopulations are very small, with individual plants occurring sporadically in space in little groups where the soil is rocky (Map 9). The number of mature plants has been observed to decline as a result of overgrazing. The total national population size estimate ranges from 1000 to 1,500 mature individuals (Table 11). There are clearly separate subpopulations. The number of mature individuals in each subpopulation ranges from 1-50 in the largest subpopulation (the exact number in the largest subpopulation is unknown). 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 overgrazing. The population is considered severely fragmented as the mountainous habitat acts as a barrier between the small subpopulations, as well as many of these subpopulations have low viability due to destructive overgrazing causing loss of reproductive organs.

Table 11: Some facts about population characteristics of *Silene schimperiana*

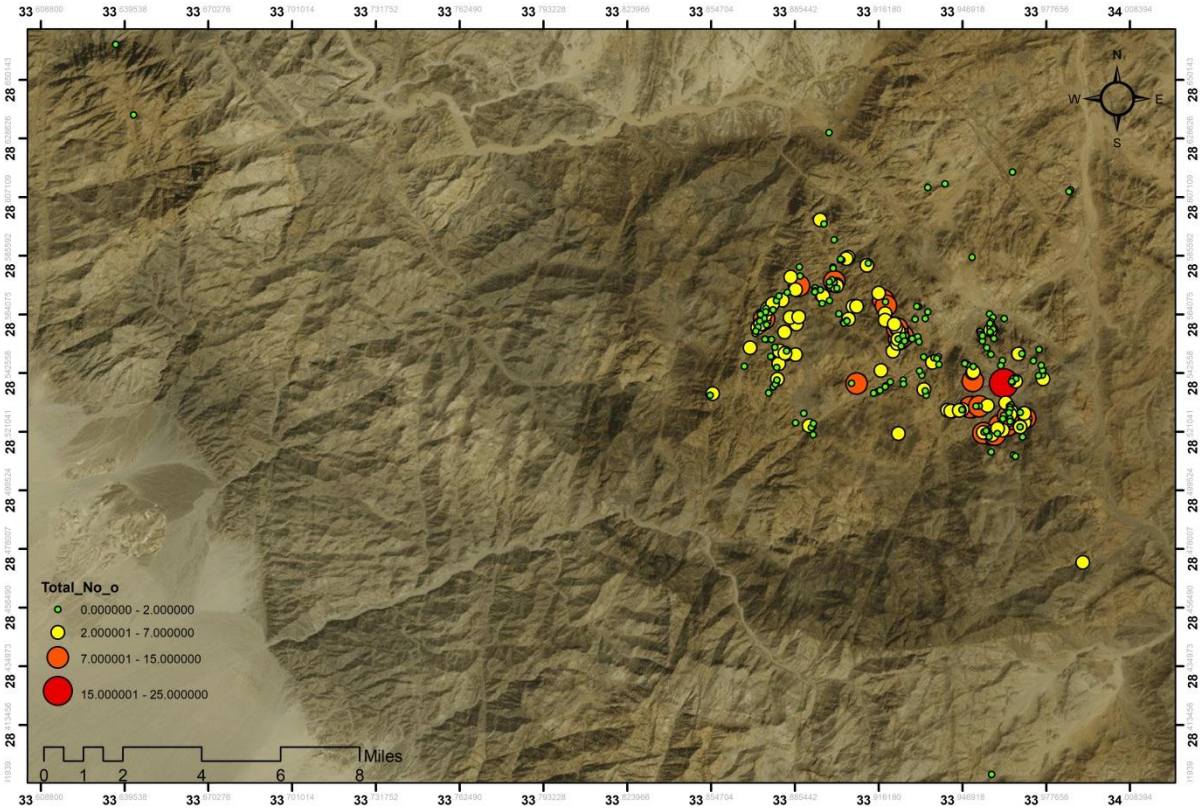
Population Information	Justification
Locations	2 locations- High Mountains Area and Serbal Mountain Area
Current Population Trend	Decreasing
Number of mature individuals	1000-1500 Estimated

(=population size	
Severely fragmented?	Yes – the mountainous habitat acts as a barrier between the small subpopulations, as well as many of these subpopulations have low viability due to destructive overgrazing causing loss of reproductive organs.
Continuing decline in mature individuals?	Yes - Observed
All individuals in one subpopulation	No
Number of mature individuals in largest subpopulation	50- Estimated



Map 9. Population structure of *Silene schimperiana inside St. Catherine Protected Area*

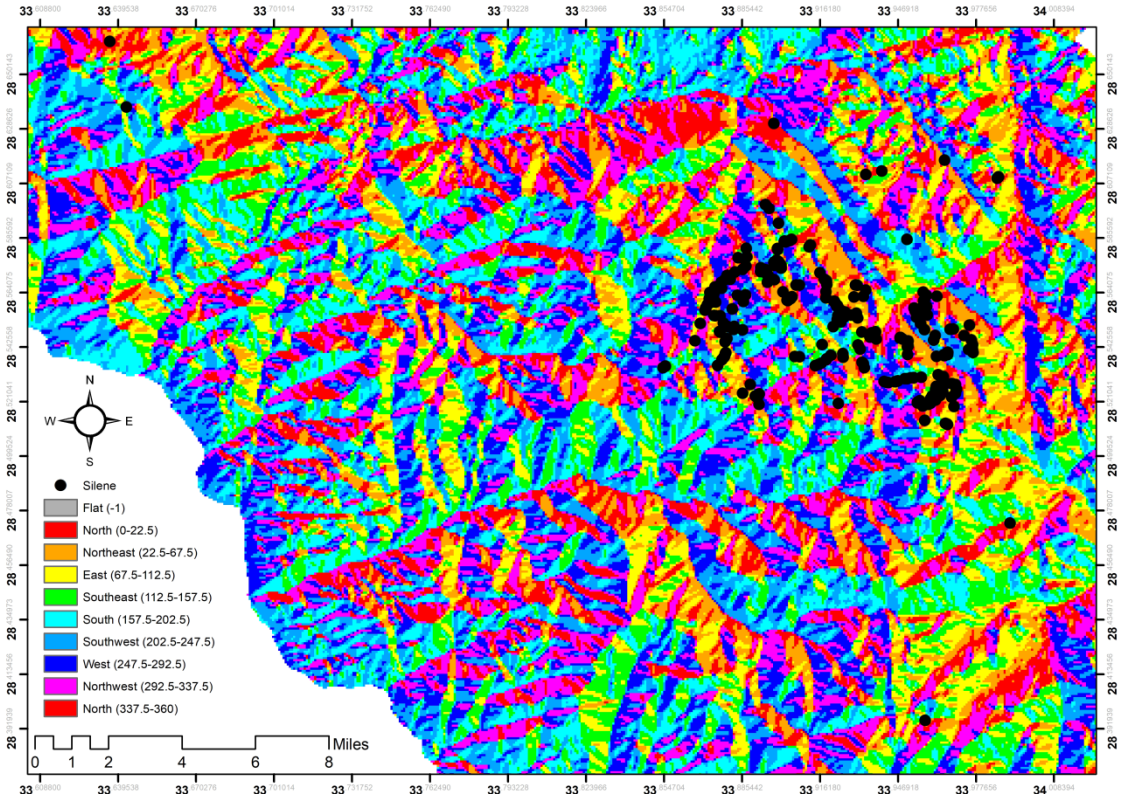
The plant is distributed within two restricted areas (High Mountains Area and Serbal Mountain Area). Wadi Gebal, Shak Musa, Elgabal Elahmar, are the highest sites for species density (Map 10).



Map 10. Density of *Silene schimperiana inside St. Catherine Protected Area*

HABITATS AND ECOLOGY:

Silene schimperiana is perennial herb. The plant in the seedling stage was observed from 1 of March to 1 of May or in early vegetative stage, the late vegetative stage at the beginning of spring and flowering stage were observed in late spring. The plant completed fruiting stage maturation stage at in summer, and finally the plant reached to dryness state to finish their life cycle and the seeds in soil may be grow at the next spring to give a new individual The survey showed that *Silene schimperiana* populations are located in very specific micro-habitats**.** Most of *Silene schimperiana* sites were recorded at terraces (36%), gorges (27%), Wadi bed (17%), and Slope (15%). It is restricted to montane wadis with granite rocky gorges of mountain areas (Table 12), with sharp slopes of up to 90°. Regarding to slope aspect it was recorded at West (20%), North East, South West (19.5%), and North West (15%) (Map 11). Optimum density was recorded between elevations 1700 to 2300 m.



Map 11. Slope Aspect map of *Silene schimperiana inside St. Catherine Protected Area*

Annual precipitation and species distribution indicate that *Silene schimperiana* naturally occurs in the low-rainfall zones (less than 150 mm), A well distributed rainfall within the range of 50–84 mm is best suited for *S. schimperiana* growth. The annual rainfall in all the collection sites ranged from 49 to 111 mm. The superimposed map of BIOCLIM annual Min-temperature, Max-Temperature and species distribution indicate that *S. schimperiana* naturally occurs in the low-temperature zones range from 8.09 – 11.08 C° at winter and from 19.4 - 22.28 C° at summer season.

It has been recorded by Schlesinger *et al.* (1996) and Durnkerley and Brown (1997) that the 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 *S. schimperiana* distribution area are 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).

It is recorded that *S. schimperiana* showed high rate of overlap with *Phlomis aurea* Decne., *Tanacetum sinaicum* and *Echinops glaberrimus.*

Table 12: Habitat of *Silene schimperiana* based on IUCN Habitats Classification Scheme

Code	Habitat	Season	Suitability	Major Importance?
6.	Rocky areas (eg. inland cliffs, mountain peaks)	resident	Suitable	Yes
8.2.	Desert -> Desert - Temperate	resident	Suitable	Yes

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

TRADE AND USES:

The species has economic importance in grazing processes as a pastoral plant.

THREATS:

Drought is the major threat affecting the distribution of *S. schimperiana* within the study area. With drought the effect of overgrazing will be most harmful and may be led to decrease the population size with time. 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. It was recorded that there is a massive grazing pressure observed on *S. schimperiana* especially by camels and donkeys (Table 13). In general, this species is severely threatened by both natural (aridity of the area and climate change) and human factors (over-grazing by domestic animals and feral donkeys). All these factors are pushing *S. schimperiana* to the brink of extinction.

Table 13: Threats on *Silene schimperiana* 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	Whole (>90%)	Very Rapid Declines	High Impact: 9
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

CONSERVATION ACTIONS:

The entire national distribution of *S. schimperiana* in Egypt is inside the St. Catherine Protected Area (SCPA). Parts of some subpopulations (Shak Musa) are already protected by fenced enclosures, and regular monitoring by SCPA rangers takes place every two years to detect the effect of this protection on population trends (Shabana *et al.* 2011). *Silene shemperiana* one of the most species showed positive response to protection after 7 years (2004-2011). 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 (Table 14). Education and awareness activities are implemented by SCPA Management and supporting projects. Much more is needed, however (Tables 15, 16).

Table 14: Conservation Actions In-Place for *Silene schimperiana* 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

Table 15: Important Conservation Actions Needed for *Silene schimperiana*

Code	Conservation Actions In-Place	Justification
1.1.	Land/water protection	Site/area protection
1.2.	Land/water protection	Resource & habitat protection
2.1.	Land/water management	Site/area management
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 *Silene schimperiana*

Code	Research Scope	Research Aspects Needed
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

IUCN RED LIST ASSESSMENT RATIONALE:

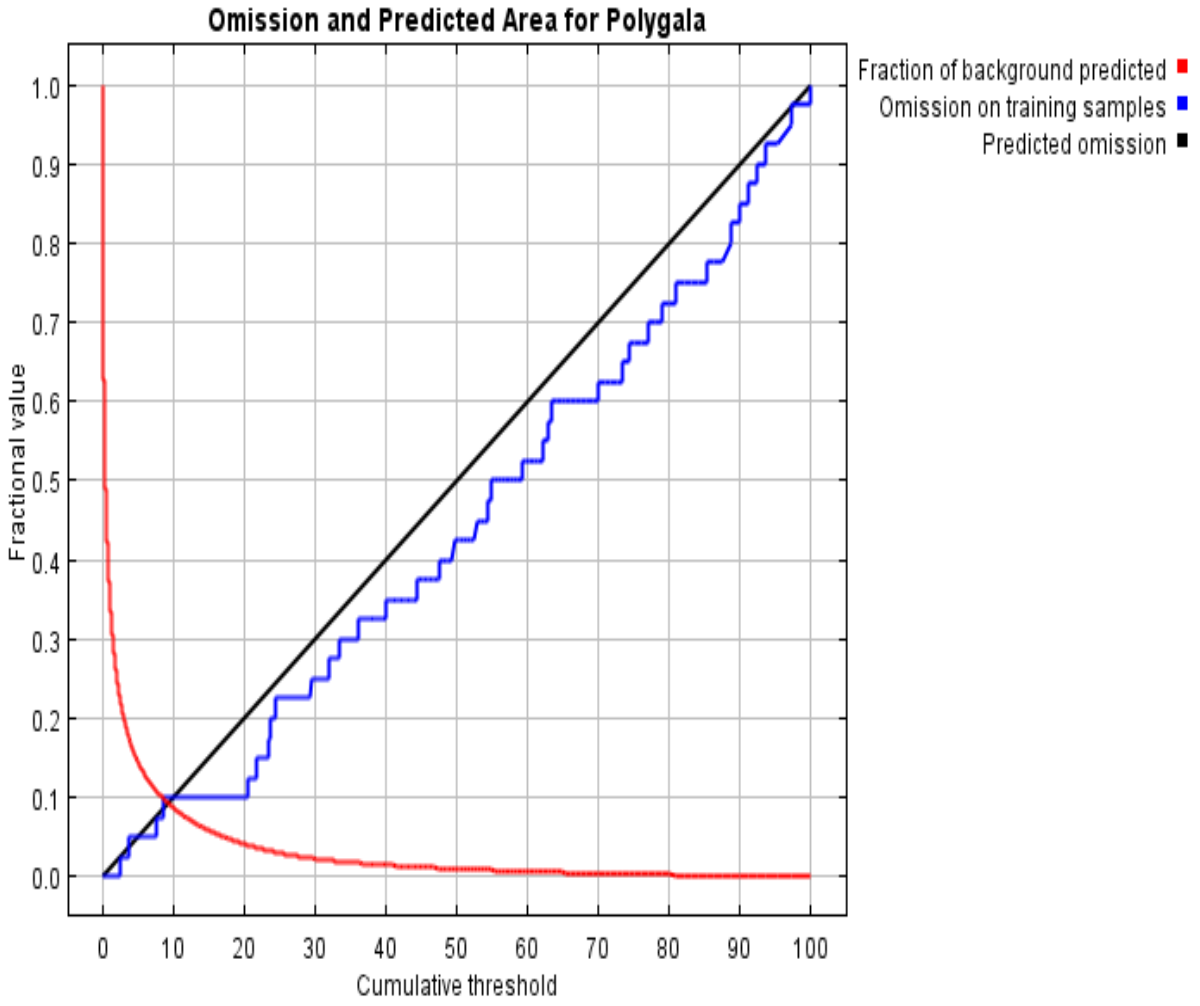
Silene schimperiana qualifies as Endangered at national scale because it is near endemic to a tiny area, with an extent of occurrence (EOO) is c. 494.5 km^2, and its area of occupancy (AOO) is 132 km^2, of the high mountain area of the St. Catherine Protected Area in southern Sinai, Egypt. There are two locations and the population is severely fragmented. There is a continuing decline in habitat quality for this species, with evidence of declines in subpopulation numbers and numbers of mature individuals. Climate change is projected to further reduce the available habitat of this high-elevation specialist.

Ecological Nice Modeling

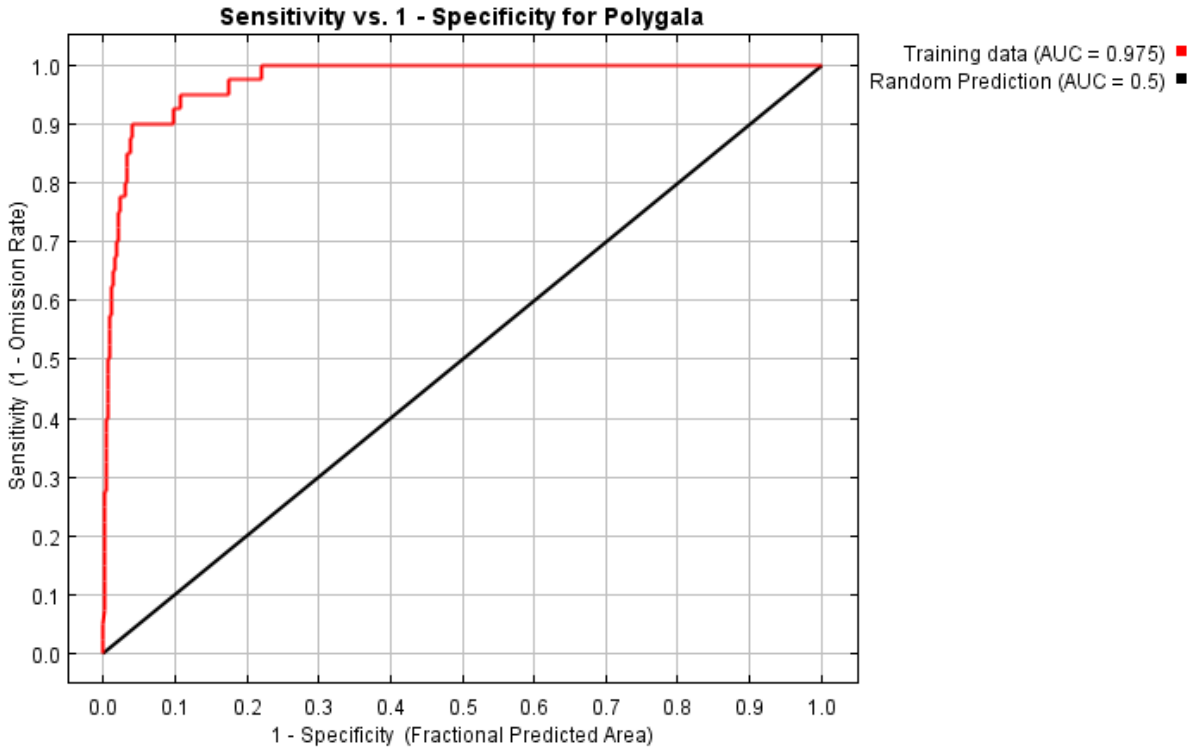
Polygala sinaica

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 0.962 rather than 1; in practice the test AUC may exceed this bound.

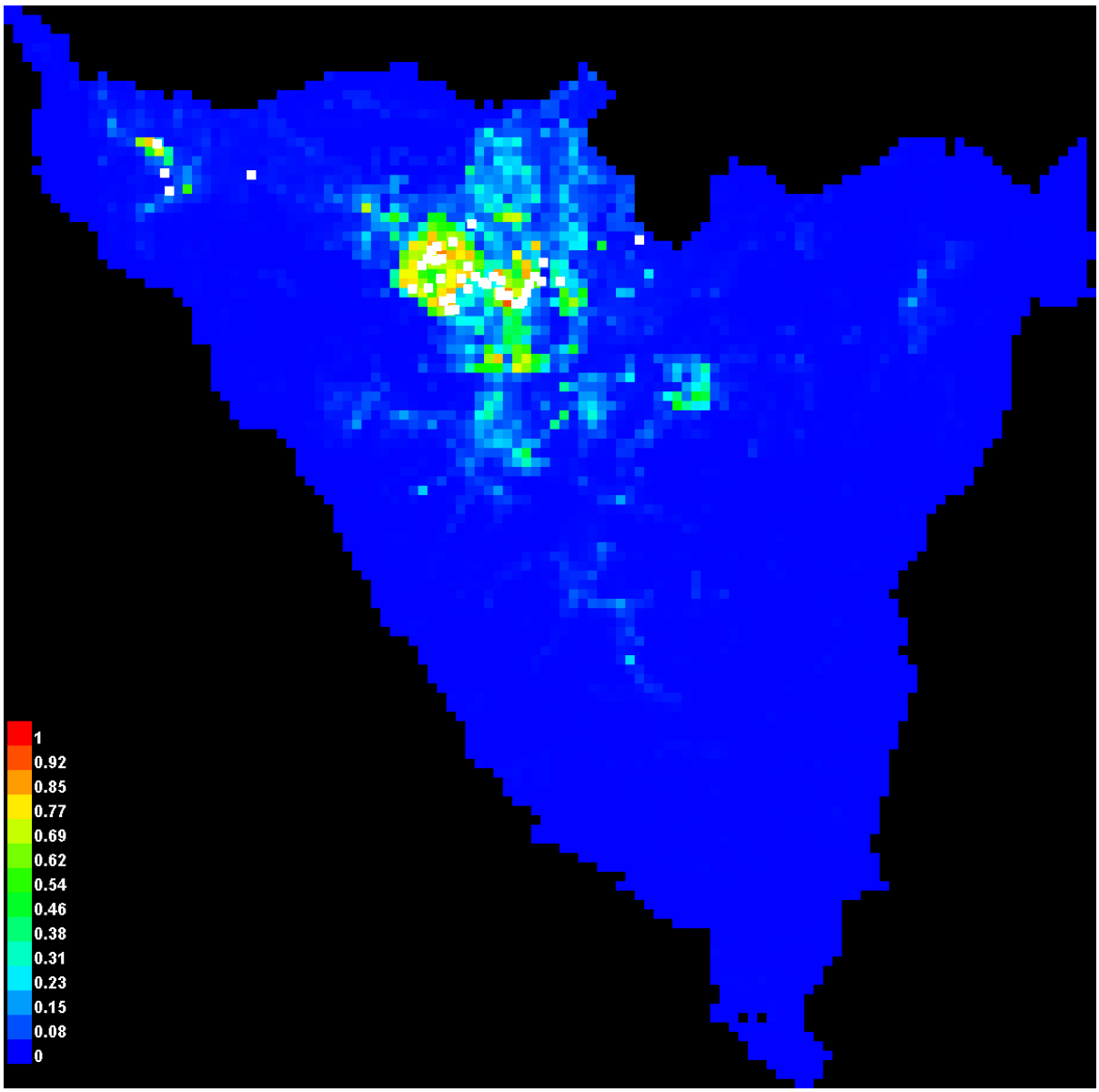


Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that 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	0.004	Fixed cumulative value 1	0.348	0.000
5.000	0.034	Fixed cumulative value 5	0.144	0.050
10.000	0.080	Fixed cumulative value 10	0.087	0.100
2.519	0.013	Minimum training presence	0.220	0.000
20.601	0.201	10 percentile training presence	0.040	0.100
8.536	0.069	Equal training sensitivity and specificity	0.099	0.100
20.601	0.201	Maximum training sensitivity plus specificity	0.040	0.100
2.519	0.013	Balance training omission, predicted area and threshold value	0.220	0.000
13.337	0.118	Equate entropy of thresholded and original distributions	0.066	0.100

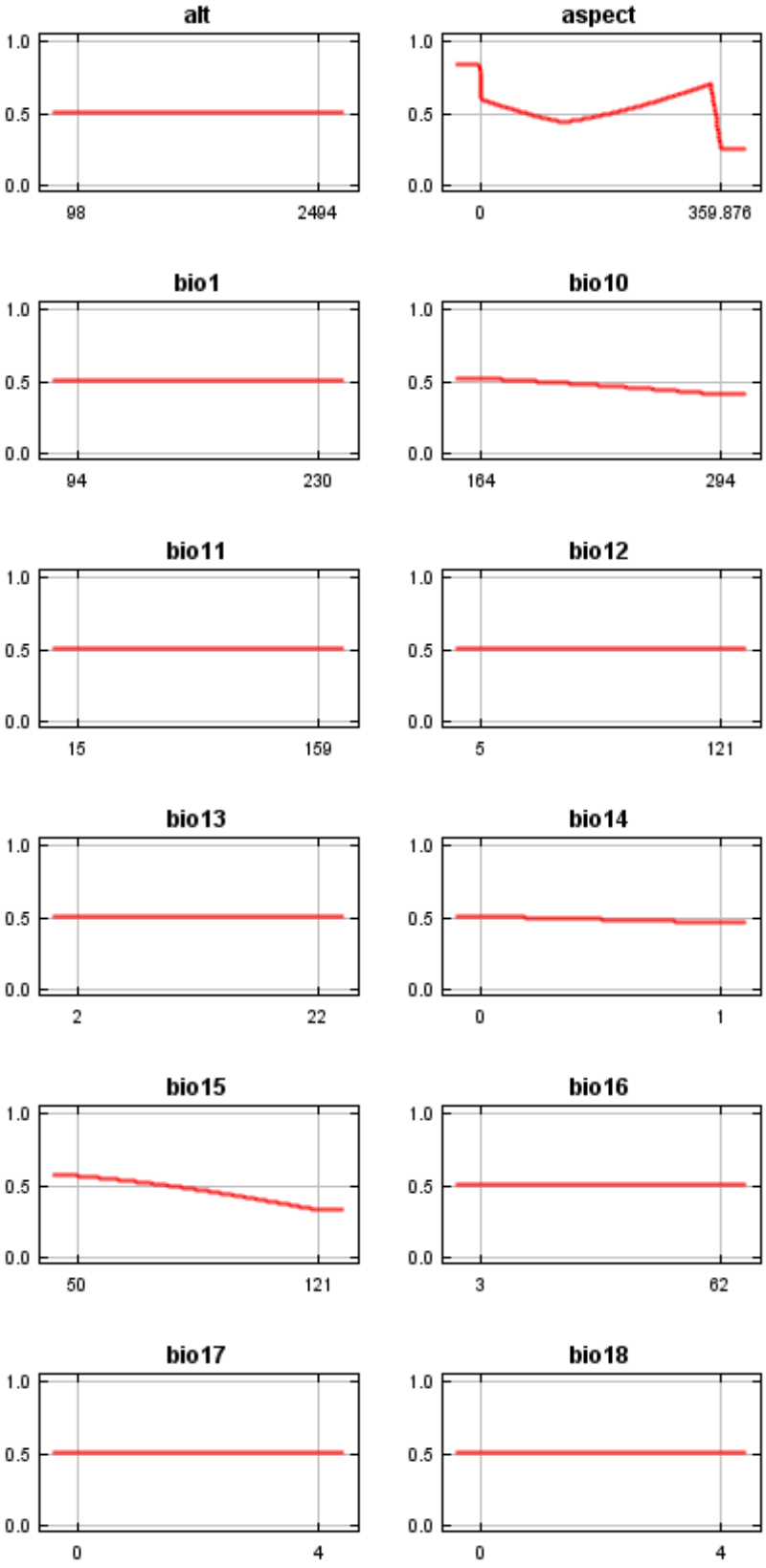
Pictures of the model

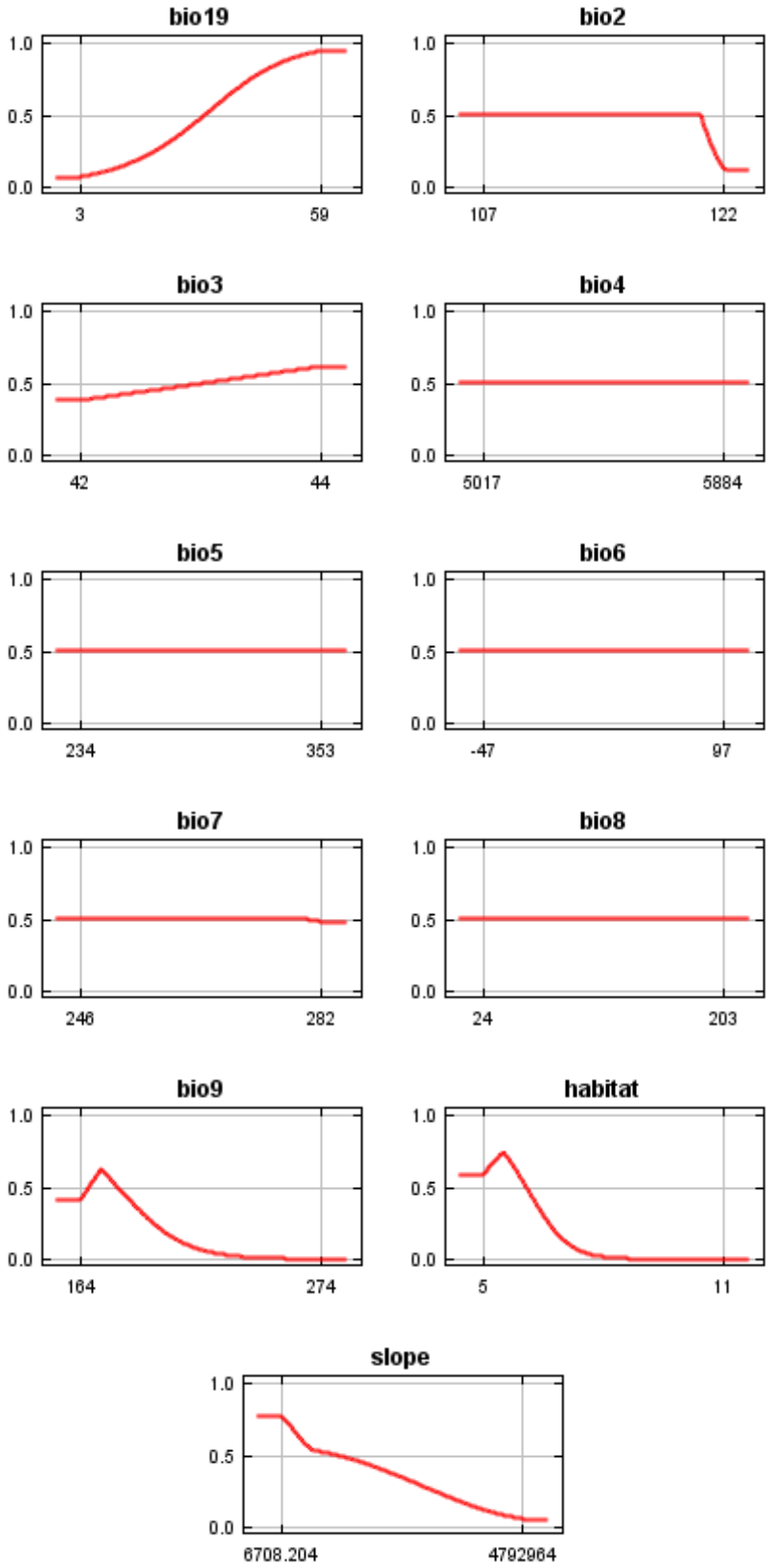
This is a representation of the Maxent model for Polygala. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size version.



Response curves

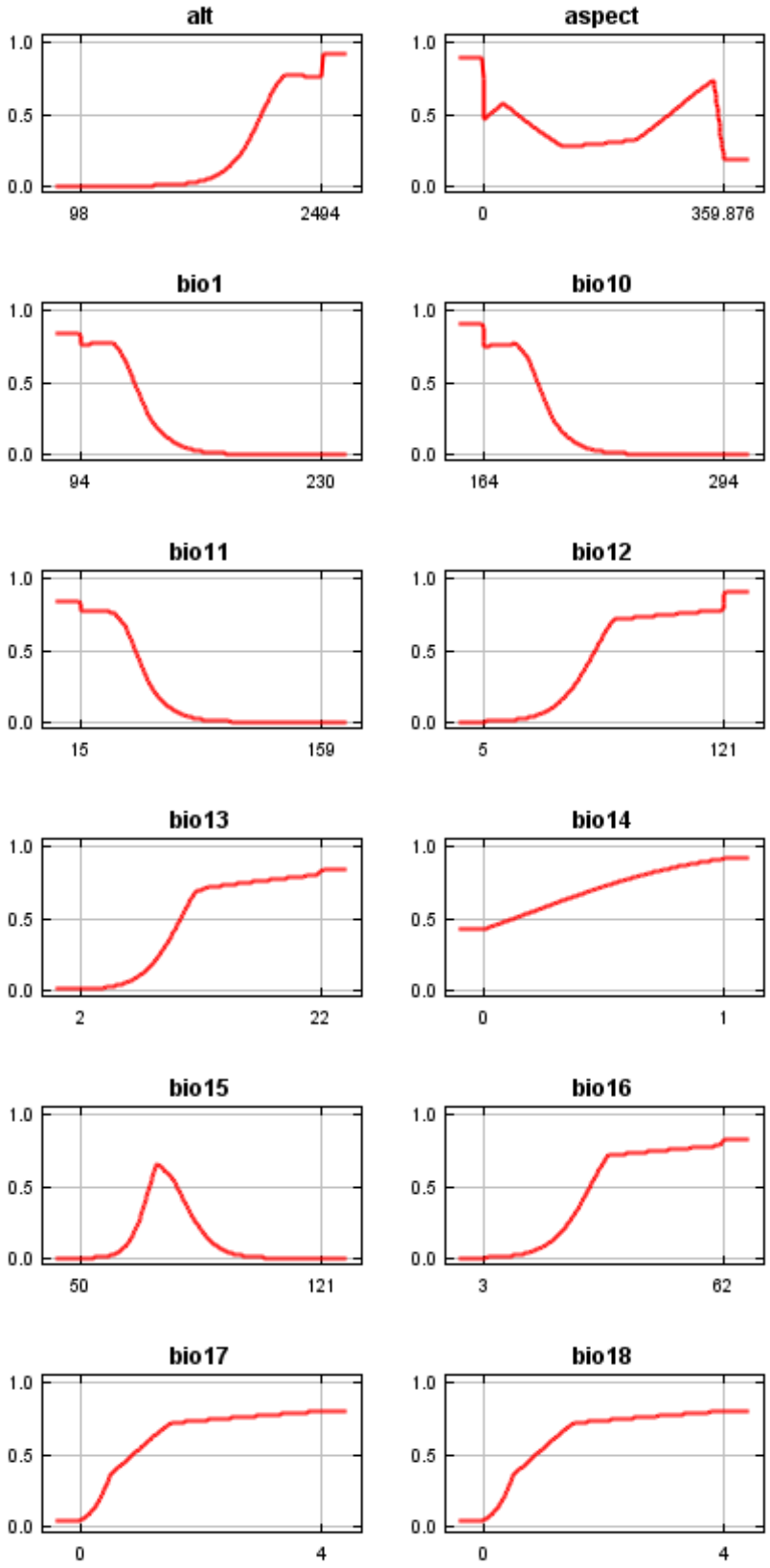
These curves show how each environmental variable affects the Maxent prediction. The curves show how the logistic prediction changes as each environmental variable is varied, keeping all other environmental variables at their average sample value. Click on a response curve to see a larger version. Note 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.

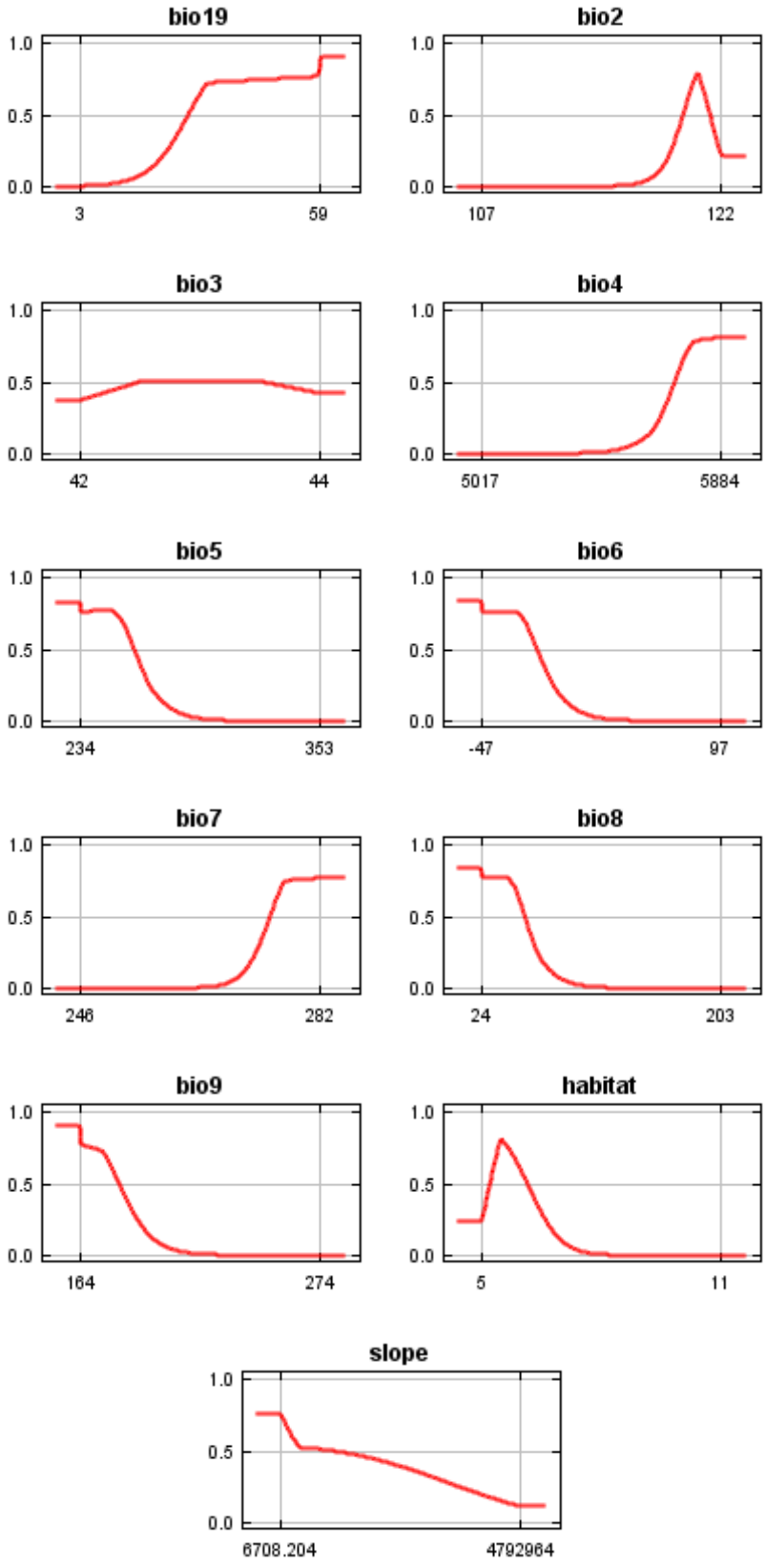

alt
1.0
0.5
0.0
98
2494
aspect
1.0
0.5
0.0
0
359.876
bio1
1.0
0.5
0.0
94
230
bio10
1.0
0.5
0.0
164
294
bio11
1.0
0.5
0.0
15
159
bio12
1.0
0.5
0.0
5
121
bio13
1.0
0.5
0.0
2
22
bio14
1.0
0.5
0.0
0
1
bio15
1.0
0.5
0.0
50
121
bio16
1.0
0.5
0.0
3
62
bio17
1.0
0.5
0.0
0
4
bio18
1.0
0.5
0.0
0
4



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.



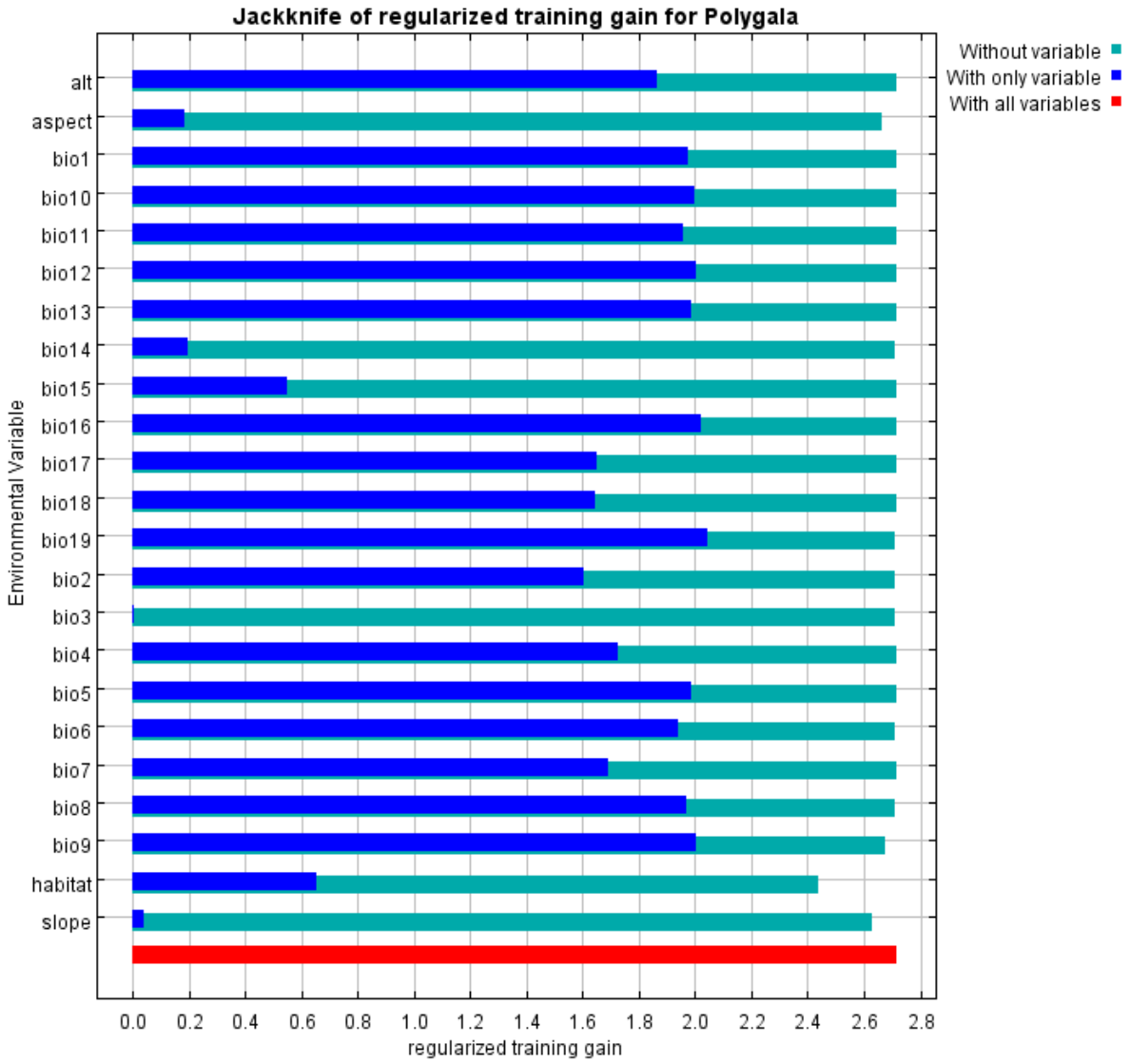

bio19
1.0
0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
1.0
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203
bio9
1.0
0.5
0.0
164
274
habitat
1.0
0.5
0.0
5
11
slope
1.0
0.5
0.0
6708.204
4792964

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	49.5
habitat	15.8
bio19	6.5
bio13	5.4
bio10	4.1
bio8	3.4
aspect	3.2
bio5	3.1
slope	3
bio12	2.2
bio2	1.5
bio18	1.3
bio9	0.9
bio3	0.1
bio15	0
bio14	0
bio7	0
bio16	0
bio4	0
bio6	0
bio11	0
bio1	0
alt	0

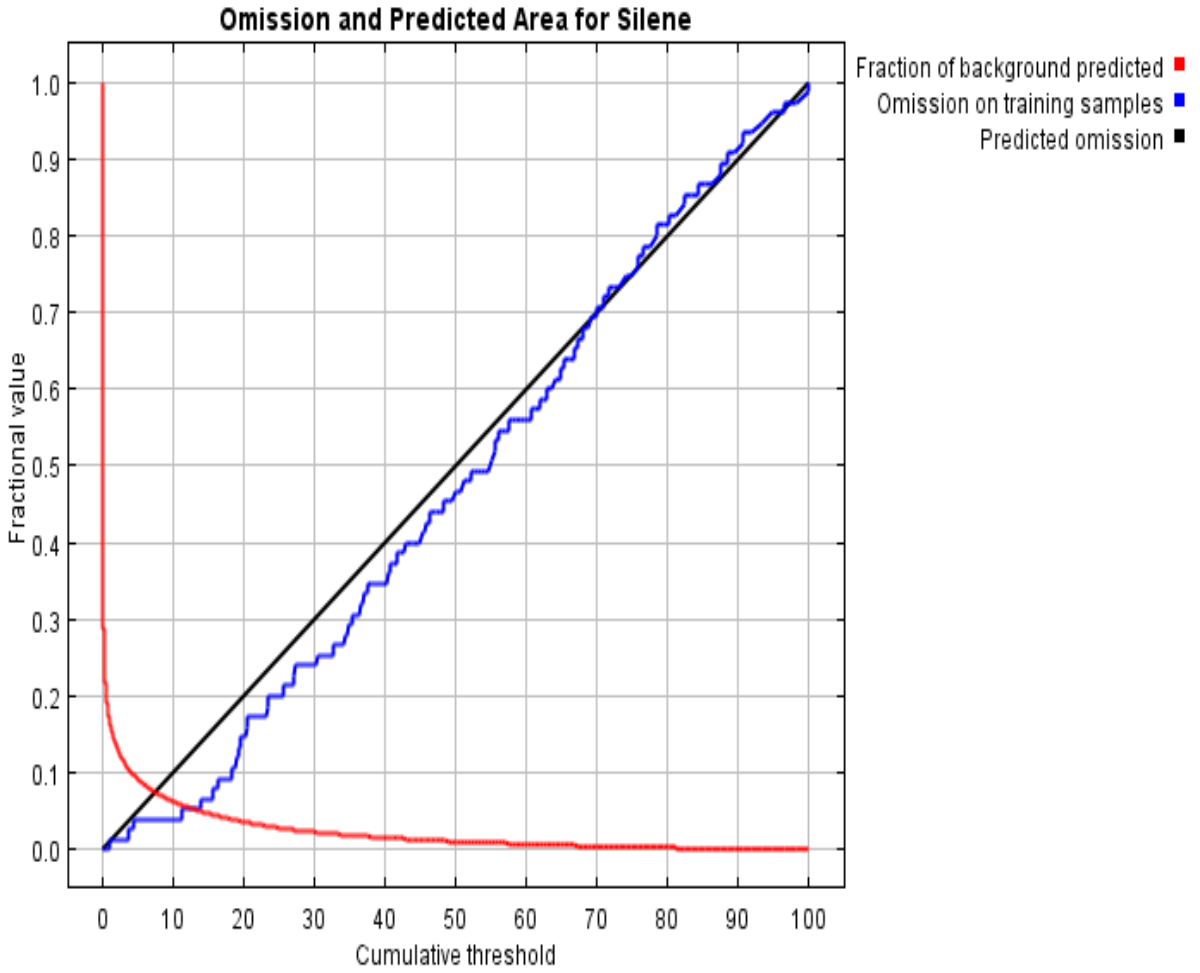
The following picture shows the results of the jackknife test of variable importance. The environmental variable with highest gain when used in isolation is bio19, which therefore appears to have the most useful information by itself. The environmental variable that decreases the gain the most when it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


Jackknife of regularized training gain for Polygala
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
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
regularized training gain

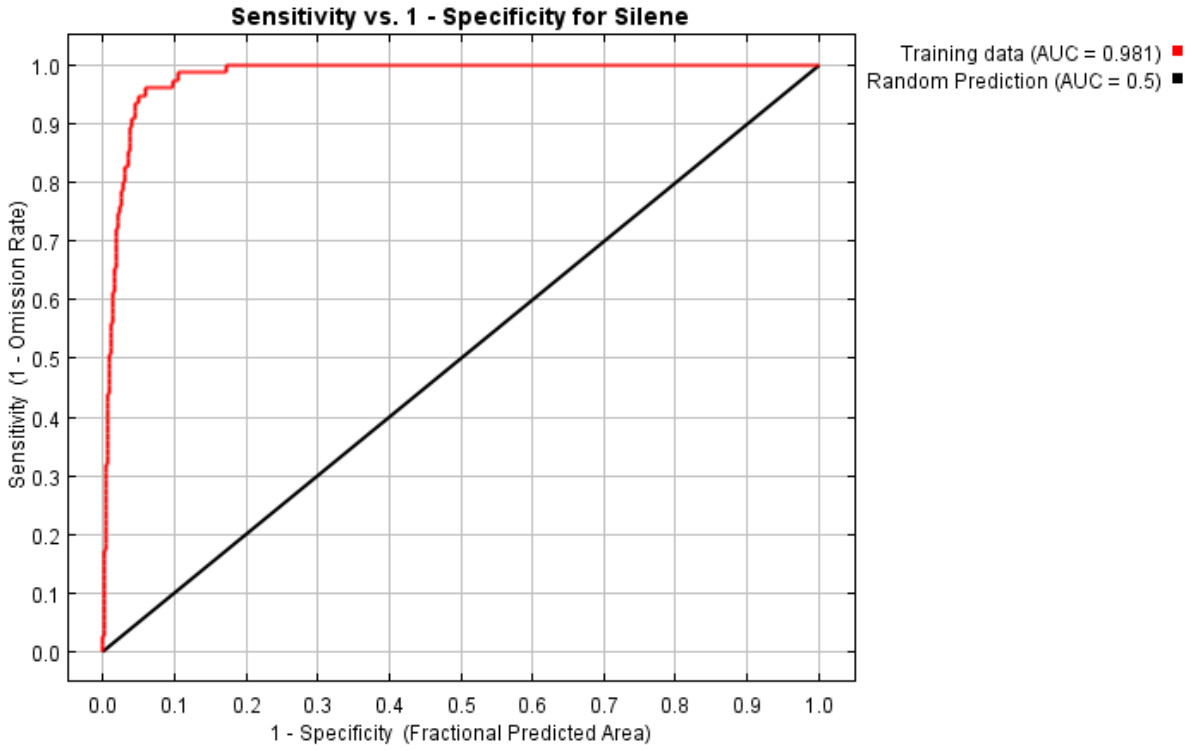
Silene schimperiana

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 0.974 rather than 1; in practice the test AUC may exceed this bound.

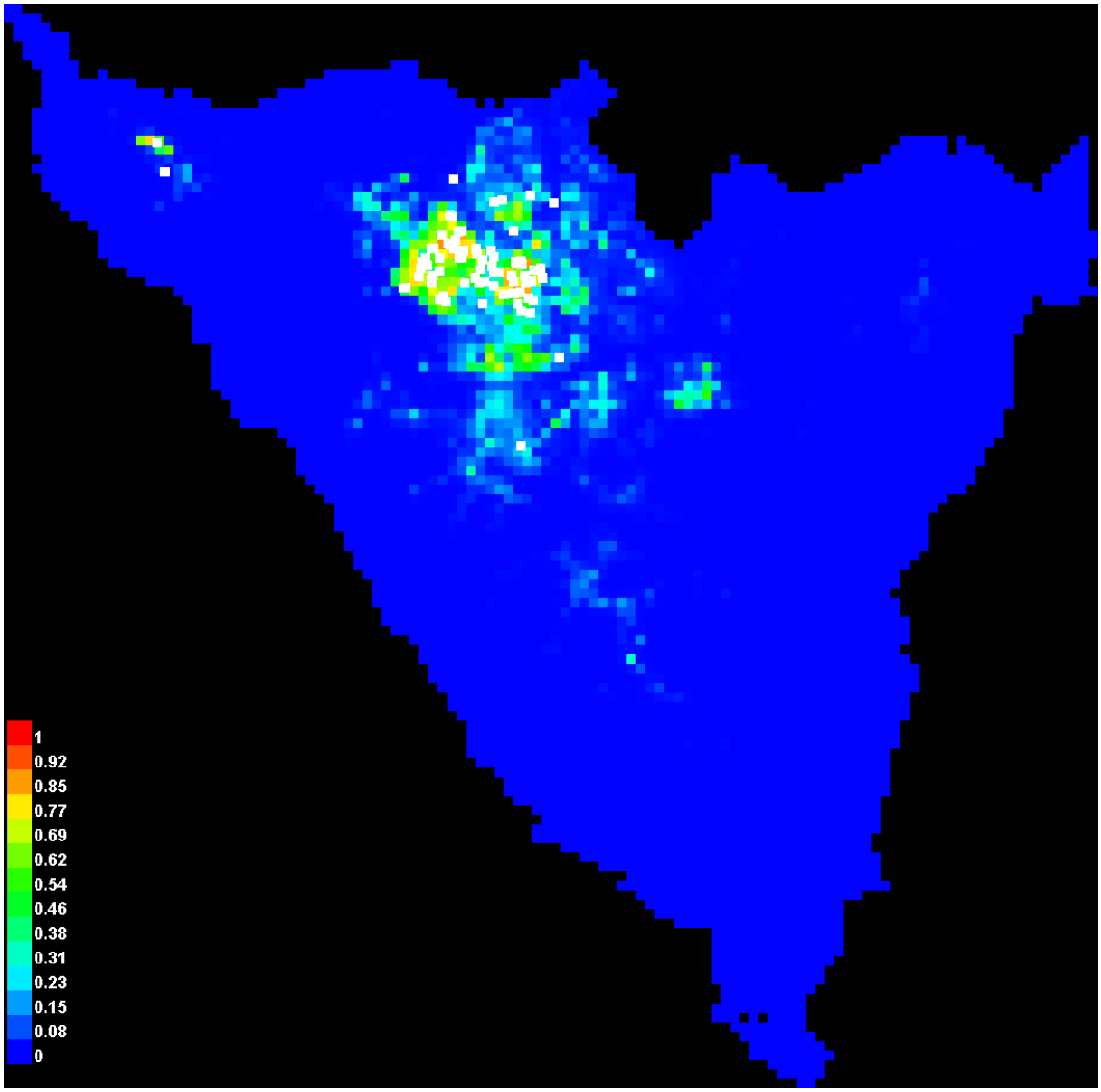


Some common thresholds and corresponding omission rates are as follows. If test data are available, binomial probabilities are calculated exactly if the number of test samples is at most 25, otherwise using a normal approximation to the binomial. These are 1-sided p-values for the null hypothesis that 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	0.011	Fixed cumulative value 1	0.167	0.013
5.000	0.064	Fixed cumulative value 5	0.092	0.040
10.000	0.126	Fixed cumulative value 10	0.063	0.040
0.901	0.010	Minimum training presence	0.172	0.000
18.290	0.221	10 percentile training presence	0.040	0.093
12.850	0.166	Equal training sensitivity and specificity	0.053	0.053
11.205	0.147	Maximum training sensitivity plus specificity	0.058	0.040
0.901	0.010	Balance training omission, predicted area and threshold value	0.172	0.000
11.205	0.147	Equate entropy of thresholded and original distributions	0.058	0.040

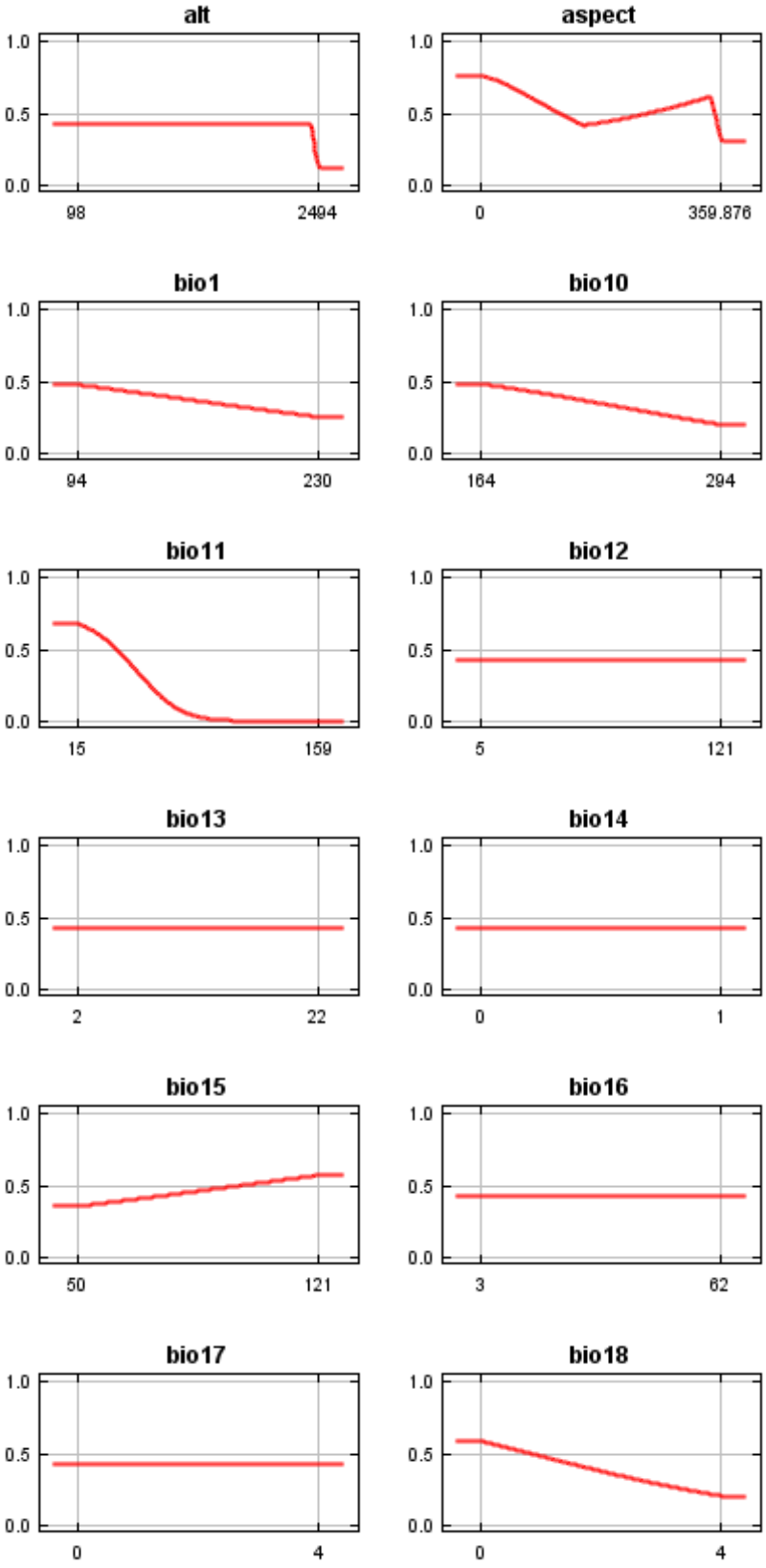
Pictures of the model

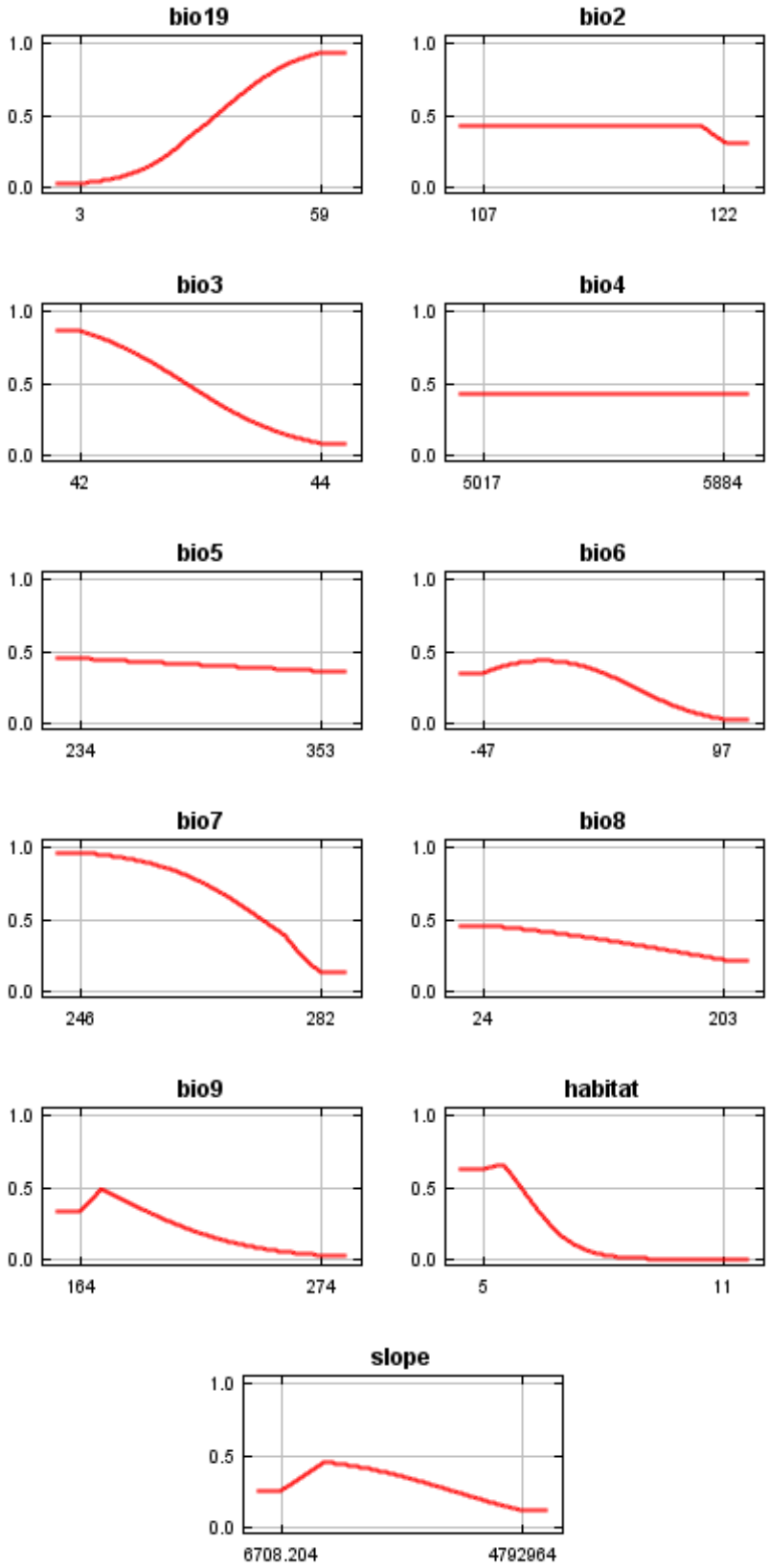
This is a representation of the Maxent model for Silene. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations. Click on the image for a full-size version.



Response curves

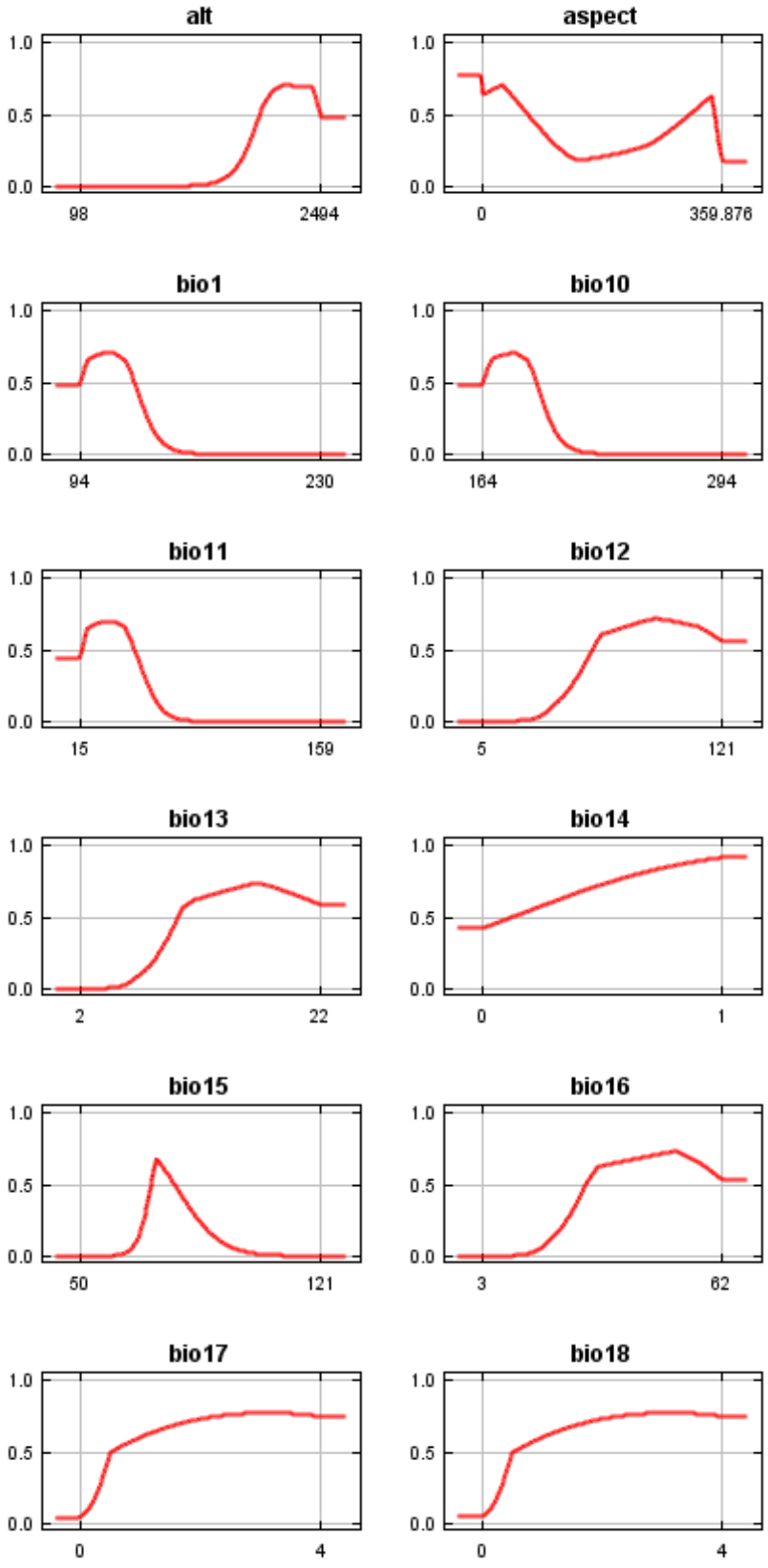
These curves show how each environmental variable affects the Maxent prediction. The curves show how the logistic prediction changes as each environmental variable is varied, keeping all other environmental variables at their average sample value. Click on a response curve to see a larger version. Note 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.

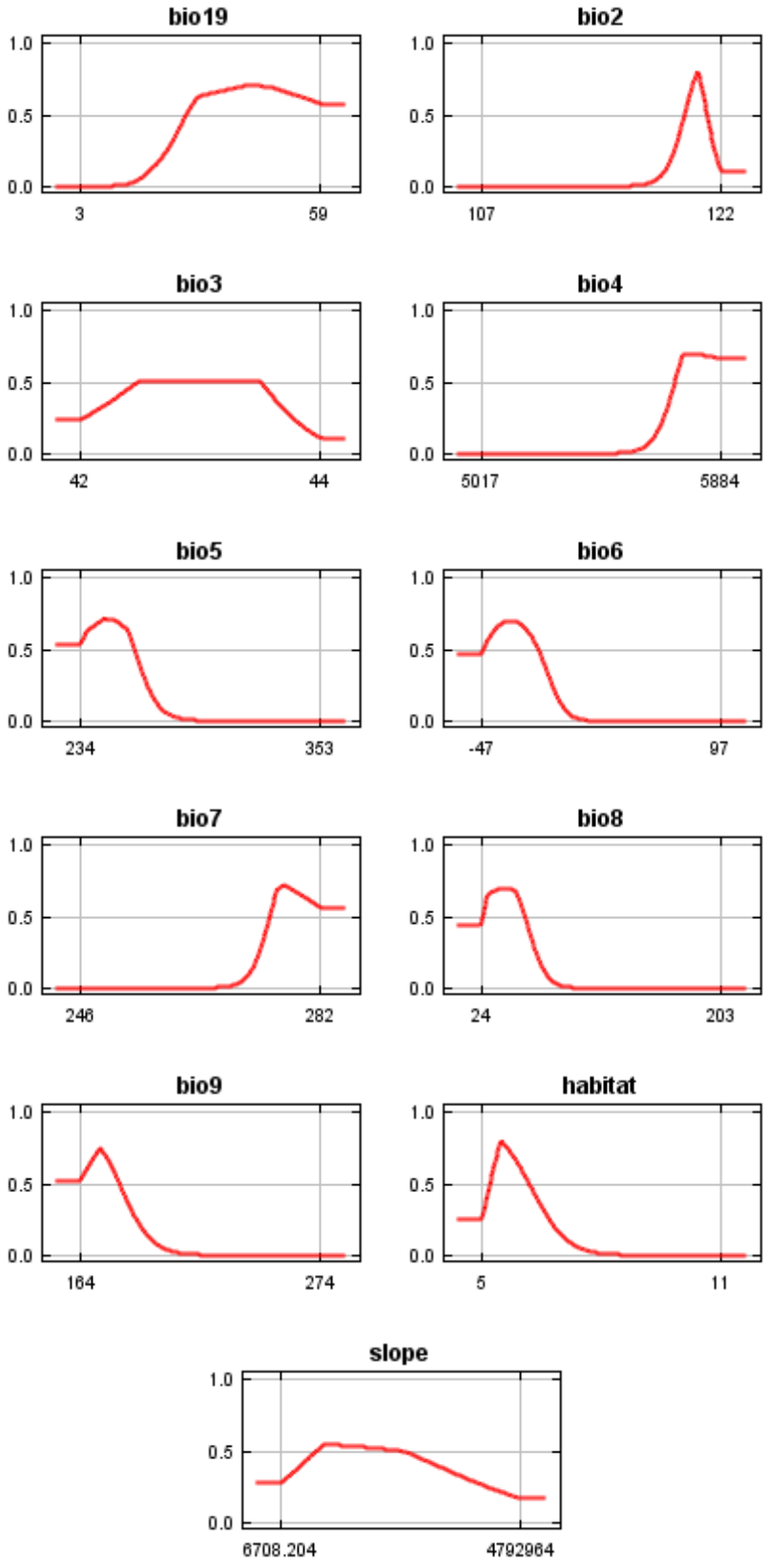

alt
1.0
0.5
0.0
98
2494
aspect
1.0
0.5
0.0
0
359.876
bio1
1.0
0.5
0.0
94
230
bio10
1.0
0.5
0.0
164
294
bio11
1.0
0.5
0.0
15
159
bio12
1.0
0.5
0.0
5
121
bio13
1.0
0.5
0.0
2
22
bio14
1.0
0.5
0.0
0
1
bio15
1.0
0.5
0.0
50
121
bio16
1.0
0.5
0.0
3
62
bio17
1.0
0.5
0.0
0
4
bio18
1.0
0.5
0.0
0
4



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.



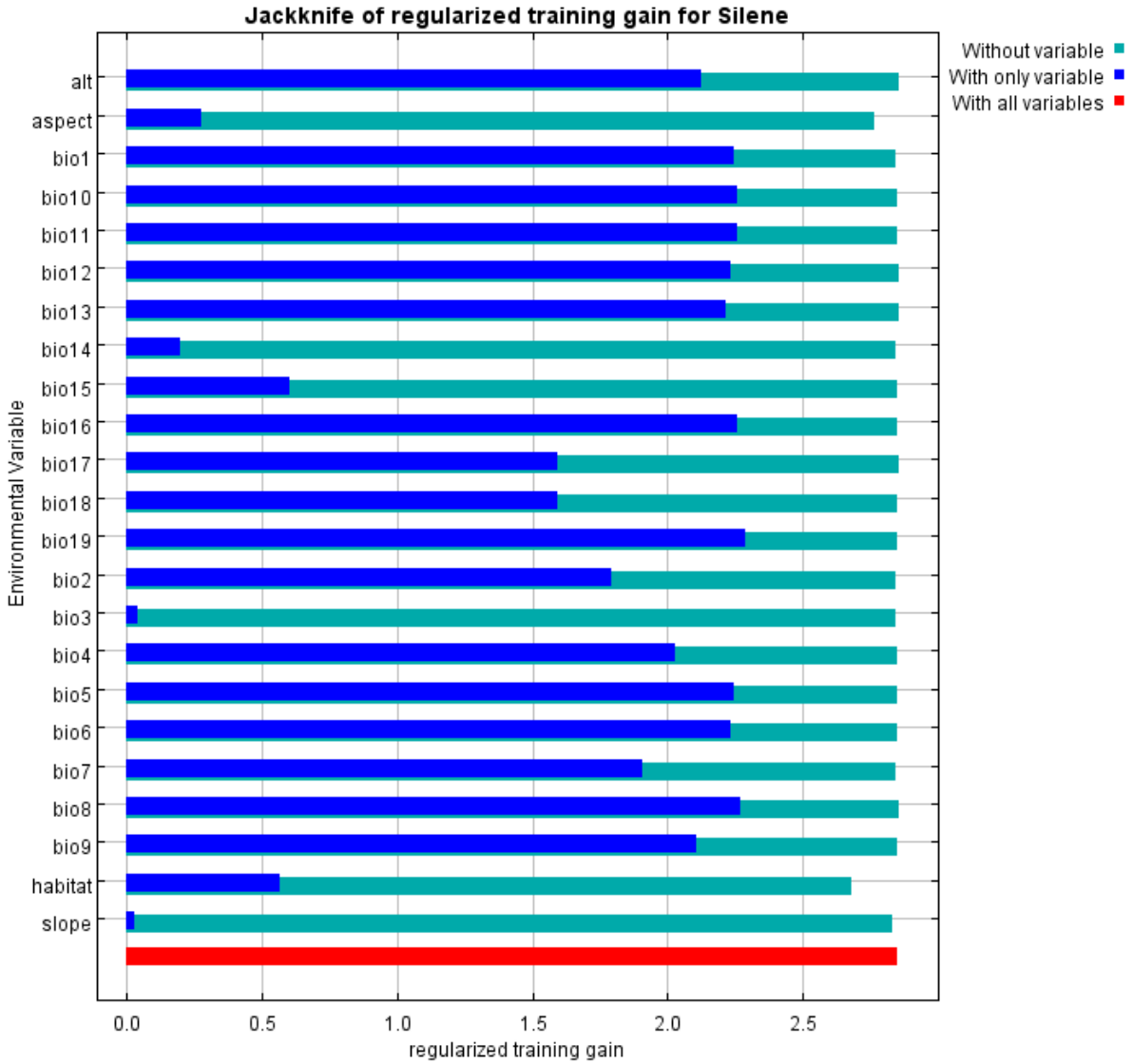

bio19
1.0
0.5
0.0
3
59
bio2
1.0
0.5
0.0
107
122
bio3
1.0
0.5
0.0
42
44
bio4
1.0
0.5
0.0
5017
5884
bio5
1.0
0.5
0.0
234
353
bio6
1.0
0.5
0.0
-47
97
bio7
1.0
0.5
0.0
246
282
bio8
1.0
0.5
0.0
24
203
bio9
1.0
0.5
0.0
164
274
habitat
1.0
0.5
0.0
5
11
slope
1.0
0.5
0.0
6708.204
4792964

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	35.3
bio13	19.6
bio19	15.6
habitat	11.8
aspect	5.3
bio10	4.8
bio1	3.7
bio8	1.1
bio2	0.8
bio6	0.7
slope	0.2
bio3	0.2
bio11	0.2
bio7	0.2
bio18	0.1
bio9	0.1
alt	0.1
bio15	0
bio5	0
bio14	0
bio12	0
bio16	0
bio4	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.


Jackknife of regularized training gain for Silene
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

Seed Collection:

- A total of 6 accessions were collected from 2 species located in 6 sites. Table 17 present these Accessions and their geographical distribution.
- A total of 3 accessions were collected from *Polygala sinaica* Botsch., and *Silene schimperiana* Boiss.
- Number of seeds and total seed weight for each accession presented in Table 18.

Table 17: Target species accessions, location and geographic distribution

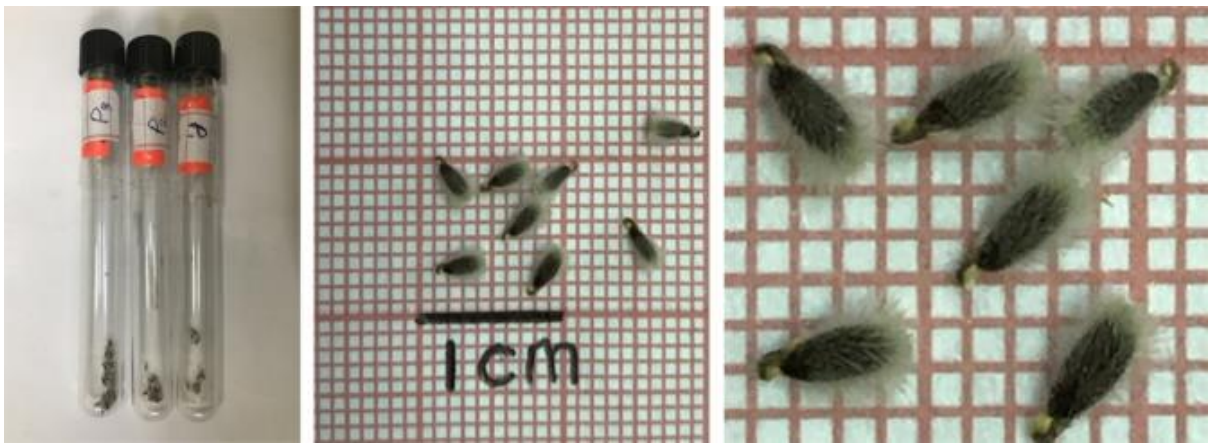
Code	Species	location Name	N	E	Alt
P1	*Polygala sinaica* Botsch	Elfaraa	28.53916667	33.96558	1860
P2	*Polygala sinaica* Botsch	Elzawitein	28.53856	33.92808	1837
P3	*Polygala sinaica* Botsch	Abu Hamman	28.545075	33.9509	1800
S1	*Silene schimperiana* Boiss	Shak Musa	28.52533	33.96324	1980
S2	*Silene schimperiana* Boiss	Abu Walee	28.53262	33.90731	1893
S3	*Silene schimperiana* Boiss	Wadi Elarbein	28.53487	33.96586	1760

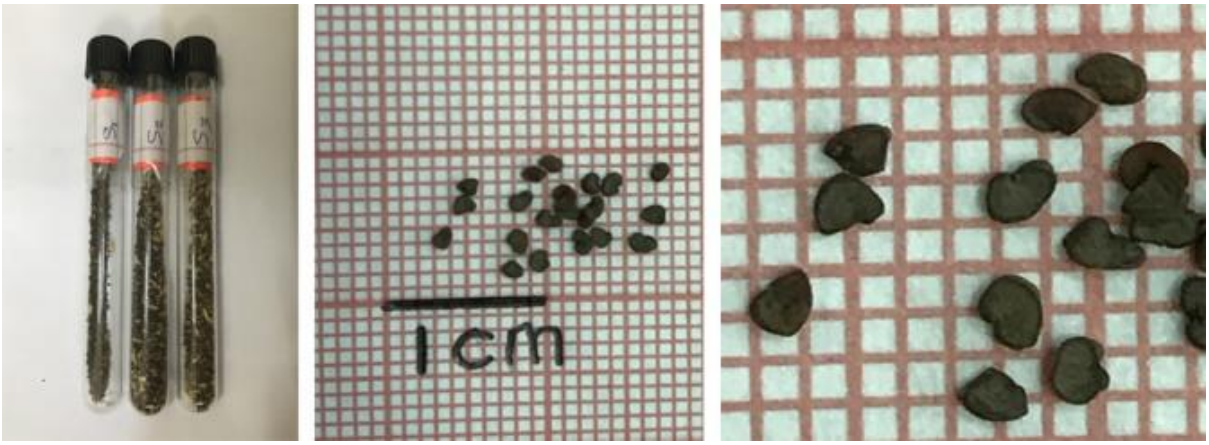
Table 18: Target species accessions with details about Number of seeds and Total Seed Weight for each replicate of each accession

Sp.	Accession 1				Accession 2				Accession 3			
	Replicate 1		Replicate 2		Replicate 1		Replicate 2		Replicate 1		Replicate 2	
	No. of seeds	Total Seed Weight	No. of seeds	Total Seed Weight	No. of seeds	Total Seed Weight	No. of seeds	Total Seed Weight	No. of seeds	Total Seed Weight	No. of seeds	Total Seed Weight
P. s	9	0.016	5	0.0087	13	0.031	8	0.139	35	0.06	7	0.0123
S. s	1394	1.22	1250	1.08	6950	4.17	4359	2.615	3142	2.2	2861	2

Note: *P. s= Polygala sinaica,* and *S. s= Silene schimperiana*

Here are some photos for the target species seed samples, with scale and zoom. Species from up to down as follow: *Polygala sinaica* Botsch., and *Silene schimperiana* Boiss,





Note: P= Polygala sinaica Botsch.., S= Silene schimperiana Boiss

Environmental factors including edaphic and climatic features were then extracted for each accession and presented in Tables 19 and 20.

Table 19: 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
P1	1.65	8.4	130	69	3.62	12.5	2	0.3	16.79	16.79	10.5	3.5	23
P2	0.41	8	160.58	334	3.45	35.5	27.5	7.5	22.72	11.7	7.5	8	82.5
P3	0.53	8.4	272	59	0.57	17.5	2	1	43.9	49.52	11	5	38
S1	0.45	8.1	312	144	4.41	16.5	4	4.5	35.05	35.05	11	5.25	28.5
S2	1.45	8.6	70.19	146	10	19.5	15	2.5	20.84	39.2	6.5	8	65
S3	0.75	8.4	214	90	2.6	16	2	2	31	32.04	7.5	5.25	29

Table 20: 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

SEED STORAGE:

- 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.

Capacity building and Awareness:

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.

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 PAs faces 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:

- Identify stakeholders and categorize them according to their influence
- Establish realistic expectations for the community input
- Identify community goals and aspects for the future of the community
- Educate residents on the process of project development
- Identify specific aspects of the project that can accommodate some of the community goals
- 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 2 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
  - 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
  - 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), IUCN Med, 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 (main participants were attached in the annexes 1 and 2).
- 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.
- 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.

TRAINING NEEDS:

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 are:

- 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 21. 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 o Developing micro-credit funds and PA-based micro-credit programs for local communities
5	Ecological monitoring and research	o Innovative methods of data accumulation and processing (GIS etc.) o Ecological monitoring and data interpretation o Complex research at a PA and interaction with scientific organizations o 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.

RECOMMENDATIONS:

Based on the information extracted from this study about the conservation status of some 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.
- *Polygala sinaica* has 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.
- 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; this include population and habitat trend, threats direct and indirect effect, threat management, species genetics, increasing productivity of medicinal plants, etc.

Table 22: 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.

- Quarterly monitoring must be done on areas of prohibited use to stand about the current situation and trends and it's possible to transform some sites to the lower level for use if the situation becomes better.
- 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.
- It's very urgent to carry such study to cover the endemic species in Egypt to cover the gap in conservation efforts.

REFERENCES:

- Abd El-Wahab, R.H., Zaghloul, M.S., and Moustafa, A.A. (2006): Vegetation and Environment of Gebel Serbal, South Sinai, Egypt. *CATRINA*, 1 (2): 9-20. Accessed via http://www.gbif.org/species/112297104 on 2015-10-04
- Abdel-Shafiq K. A. Chemical Studies on Certain Plants of Family Labiate. M.Sc. Thesis, Chemistry Dep. Faculty of Science, Cairo University. 1997; Pp.174.)
- Ainsworth, E.A., and Long, S.P. (2004): "What have we learned from 15 years of free-air CO2 enrichment (FACE)? A meta-analytic review of the responses of photosynthesis, canopy properties and plant production to rising CO2". *New Phytologist* 165 (2): 351–372.
- 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.
- Batanouny, K.H. (1983): Human impact on desert vegetation. In: Man's Impact on Vegetation, W. Holzner, M.J.A. Werger, and I. Ikusima, (eds.), Dr. W. Junk Publishers, London, 380 pp.
- 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.
- Brandon, K. (1997): Policy and practical considerations in land-use strategies for biodiversity conservation. In: Kramer, R., van Schaik, C., Johnson, J. (Eds.), Last Stand. Protected Areas and the Defense of Tropical Biodiversity. Oxford University Press, New York, 90–114.
- Bretting, P.K. and Duvick, D.N. (1997): Dynamic conservation of plant genetic resources. Advances in Agronomy 61:1-51.
- Bridgewater, P.B. (1993): Landscape ecology, geographic information systems and nature conservation. In: Haines-Young, R., Green, D.R., Cousins, S.H. (Eds.), *Landscape Ecology and GIS*. Taylor and Francis, London, pp. 23-36.
- Bridgewater, P.B. (1993): Landscape ecology, geographic information systems and nature conservation. In: Haines-Young, R., Green, D.R., Cousins, S.H. (Eds.), *Landscape Ecology and GIS*. Taylor and Francis, London, pp. 23-36.
- 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.
- Câmara, G., Monteiro, A.M., Fucks, S.D. and Carvalho, M.S. (2001): Spatial Analysis and GIS: A Primer. São José dos Campos, INPE, 30 pp.
- Caraci F, Crupi R, Drago F, Spina E. (2011): Metabolic drug interactions between antidepressants and anticancer drugs: focus on selective serotonin reuptake inhibitors and hypericum extract." Curr Drug Metab. 1,12 (6):7-570.

- Caswell, H. (1989): Matrix population models. Sinauer, Sunderland, USA.
- Caswell, H. (2001): *Matrix population Models: Construction, Analysis and Interpretation*. Sinauer, Sunderland, M. A. second edition.
- Collar, N.J. and Andrew, (1988): Birds to Watch – The ICBP World Check-list of Threatened Birds, International Council for Bird Preservation.
- Collar, N.J., (1996): The reasons for Red Data Books. *Oryx* 30, 121–130.
- Commonwealth of Australia, (2009): Australia's Terrestrial Biodiversity 2008. *Chapter 5 Threats to Australian biodiversity. Australian government, Department of Environment, Water, Heritage and the Art. 149-212.*
- Dale, M.R.T. (1999): *Spatial pattern analysis in plant ecology*. Cambridge: Cambridge University Press, Cambridge
- 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.
- De la Cruz-Rot, M. (2001): Manejoy conservacio´n de comunidades vegetales. II Seminario de Biologı´a de la Conservacio´ n de Plantas Amenazadas. Universidad Polite´cnica, Madrid.
- Doney, S.C., Fabry, V.J., Feely, R.A., KleyPA, J.A. (2009): "Ocean Acidification: The Other CO Problem". *Annual Review of Marine Science* 1 (1): 169–192.Bibcode:2009ARMS....1..169D.doi:10.1146/annurev.marine.010908.163834.
- 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.
- El-Husseini, N., Abd El-Ghani, M.M. & El-Naggar, S.I. (2008): Biogeography and diversity of the tubiflorae in Egypt. Polish Botanical Journal 53(2): 105–124
- 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.
- Engler, R., Guisan, A., Rechsteiner, L., 2004. An improved approach for predicting the distribution of rare and endangered species from occurrence and pseudo-absence data. J. Appl. Ecol. 41: 263-274.
- Ezcurra, E., Equihua, M. and Lopez-Portillo, J. (1987): The desert vegetation of El Pinacate Sonora Mexico. *Vegetatio* 71: 49–60.
- 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.
- Ferrier, S., Watson, G., Pearce, J., Drielsma, M., 2002 Extended statistical approaches to modeling spatial pattern in biodiversity: the north-east New South Wales experience. I. Species-level modeling. Biodiv. Conserv. 11: 2275–2307.
- 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.

- Freese, C.H. (1997): The “use it or lose it” debate. In: Freese, C.H. (ed.), Harvesting Wild Species: Implications for biodiversity conservation. Johns Hopkins University Press, Baltimore, MD, USA. pp. 1–48.
- Gaston, K.J., 1996. Species richness: measure and measurement. Biodiversity: a biology of numbers and difference ed. K.J. Gaston, Blackwell Science, Oxford pp. 77–113.
- Goward, S.N., and Prince, S.D. (1995): Transient effects of climate on vegetation dynamics: Satellite observations. *Journal of Biogeography*, 22: 549– 563.
- Graham, C.H., Hijmans, R.J., 2006. A comparison of methods for mapping species ranges and species richness. Glob. Ecol. Biogeogr. 15: 578– 587.
- 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.
- Harper, J.L. and White, J. (1974): Demography of Plants. *Ann. Rev. Ecol. Syst.*, 5: 419-463.
- 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.
- Hegland, S.J., Nielsen, A., Lázaro, A., Bjerknes, A., Totland (2009): "How does climate warming affect plant-pollinator interactions?". *Ecology Letters* 12 (2): 184–195.
- 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.
- Heywood VH, Dulloo ME. (2005): *In situ* conservation of wild plant species: a critical global review of best practices. IPGRI Technical Bulletin 11. IPGRI, Rome, Italy.
- Heywood VH, Iriondo JM (2003): Plant conservation: old problems, new perspectives. Biological Conservation 113: 321–335.
- Heywood, V.H. (1999a): Use and Potential of Wild Plants in Farm Households. FAO Farm Systems Management Series 15. FAO, Rome, Italy.
- 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.
- Hutchings, M.J. (1997): The structure of plant populations. In: *Plant Ecology,* (Ed.): M.J. Crawley. pp 325-358. 2nd edn. *Blackwell Science*: Oxford.
- Hutton, J.M. and Leader-Williams, N. (2003): Sustainable use and incentive-driven conservation: realigning human and conservation interests. Oryx 37(2):215– 226.
- IUCN (2012): "IUCN Red List version 2012.2: Table 2: Changes in numbers of species in the threatened categories (CR, EN, VU) from 1996 to 2012 (IUCN Red List version 2012.2) for the major taxonomic groups on the Red List" (PDF). Retrieved 2012-12-31.
- IUCN, (1994): IUCN Redlist Categories. Prepared by the Special Survival Commission. IUCN, Gland, Switzerland.
- IUCN, (2010): Biodiversity in crisis, ”Why is biodiversity in crisis?” available online on: http://www.iucn.org/what/biodiversity/about/biodiversity_crisis/
- IUCN. (2001): IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, U.K.

- IUCN. (2003): A Guide to Securing Protected Areas in the Face of Global Change: Options and guidelines. Draft Report by the Ecosystems, Protected Areas, and People Project. IUCN World Commission on Protected Areas, IUCN, Gland, Switzerland.
- IUCN. (2004): *2004 IUCN Red List of Threatened Species*, IUCN-SSC (http://www.iucnredlist.org)
- IUCN. (2012b): IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. Available at www.iucnredlist.org/technical-documents/categories-and-criteria
- 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.
- Jimenez-Valverde, A., Lobo, J.M., 2007. Threshold criteria for conversion of probability of species presence to either-or presence-absence. Acta Oecologica-Int. J. Ecol. 31: 361-369.
- 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.
- Kannan, R. and James, D. A. (2009): "Effects of climate change on global biodiversity: a review of key literature". *Tropical Ecology* 50 (1): 31–39.
- Khafagi, O. and Omar, K. (2012). Geographical Attributes Analysis for Egyptian *Hypericum sinaicum*. Universal Journal of Environmental Research and Technology 2, (6): 500-514.
- 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.
- Khafaja T, Hatab A and Dsouki A. (2006): Report on the current situation of the plant vegetation cover in the high mountain area of Saint Katherine. Plant Conservation and Monitoring Programme, St. Catherine Protected Area.
- Khairallah, S. (2010). "Plant story - helping to conserve *Origanum syriacum*". Kew News. Kew Royal Botanic Gardens. Retrieved 21 April 2013.
- Khedr, A. (2007): Assessment, classification, and analysis of microhabitats supporting globally significant Plant species: Abdel-Hamid A. Khedr, May-September 2007, 1-37.
- Kramer, R., van Schalk, C. and Johnson, J. (Eds.), (1997): Last Stand. Protected Areas and the Defense of Tropical Biodiversity. Oxford University Press, New York, 242 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.
- Leverkuhn, A. (2014): What Is an Endemic Species?. Conjecture Corporation. Available online on: http://www.wisegeek.org/what-is-an-endemic-species.htm.
- Loarie, S.R., Duffy, P.B., Hamilton, H., Asner, G.P., Field, C.B., Ackerly, David D. (2009): "The velocity of climate change". *Nature* 462 (7276): 1052–1055.
- Mace, G.M. and Lande, R. (1991): Assessing extinction threats toward a reevaluation of IUCN Threatened Species Categories. *Conserv. Biol.* 5, 148–157.
- Mahmoud, M.A.M., Zalat, S.M., El-Akkad, S.S., Gilbert, F. (2008): Genetic variability in the endemic bee *Anthophora pauperata* among wadisin the St Katherine Protectorate. *Egyptian Journal of Biology*, Vol. 10, pp 77-86.
- Malcolm, J.R. and Markham, A. (2000): Global Warming and Terrestrial Biodiversity Decline. Report prepared for WWF. WWF, Gland, Switzerland.
- Milton, S.J., Dea, W.R.J., Du Plessis, M.A., and Siegfried, W.R. (1994): A conceptual model of arid rangeland degradation. BioScience 44: 70-76.
- Min, S., Xuebin Z., Francis, W. Z., Gabriele C.H. (2011): "Human contribution to more-intense precipitation extremes". *Nature* 470(7334): 378–381.

- 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 St. Catherine Protected Area, 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.
- Newmark, W.D. (2008): Isolation of African protected areas, Front Ecol Environ, 6, pp. 321–328.
- Nix, H.A., 1986. A biogeographic analysis of Australian Elapid snakes. In: Longmore R Editor, Australian Flora and Fauna Series 8: 4-15.
- 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 St. Catherine Protected Area, South Sinai, Egypt. *M.Sc., Thesis*, Fac. Sci., Al-Azhar Univ., 350 pp.
- Omar, K. (2013a): Using Geographical Information Systems (GIS) to detect the ecological and geographical status of *Hypericum sinaicum* in St. Catherine Protected Area, South Sinai, Egypt. Faculty of Science, Al-Azhar University.
- Omar, K., Khafagi, O. and Elkholy, M.A. (2012): *Eco-geographical analysis on mountain plants: A case study of Nepeta septemcrenata in South Sinai, Egypt*. Lambert Academic Publishing, 236 pp.
- Omar, K., Khafagi, O. and Elkholy, M.A. (2013): *Geomatics and plant conservation: GIS for best conservation planning*. Lambert Academic Publishing.
- 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.
- Palmberg-Lerche, C. (2002): Thoughts on genetic conservation in forestry. Unasylva 53(209) [online].
- 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., Raxworthy C.J., Nakamura, M., Peterson, A.T., 2007. Predicting species distributions from small numbers of occurrence records: a test case using cryptic geckos in Madagascar. J. Biogeo. 34: 102- 117.
- Peterson, A.T., 2006. Uses and requirements of ecological niche models and related distributional models. Biodiv. Inform. 3: 59-72.
- 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.
- Primack, R.B. (2012): Conservation Outside Protected Areas. In: Primack RB (ed) A Prim. Conserv. Biol., 5th ed. Sinauer Associates, Massachusetts, USA, pp 256–281.

- 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.
- Rezanka, T. and Sigler, K. (2007): Sinaicinone, a complex adamantanyl derivative from *Hypericum sinaicum*. Phytochemistry, 68: 1272–1276.
- Ricklefs, R.E., Naveh, Z. and Turner, R.E. (1984): Conservation of Ecological Processes.vIUCN Commission on Ecology Paper 8. IUCN, Gland, Switzerland.
- 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.
- Shabana, H., Moursy, M.M., Omar, K. (2011): Survey of the Flora Enclosures of St. Catherine Protected Area "in-situ conservation". Plant Conservation and Monitoring Programme, St. Catherine Protected Area.
- Shaltout, K. H., Heneidy, S. Z., Al-Sodany, Y. M., Marie, A. M., Eid, E, M., Hatim, M, Z., El-Gharaib, A, E. (2004). Floristic Survey of the Mountainous Southern Sinai: St. Catherine Protected Area, Conservation and Sustainable Use of Medicinal Plants in Arid and Semi-arid Eco-systems Project, Egypt, Final Report (GEF & UNDP) (Project No: 12347/12348).
- Sharma, S.K. and Shankar, V. (1991): Classification and ordination of vegetation of the Kailana catchments in the Indian Thar Desert ii. Woody Vegetation. *Tropical Ecology* 32: 269–286.
- Silvertown, J. (1982): Introduction to Plant Population Ecology., Longman, London, UK.
- SCPA Management Plan 2003. The management and development plan for St. Catherine Protected Area, Full reference edition, 148 pp.
- Soltan, MM. and Zaki AK., (2008): Assessment of the anti-microbial and anti-viral properties of extracts from *Nepeta septemcrenata*. Planta Med 2008; 74: 1–338 Georg Thieme Verlag KG Stuttgart · New York · ISSN 0032-0943.
- Soule´, M.E. and Sanjayan, M.A. (1998): Conservation targets: do they help? *Science*, 279: 2060–2061.
- Sutherland, W.J. (2001): The Conservation Handbook: Research management and policy. Blackwell Science, Oxford, UK.
- Sutton, J. (2004). *The Gardener's Guide to Growing Salvias*. Workman Publishing Company. p. 116. ISBN 978-0-88192-671-2
- Taran Mojtabaa, Ghasempour Hamid Rezab, Safoora Borzob, Najafi Shivab & Samadian Esmaeila (2011): In vitro Antibacterial and Antifungal Activity of *Salvia multicaulis*. Journal of Essential Oil Bearing Plants. Volume 14, Issue 2, 255-259 pp.).
- Tian, H., Melillo, J.M., Kicklighter, D.W., McGuire, A.D., Helfrich, J., Moore III, B., & Vorosmarty, C.J. (2000): Climatic and biotic controls on annual carbon storage in Amazonian ecosystems. *Global Ecology and Biogeography*, 9, 315– 335.
- 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.
- United Nations Environment Programme (UNEP). (1995): Global Biodiversity Assessment. Cambridge University Press. New York, NY.
- 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.
- Walther, G., Roques, A., Hulme, P.E., Sykes, M.T., Pyšek, P.K.I, Zobel, M., Bacher, S., Botta-D.Z., Bugmann, H. (2009): "Alien species in a warmer world: risks and opportunities". *Trends in Ecology & Evolution* 24 (12): 686–693.

- Watkinson, A.R. and White, J. (1985): Some life-history consequences of modular construction in plants. *Philos. Trans. Royal Soc. London, Series B,* 313: 31-51.
- Watt, J., Breyer, M., (1962): Medicinal and Poisonous Plants of Southern and Eastern Africa. Livingstone, London.
- Weiner, J. (1985): Size hierarchies in experimental populations of annual plants. *Ecology*, 66: 743-752.
- 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
- Wolfson, L.J., Kadane, J.B. and Small, M.J. (1996): Bayesian environmental policy decisions: two case studies. Ecological Applications, 6: 1056–1066.
- 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
- Woods, K.D. (2004): Intermediate disturbance in a late successional hemlock-northern hardwood forest. *J. Ecol.,* 92: 464-476.
- Zhou, L., Tucker, C.J., Kaufmann, R.K., Slayback, D., Shabanov, N.V., and Myneni, R.B. (2001): Variations in northern vegetation activity inferred from satellite data of vegetation index during 1981 to 1999. *Journal of Geophysical Research*, 106 (17. 269–283.

PHOTOS:

Fieldwork, GIS Training, fieldwork training, local community meeting, protected area workshop, seed collection training for children, awareness for school children


م
التهديد
المساحة
شدة التأثير
سرعة ردالفعل
المجموع
التغير الأخير