Conservation Assessment of the Arabian Dragon's Blood Tree (*Dracaena serrulata*) in Oman.

Final Report - CLP project ID 05323417

Site location: Sultanate of Oman. Dhofar, Southern Oman

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Table of Contents

List of Figures

List of Tables

Project Partners & Collaborators

Table 1. A list of project partners and collaborators and their involvement

Project Partners & Collaborators	Involvement
The Anglo-Omani Society (AOS)	Provided invaluable assistance in field work, data collection and mapping. Produce essential maps for the study area.
Environment Society of Oman (ESO)	Participated during school visits and contributed to the presentations given to schools.
National Survey Authority (NSA)	Produce GIS-MAPS for the project study area. Provided GIS training for one of the project team members (Khadija Al Mawali).
Office of Conservation & Environment (OCE) (Dhofar Governorate)	Assisted in field work - data collection and logistics
General Directorate of Environment & Climate Affairs in Dhofar Province (MECA)	Assisted in field work - data collection and logistics
Civil Aviation Authority (CAA)	Provide metrological data for the area
Office of the Minister of State and the Governor of Dhofar	Contacted village sheikhs- ensured the participation of local leaders in the project.
General Directorate of Education in Dhofar province	Liaised with schools, ensured their participation in the project.
Public Authority for Civil Aviation (PACA), Mr. Hilal Al Hajri	Provide metrological data for the area
Agriculture research centre	Tissue culture propagation facilities and training for one team member (Hanan Al Moqbali)

SECTION 1

1. SUMMARY

The project's key objective was to reassess the conservation status of *Dracaena serrulata* Bak. in Oman. In 2018 43,683 individual trees were recorded and mapped. The trees occured within an area of 120 km^2 – populations were fragmented and majority are confined to steep mountain slopes between 400m and 1155 m a.s.l. Regeneration is evident through the presence of juvenile plants, however, the rate of population regeneration against population loss is not clear from these results. Using the population distribution data an IUCN Red List national assessment was carried out – *D. serrulata* in Oman is designated as Endangered (EN). A morphological – taxonomic review of the species was undertaken, 63 leaf samples were analysed. The presence of serrulated leaf margins was consistent throughout all leaf samples. The project's finding support the classification of the species as *Dracaena serrulata*. Propagation trials, including: seed germination, vegetative propagation and in-vitro trial of the species at Oman Botanic Garden proved unsuccessful. Traditional knowledge, practices and local perceptions of *D. serrulata* were recorded via photographis, video, audio and written means – these data are archieved at Oman Botanic Garden. The Education and Community Outreach activities were very successful – 9 local schools, with a total of 1,601 students were visited. Presentations, posters and information booklets designed by the project team were given to the schools. Feed back from the schools was extremely positive – the conservation message was clearly understood.

2. INTRODUCTION

Dracaena serrulata (English: Dragon's blood tree, Dhofari Arabic: ariyeb) is listed as Endangered (EN) on the Global IUCN Red List (1996). It is restricted to high altitude areas in Southern Oman, Yemen and Saudi Arabia. The study area was centred on the Dhofar Mountains in southern Oman (figure 1) is the mountain ranges on which the species is found. Many of the trees are located along the summer monsoon (Khareef) effected slopes of the Dhofar Mountains (Figure 2). Oman holds ca. 70% of the global population (Patzelt, 2015). Anecdotal evidence and field observations over the last decade suggests there is no active regeneration of Dracaena serrulata in Southern Oman. In addition, adult trees appear to be suffering from severe dieback. A lack of evidence based understanding of these impacts poses a serious threat. The project team carried out a conservation assessment between 2018-2019, including: a population census, species mapping, health assessment, habitat description the establishment of an ex-situ collection (including seed and living plants), and an assessment of local traditional uses and attitudes. In addition the team embarked on a drive to raise awareness and promote the conservation of D. serrulata in Oman, focusing largely on school children living within the boundaries of the species range.

The results and outcomes of the project provide a very valuable baseline from which to plan and implement conservation measures. For the first time there are quantitative data to support conservation – tree numbers, demogrpahic information, agreed taxonomy and a reassessed IUCN Red List national assessment contribute significantly towards establishing a national strategy for the conservation of D. serrulata in Oman.

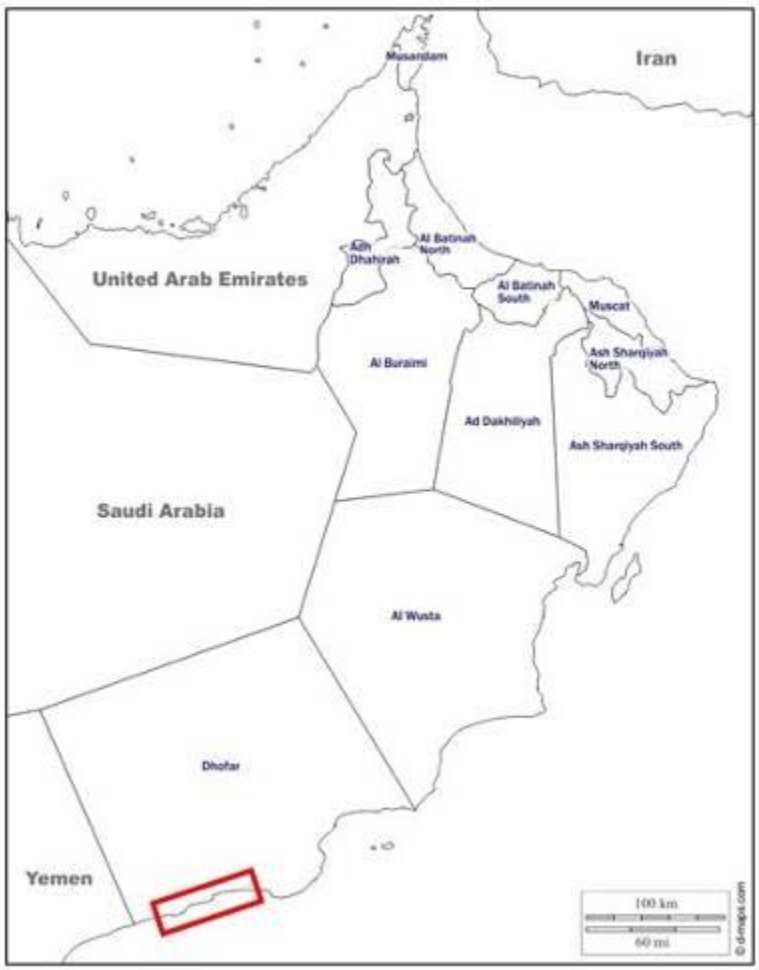

Figure 1. Study area for *Dracaena serrulata* – the Dhofar Mountains, Dhofar, southern Oman 2018 -2019.

Fundamental to viable conservation work is the inclusion of key partners, including: government bodies and local commuities. From the outset the project team worked hard to establish links with local government, community leaders and school teachers. Following persistent efforts the team established relationships with a number of key people and local schools. Although most local people knew of the tree, many were unaware of its global conservation significance. Village elders and leaders were very keen to learn more and were in turn happy to share their knowledge, experiece and opinions in relation to the tree's uses and signifance to local people. The nine local schools visited were equally enthusiatic to learn and share.

The students responded very favourably to the ideas presented to them. The project team were extremely pleased by their reactions and enthusiasm. Additional key project partners (Table 1) were involved in the project field work – assisting with field work logistics, data collection and mapping. Although many of the partners were from envrionmental sections of the government, many had never undertaken field work before. They were exposed to a lot of new ideas and methods and learned a great deal from their inclusion in the project. The inclusion of members of the Anglo – Oman Society in the 2018 field work proved to be extremely helpful and beneficial to all involved. Young Omani scientists shared lots of time and ideas with their equivalents from the UK. It was a wonderful experiene sharing knowledge and ideas on conservation.

Figure 2. *Dracaena serrulata* in the Dhofar Mountains, Southern Oman.

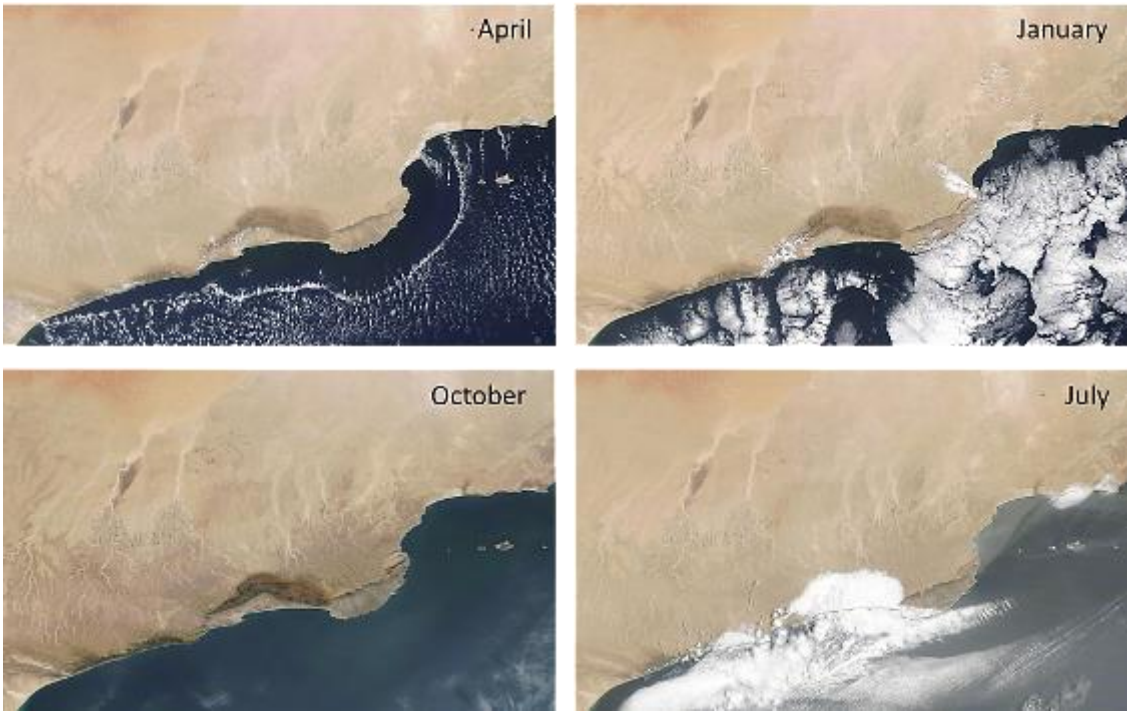

Figure 3. Satellite images of the Dhofar Mountains taken in January, April, July and October, 2018. The July image shows the dense 'Khareef' cloud cover over the mountains. Jabal Qamar and Jabal Qara are completely enveloped in cloud. Jabal Samhan on the North Eastern end of the mountain range is largely outside of the effect of the 'Khareef' cloud precipitation. (Source- NASA's Global Imagery Browse Services).

3. PROJECT MEMBERS

Ghudaina Al Issaey (Team Leader)

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Ghudaina has a M.Sc. degree in Taxonomy and biodiversity of Plants from the University of Edinburgh, UK. Currently, Ghudaina is part of the operational management team at Oman Botanic Garden - a role that involves research coordination and project management.
She has gained a broad experience in conservation based projects since she started working for OBG in 2007. Examples of her most recent work, in the conservation assessment of seven endemic plant species in the central desert of Oman the spatial and genetic pattern of the coniferous tree species *Juniperus servachanica* in the Hajar Mountains in Northern Oman. She has also been involved in workshops that lead to the designation of IUCN - Important Plant Areas (IPAs) in Oman. Ghudaina has an experience in handling biological databases and managing data for OBG. For this project, Ghudaina was responsible for team coordination and financial management. She was also responsible for compiling some reports, contributing in outreach and educational programmes, coordinating some training sessions for the team members and purchasing equipment. She has been responsible for the overall communications aspects, report submissions and and field data analysis.

Abdulrahman Al Hinai (Team Leader)

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Abdulrahman has a B.Sc. in Environmental Science from Sultan Qaboos University, Oman. He worked as a biology lab technician in a local college from 2004-2010. He joined Oman Botanic Garden as a field botanist and ethnobotanist in 2010. He has been involved in a variety of conservation projects, including, the conservation assessment of seven endemic plant species in the central desert of Oman, documentation and conservation of traditional plant uses in Oman, and the discovery and publication of new plant species and records for Oman. Abdulrahman attended the CLP course in Sulawesi in 2017.Currently, Abdulrahman leads a team to collect plant materials from the field, carry out some taxonomic research, and compiling ethnobotanical data to publish a book on traditional uses of native plants from the Eastern part of Oman. He has been collecting the country traditional crops germplasm, including wheat, saffron, etc. For this project, Abdulrahman lead the field activities and expedition. He was responsible for the communication with stakeholders and local communities. He was also responsible for liaising with different team members. Abdulrahman was acting as the team leader when Ghudaina was on leave. He was the superstar of the project during its early phase. He managed to convince the government authority of the importance of the project and how essential is the fund we received from the CLP in order to raise the conservation profile in Oman.

Saif Al Hatmi

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Saif has a M.Sc. in Ethnobotany from the University of Kent, UK. He is a trained field botanist since he joined OBG in 2006. Saif has contributed greatly to collecting plant material and associated environmental data for OBG over the last 13 years. He also leads the OBG ethnobotany team, who are responsible for the collection of traditional plant knowledge and plant based products throughout Oman. In 2019, Saif was responsible for a project to eradicate an invasive species from the OBG site and developed a 3 year monitoring programme to ensure that this species does not grow back. His eradication methods and over all invasive species management are being used as a case study to plan a country wide eradication program for invasive species. Currently, Saif is focused on documenting and developing a database of traditional plant knowledge in Oman and training young Omani staff in the gathering and recording of traditional plant knowledge. Saif is a key member of the OBG field team were continues to contribute hugely to the growth of OBG's pant collections and knowledge. I addition to this project's field work logistics, which Saif managed in 2018, he was a key member in the field survey team. He was also responsible for the collection of ethnobotanical data about *Dracaena serrulata*. He has documented all the data using voice and video recording for the interviews with the local people.

Zawan Al Qasabi

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Zawan has an M.Sc. in Plant Diversity from Reading University, UK. She has experience in carrying out EIAs when she worked for an environmental consultancy in 2006/2007. Since she joined OBG, Zawan has been the herbarium curator. Her responsibilities include -but not limited to- physical curation of herbarium specimens, including dealing with request for loans of research materials, organise the herbarium collection, assimilate new species, facilitate name changes and knowledge of handling herbarium pests, liaison with the Oman Botanic Garden Plant Records team to ensure that all herbarium data is communicated appropriately, identification and procurement of materials, equipment and literature for the herbarium as required. She has been involved in a number of taxonomic research projects and publication as well as national IUCN-IPA workshops. She has experience in conducting tours within OBG and giving training in herbarium processes. Currently, she is aiming to collect all species from Oman for conservation purposes. For this project, Zawan was responsible for the morphological assessment of the Arabian Dragon Tree (*Dracaena serrulata*). She carried out field work to collect the specimens for the taxonomic analyses and assessment. . She was also responsible for collating all the invoices and producing the preliminary financial report.

Hanan Al Maqbali

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Hanan holds a M.Sc. in Plant Protection and B.Sc. in Crop Science from Sultan Qaboos University, Muscat, Oman. She has an interest in the genetics of crops and their pest tolerances. Hanan started working for Oman Botanic Garden in 2009 where she is focusing on propagating Omani native flora from seeds and/or vegetative. Hanan leads a team whose main task is to propagate and take care of plants until they are well established to move to the next stage. Currently, she also plans field trip to collect plant to propagate them as well as keeping the database up to date. For this project, Hanan was responsible for the germination experiments and exploring the potential of growing *D. serrulata* using tissue culture. She has also participated in the presentations that were given to schools in Dhofar as part of the project.

Khadija Al Maawali

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Khadija holds a B.Sc. in Crop Science from Sultan Qaboos University, Muscat, Oman. Khadija joined Oman Botanic Garden in 2012 as a botanist. Her main duties are to work on the databases and perform data entry. Currently, she manages all databases of OBG and coordinates data management activities between the different divisions at OBG. In 2014, she showed interest in developing her skills into mapping and GIS, she received basic training in this area, currently she provide maps and map data to a variety of research projects at OBG.
For this project, Khadija received excellent training in using ArcGIS from our partners. She established good understanding of mapping which allowed her to produce distribution maps for this project. She also has contributed in the data analysis.

Mohammed Al Saidi

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Mohammed has a M.Sc. in Environmental Science from Sultan Qaboos University, Oman. He used to be a science teacher before joining OBG in 2014 as environmental education specialist. Mohammed also has an International Diploma in Botanic Garden Education from Royal Botanic Garden, Kew, U.K. His current role at OBG includes but is not limited to: planning, preparing and delivering lessons to a range of classes of different ages, organizing tours and conducting educational program for school students linking these programs to the curriculum.
For the project, Mohammed played a big role in planning and producing the educational presentations and posters for the schools. He gave the presentations to the boys' schools and guided some groups into a site visit where the methods of the field survey was explained and demonstrated. He established contacts with the various schools.

Salha Al Mahrouqi

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Salha holds a B.Sc. in Biotechnology from Sultan Qaboos University, Muscat, Oman. Salha studied plant science and she did many projects related to science and environment during her studies. She joined Oman Botanic Garden in 2011 as an outreach and awareness administrator. In 2014, she received a training course in she received an International Diploma in Botanic Gardens education from RBG Kew, UK. Her project was about informal outreach programs in Oman Botanic Garden. Salha's role at OBG is to develop activities and deliver awareness programs and organizing events within the botanic garden and outside for local communities, schools, associations, government and private institutions. She also gives presentations to visitors, develops outreach programs on specific environmental and sustainability matters such as, celebrating world environmental day, water day, recycling, etc. Her role for the project was significant, she was involved in the school visits and in producing all the educational materials, including the posters and the presentation. She kept contact with the local schools from Dhofar and encouraged them to start environmental initiatives.

Laila Al Jahwari

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Laila holds a B.Sc. in Plant Science from Sultan Qaboos University, Muscat, Oman. She joined Oman Botanic Garden in 2011 as horticultural specialist. She worked with the plant health team in the protection of plants against pests and diseases, developing monitoring programs and establishing the biological control system at OBG. Laila is a talented artist and in recent years has undergone training in botanical illustration, including water colour, pen and ink techniques. She has quickly learned the skills required and has focused her entire time at OBG to illustrating the native plants of Oman. Her role for the project was to produce a story booklet for kids, using the *D. serrulata* tree. She creatively drew the storyline and illustrated the tree and the habitat (Full copy in ibackup).

SECTION 2

2. 1 AIMS AND OBJECTIVES

The primary aim of the project was to reassess the conservation status of *Dracaena serrulata* in Oman by providing baseline data and highlight the need for conservation measures and promoting communication and capacity building within and between national conservation agencies.

The objectives are:

1- To geo-reference 75% of *D. serrulata* population from southern Oman and carry our population census, ecological and dendrological analysis, conduct germination trials using different methods and taxon verification using merphological analysis. In addition, carry out a national Red List assessment of the species based on the gathered data.
2- Document traditional knowledge, uses, practices and pereception of *D. serrulata* by interviwing local people.
3- Develop the capacity of the team memebers as well as of stakeholders in various fields including practical field work, data documentation, project management and establishment of trees long-term monitoring programme.
4- Produce a range of educational material for local schools and community groups to highlight and promote the conservation requirements of *D. serrulata* in Oman with an emphasis on the current and potential threats.

2.2 CHANGES TO THE ORIGINAL PROJECT PLAN

Main Problem: The project activities were delayed by three months because of the approval process within the administrative authority. Compulsory approval from Oman Ministry of Foreign Affairs was required to undertake the project.

Solution: We resolved this issue through personal communication and discussions with the administration people from the Ministry.

Objective 1

Problem 1: Since 2018 all drone flights in Oman require rigorous and expensive approval. This precluded the use of a drone in the population survey.

Solution: The population census was carried out by walking through accessible sites, counting the trees or by using binoculars to count trees in inaccessible sites.

Problem 2: Establishment of a long term monitoring programme was to be managed by a project partner in Dhofar. Unfortunately, they were not interested.

Solution: Our team members with the support from Oman Botanic Garden will manage the monitoring plan going forward.

Objective 2

Problem 1: Documenting and filming of the local people was delayed. The arranged photographer let the team down and could not be relied upon.

Solution: The team contacted a new photographer from Southern Oman who agreed to produce the film and edit it for a relatively small fee.

Objective 4

Problem 1: Approval from the Ministry of Education on the participation of the selected schools was received during the summer holidays of 2018, thus no schools were available.

Solution: Although delayed, the team resumed the activities related to schools in September 2018.

Problem 2: We could not include visits to colleges in our work. This was again due to very lengthy delays in the approval process.

Solution: We dropped colleges and focused on schools and local communities.

2.3 METHODOLOGIES, OUTPUTS & RESULTS

2.3.1 Objective 1: Assess the conservation status of *D. serrulata* in Southern Oman.

2.3.1.1 Activity 1: Geo-reference and map c. 75% of mature trees and carry out an IUCN National Threat Assessment.

Methods

Population size and distribution

Fieldwork was conducted in January 2018 in Dhofar, Southern Oman. The team carried out a population census of *D. serrulata* across the Dhofar mountains, including, Jabal Qamar, Jabal Qara and Jabal Samhan. Sites in physically dangerous or difficult to access locations were not surveyed.

The counting process was performed by direct counting (unaided or aided by binoculars) coupled with viewshed analysis. Counting was carried out by standing at a fixed point and counting all the trees visible from that single point. The counted trees were categorized as mature, juvenile or dead. A tree was considered juvenile if, 1) a plant had a single rosette without trunk and 2) a plant had a single rosette and a trunk < 1m.

The coordinates, aspect and altitude of each single point were recorded on a Garmin etrex 20x hand held GPS device. All data were stored on MS Excel generated recording sheets. (APPENDIX 4.5). Viewshed maps were produced using ArcMap 10.5.1.

IUCN National Threat Assessment of *Dracaena serrulata*

Using the field data collected in 2018 the Extent of Occurrence (EOO) and Area of Occupancy (AOO) were calculated using the Geospatial Conservation assessment tool - GeoCat. GeoCAT (geocat.kew.org) provides a tool to collate primary biodiversity data for application of the IUCN Red List assessment systems and provides baselines in the threat status of species from which changes in status can be monitored over time. The GeoCat outputs were used to complete an IUCN Red List Assessment. The assessment was undertaken at the national level, following the guidelines for IUCN national assessments (Gardenfors et.al. 2001).

Figure 4. Members of the project team on Jabal Qara - population census, January 2018.

Results

Population size and distribution

A total area of approximately 120 km^2 across the entire-accessible range of *D. serrulata* in the south of Oman was covered. A total of 43,683 individual trees (table 2) were counted from 226 individual viewshed points. A distribution map, illustrating the narrow geographic range for the species and the population size for each survey point (figure 5) was created. Viewshed maps detailing the distribution and population sizes on Jabal Qamar, Jabal Qara and Jabal Samhan (figures, 6, 7, 8) were also created, providing a more detailed picture of the overall distribution patterns and tree numbers. Total tree numbers and population demographic patterns varied between Jabal Qara, Jabal Qamar and Jabal Samhan (table 2).

Table 2. Population census of *D. serrulata* from the Dhofar Mountains - Jabal Qamar, Jabal Qara and Jabal Samhan, January 2018. 43,683 trees, including mature, juvenile and standing dead trees were recorded. Jabal Qamar had the highest number of recorded trees.

Location	Total survey points	Total survey area	Total living trees	Total dead trees	Total juvenile trees	Total
Jabal Qamar	89	42	18,077	1,021	1,102	20,200
Jabal Qara	50	24	14,502	1,050	1,475	17,027
Jabal Samhan	86	66	6,041	261	154	6,456
Total	**225**	**132**	**38,620**	**2,332**	**2,731**	**43,683**

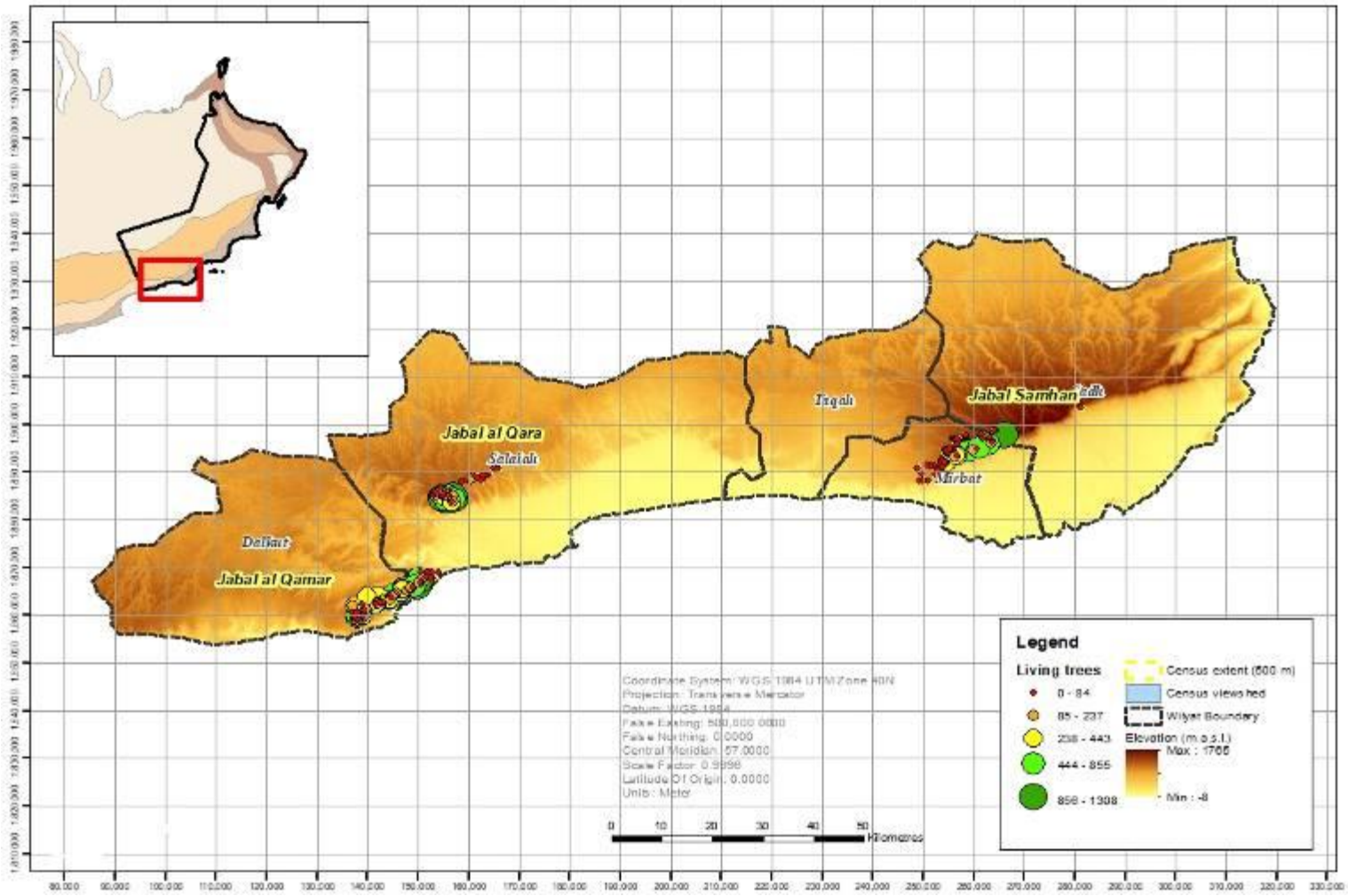


Figure 5. Overall distribution of *D. serrulata* across the Dhofar Mountains, including Jabal Qamar, Jabal Qara and Jabal Samhan as recorded in the project census, January 2018 (Source: ArcGIS v. 10.4).

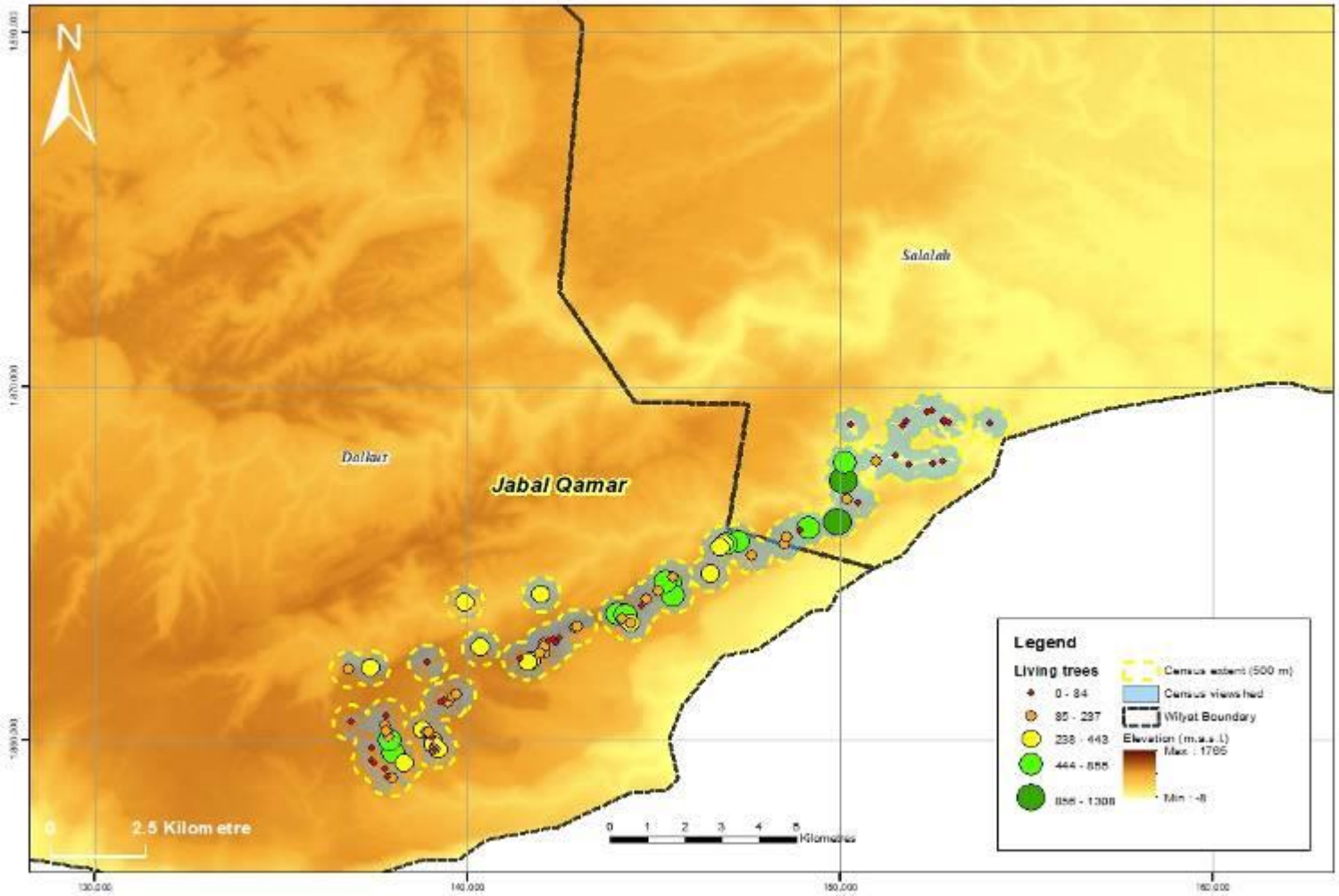


Figure 6. Distribution of census counting points, viewshed areas (depicted in grey within the dashed yellow lines) and total tree numbers for *D. serrulata* on Jabal Qamar, Southern Oman, January 2018 (Source: ArcGIS v. 10.4).

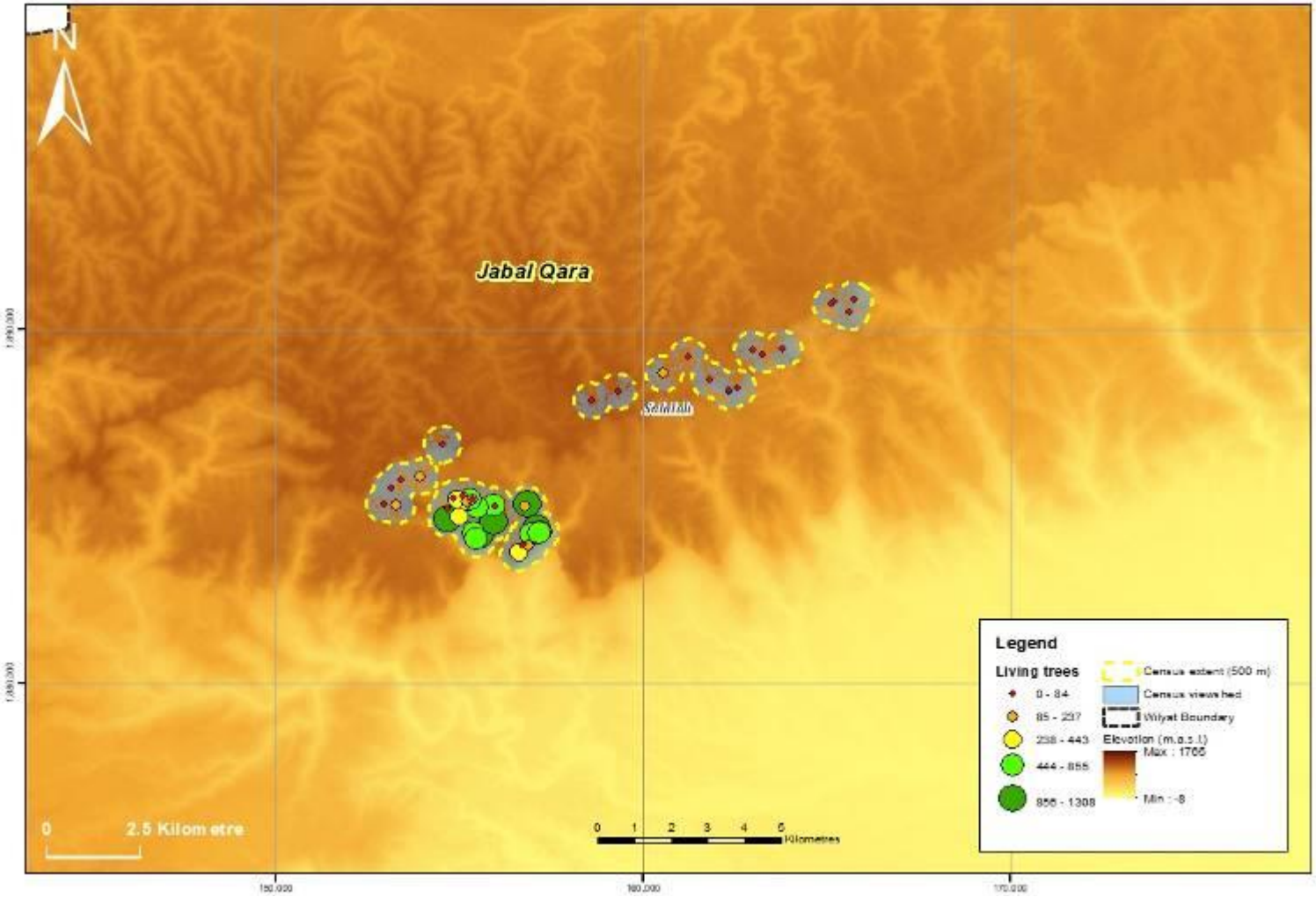


Figure 7. Distribution of census survey points, viewshed areas (depicted in grey within the dashed yellow lines) and total tree numbers on Jabal Qara, Southern Oman, January 2018 (Source: ArcGIS v. 10.4).

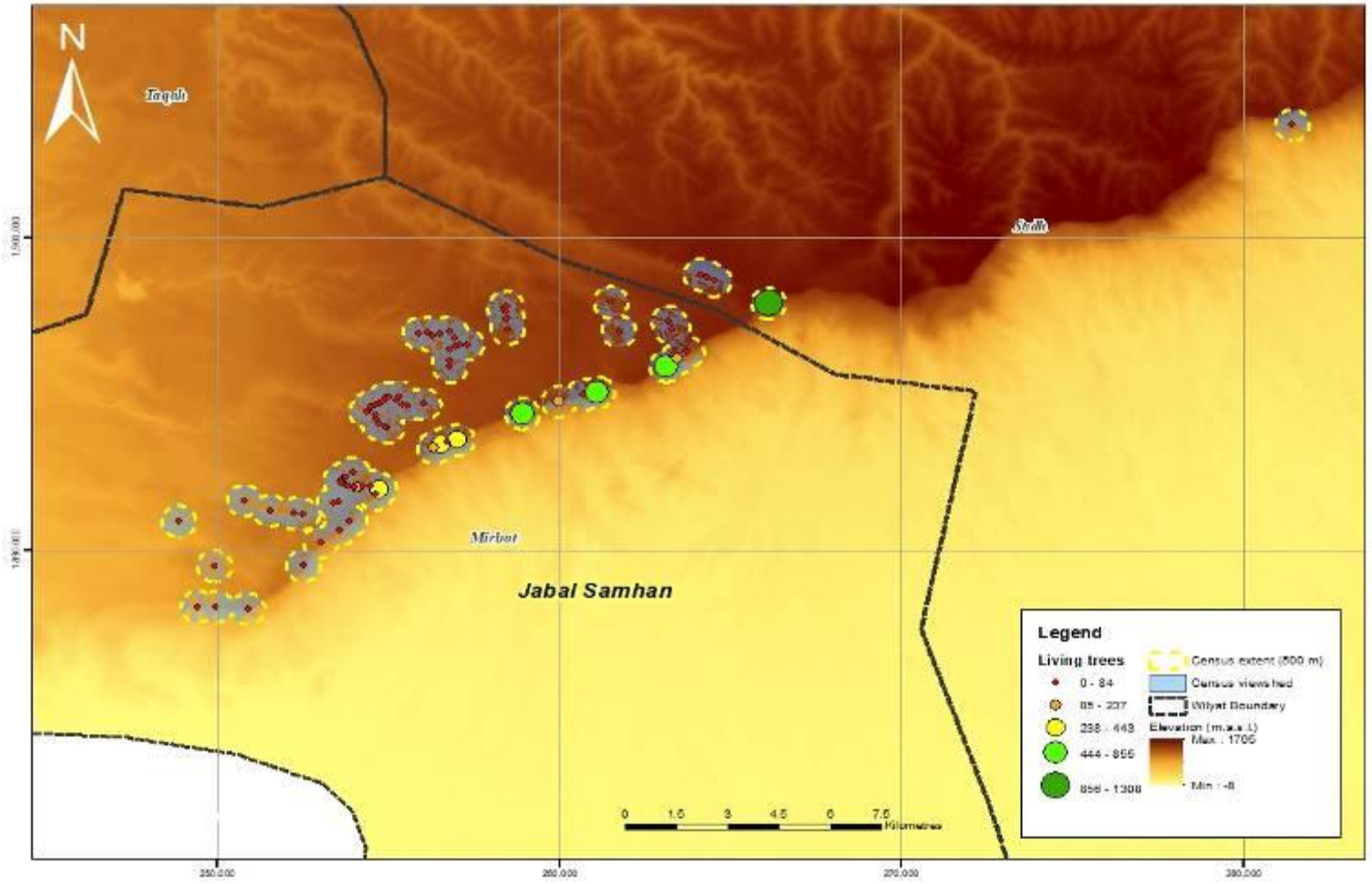


Figure 8. Distribution of census counting points, viewshed areas (depicted in grey within the dashed yellow lines) and total tree numbers on Jabal Samhan, Southern Oman, January 2018 (Source: ArcGIS v. 10.4).

IUCN National Assessment of *Dracaena serrulata*

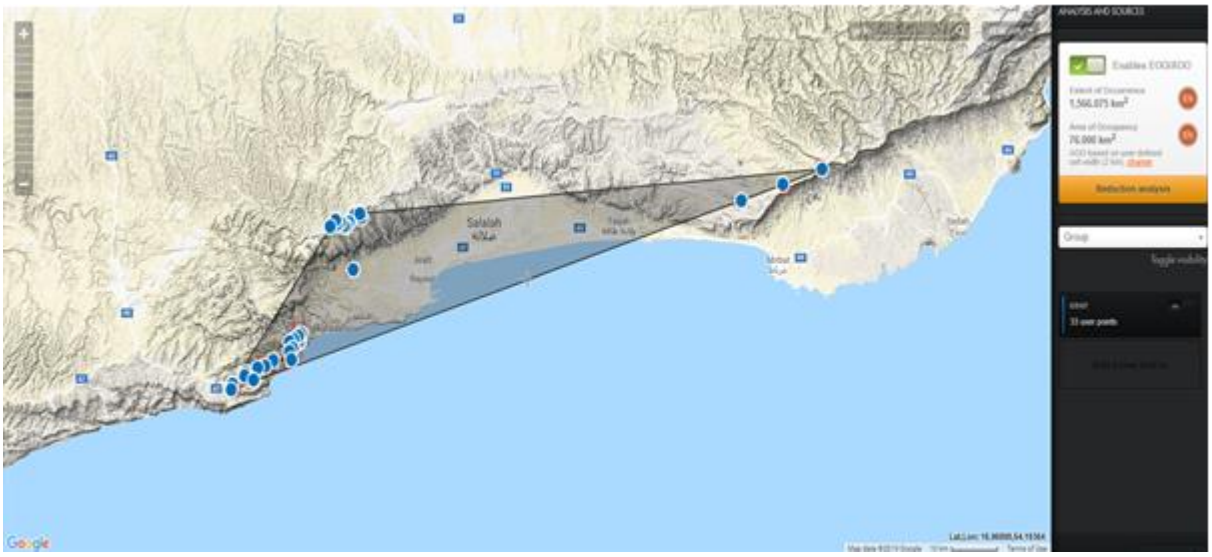


Figure 9. GeoCat - IUCN Threat Status Classification map showing the Extent of Occurrence (EOO) [1,566.075km^2] and Area of Occupancy (AOO) [76,000km^2] for *Dracaena serrulata* across the Dhofar mountains.

Dracaena serrulata was categorized under **Criterion B** of the IUCN Red List Threat Status. This criterion is the most commonly used to assess plant species. *D. serrulata* has an Extent of Occurrence (EOO) of 1, 566km^2 - falling short of the 5,000 km^2 threshold, therefore, *D. serrulata* qualifies under category - **Endangered (B1).** *D. serrulata* has an Area of Occupancy (AOO) of 76km^2 - falling short of the 500 km^2 threshold, so qualifies under category - **Endangered (B2).** The collected and observed data suggest *D. serrulata* in Oman is under threat from a continuing decline in extent or quality of habitat and in the number of mature individuals.

The IUCN Red List Category and Criteria assigned to *D. serrulata* in Oman is Endangered B1ab(iii,v)+2ab(iii,v) – details are outlined below:

B1 – Extent of occurrence (EOO) < 5,000 km^2

(a) Number of locations ≤ 5 (locations the threats on the taxon)
(b) Continuing decline inferred in (iii) extent and/or quality of habitat, (v) number of mature individuals.

B2 – Area of occupancy < 500 km^2

(a) Number of locations ≤ 5 (locations the threats on the taxon)
(b) Continuing decline inferred in (iii) extent and/or quality of habitat, (v) number of mature individuals.

2.3.1.2 Activity 2: Gather and analyse demographic and ecological data

Methods

Quadrat establishment

Eight 50m x 50m (0.25ha^2) quadrats were established across the species known range in the Dhofar mountains (Figure 1). The quadrats were selected based on previously known locations on the three mountain ranges: Jabal Qamar, Jabal Qara and Jabal Samhan. Health status, tree density, size – age class, associated vegetation and habitat description and reprpductive potential were assessed using a variety of direct and proxy measures. The methods used for each are outlined below. Three quadrats were identified as long term monitoring sites. Georeference coordinates, photographs and obvious wayfinding landmarks were gathered to help locate the long term monitoring plots in the future.

Habitat description and associated vegetation

To describe the associated vegetation an inventory of associated plant species for each quadrat were recorded. Due to time constraits the study did not record the abundance or frequency of associated plants species. The study focused on recording the presence of woody plants. Herbaceous species and grasses were not included – the survey was conducted in January which coincides with the dormant season in Dhofar – all herbaceous plants and grasses were dormant, below ground.

Tree density and population structure

The density of *D. serrulata* in each plot was recorded. Associated enviromental data were collected, including: aspect, slope, altitude and associated plant species (Table 4).
The age of the surveyed trees was estimated by using the size of trees plus the number of branches and rossettes per tree as a proxy measure of age. Small, single rosette trees were considered juvenile and large trees with multiple rossettes were categorised as mature (see table 3 and figure 9).

Table 3. Size-Age class scale used to infer the age of the surveyed trees.

Scale	Description
1	Plant with a single rosette and without trunk
2	Plant with one rosette and a small and young trunk (less than 1 m in height),
3	Plant with one rosette and a trunk (more than 1 m in height),
4	Plant with 2 main branches, more than one rosette, crown with a diameter < 2 m
5	Plant with > 2 main branches, multiple upper branches, multiple rosettes, crown > 2 m

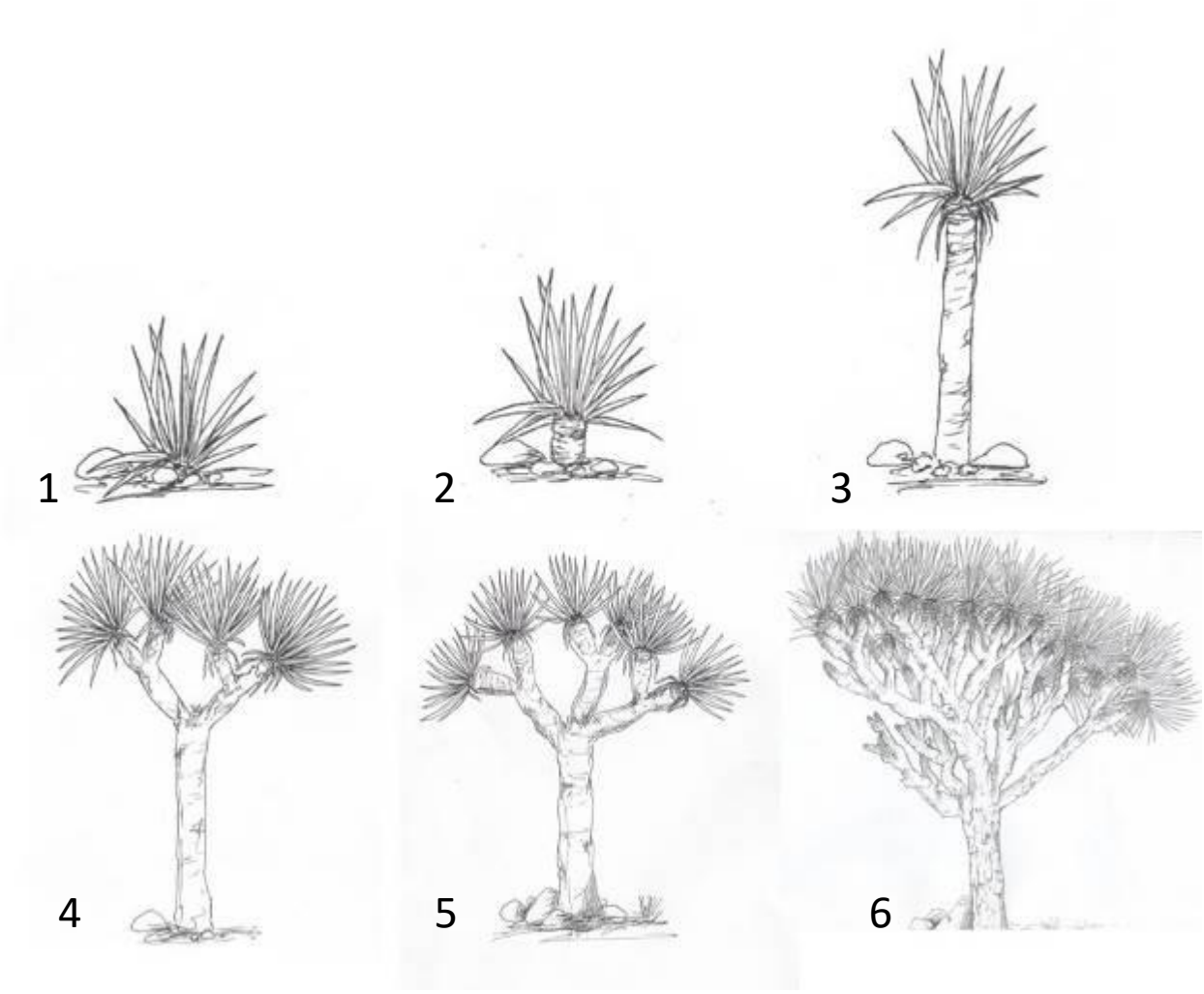


Figure 10. Size – Age class scale based on tree height and the number of branches and rosettes (images: Laila Al Jahwari – project team member)

Assessing the reproductive potential

Reproductive potential was assessed by recording the number infloreseces, flowers and seeds per tree.

Health status

Ten mature trees were measured in each quadrat – health status was assessed for each tree by recording the percentage of dead branches per tree. The schematic diagram in Figure 10 was used in the field as a guide to estimating the percentage of dead branches per tree.

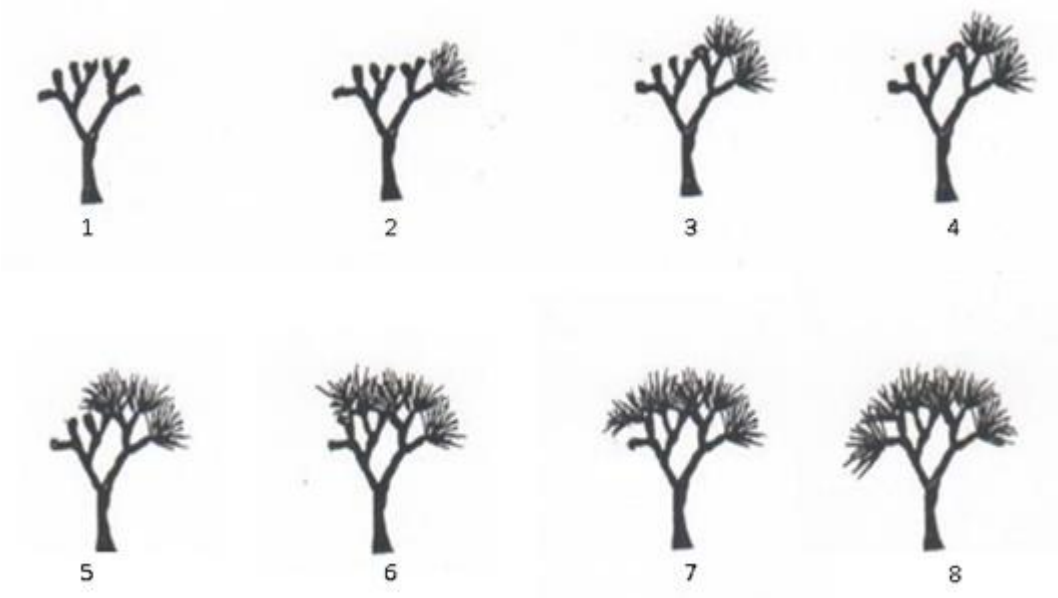


Figure 11. Schematic diagram of the health status scale for *D. serrulata* (1 – all branches dead to 8 - all branches with fully entact rosettes (images: Laila Al Jahwari – project team member).

Taxonomic verification of *D. serrulata* in Oman

A total of 63 trees from across the species range in Dhofar were examined. The studied trees were predominantly mature, however, to capture any potential age associated morphological variation a number of juvenile trees were also examined. Clustered groups of trees and isolated individuals were included in the sample set.

21 trees were assessed on Jabal Qara from (4 locations). 22 trees were assessed on Jabal Al Qamar (12 trees - 2 locations and 10 trees- 3 locations). 20 trees were assessed on Jabal Samhan (10 trees – 1 location and 10 trees - 3 locations).

Evaluated morphological characters were selected based on previous descriptions (Boulos, 2005; Miller & Morris, 2004; Miller & Morris, 1988; Thulin, 1995; Walker, 2017). Eleven scored morphological traits were used (Appendix 4.7) to assess diversity within the population. Characterization was limited to vegetative traits such as, tree height and leaf characters. The floral characters were not included because no trees were flowering at the time of the study. A character matrix using MS EXCEL was created and all morphological characters were entered into the sheets for each single tree (Appendix 4.6). The leaf specimens were examined under Light Microscopy (LM) to assess the morphology of the margins.

Results

Quadrat establishment

Eight 0.25ha^2 quadrats were set up and assessed (Jabal Samhan – 2, Jabal Qamar – 3, and Jabal Qara - 3). Due to the steep and often dangerous nature of the slopes on Jabal Samhan only two quadrats were established. In total 75 trees across the eight quadrats were measured – (table 4 – summary of results).

Three quadrats were established as long-term monitoring sites – additional photographs capturing the tree density and over all condition of the long-term monitoring sites were taken and catalogued. These will be used in the future as an aid for monitoring changes in the condition of the sites.

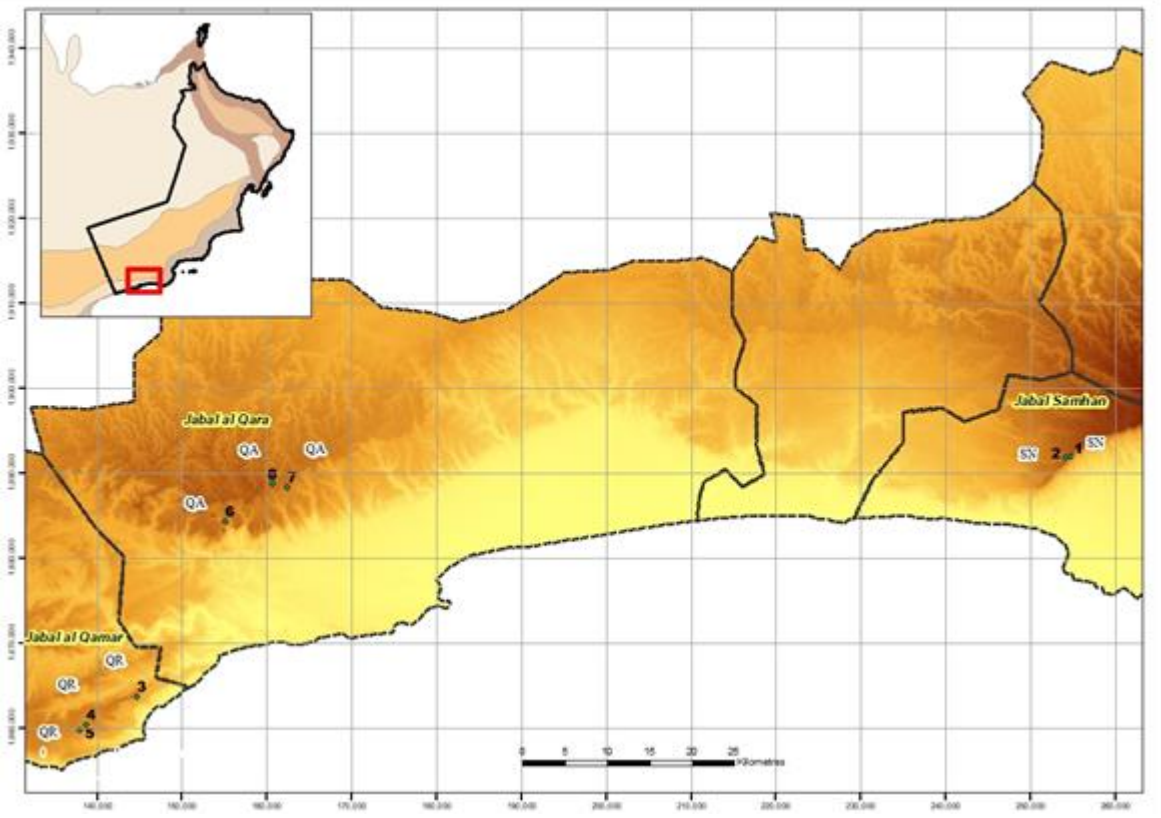


Figure 12. Location of the x8 (0.25ha^2) survey plots. Jabal Qamar (QR) x3, Jabal Qara (QA) x 3, Jabal Samhan (SN) x 2.

Habitat description and associated vegetation

All trees surveyed were found within an attitudinal zone of between 860m and 1155m above sea level on a mean slope of 44 degrees within a range of 10 to 85 degrees. All trees surveyed on Jabal Samhan were on precipitous slopes of between 80 to 85 degrees. Trees on Jabal Qara and Jabal Qamar occur on a broader range of gradients between 10 and 50 degrees (table 4).

Dracaena serrulata is predominantly confined to cliffs and steep hillsides in open woodland, dominated by woody species (table 5), including the tree species: *Acacia etbaica* Schweinf. subsp. *uncinata* Brenan and *Acacia senegal* (L.) Willd and the shrub species: *Euphorbia balsamifera* Aiton subsp. *adenensis* (Deflers) Govaerts, *Euphorbia cactus* Ehrenb. ex. Boiss., *Grewia erythraea* Schweinf., *Teucrium nummularifolium* Baker, *Vernonia arabica* F.G.Davies.

Table 4. *D. serrulata* quadrat survey - ecological data recorded - January 2018. Quadrats 1, 3 and 8 were established as long-term monitoring sites and will be used to monitor the status of *D. serrulata* in the future.

Location	Quadrat no.	Latitude	Longitude	Aspect	Slope º	Altitude (m)
Jabal Samhan	**1***	**17.09887**	**54.69514**	**SSE**	**85**	**1155**
Jabal Samhan	2	17.09824	54.68934	SE	80	1148.9
Jabal Qamar	**3***	**16.82866**	**53.66665**	**SSW**	**25**	**975**
Jabal Qamar	4	16.7982	53.61169	NNW	50	860
Jabal Qamar	5	16.79205	53.60477	N	25	955
Jabal Qara	6	17.01719	53.76094	NNE	20	1071
Jabal Qara	7	17.05401	53.82872	SSW	10	1087
Jabal Qara	**8***	**17.05781**	**53.81337**	**NW**	**35**	**1064**
Mean					**44**	**1040**
Range					**10 - 85**	**860 - 1155**

Table 5. Associated plant species recorded in the eight quadrats. Plant species in bold were common throughout all quadrats and are key indicators of suitable *D. serrulata* habitat.

Plant species	IUCN Red List threat Category	IUCN Red List Endemism level
Acacia etbaica Schweinf. subsp. *uncinata* Brenan		
Acacia senegal (L.) Willd.		
Blepharispermum hirtum Oliver	Near Threatened	Near Endemic
Commiphora gileadensis (L.) C.Chr.		
Commiphora kua (R.Br. ex Royle) Vollesen		
Corallocarpus epigaeus (Rottler) Hook.f. ex C.B.Clarke		
Cordia monoica Roxb.		
Dhofaria macleishii A.G. Mill.	Near Threatened	Near Endemic
Ephedra milleri Freitag & Maier-Stolte	Vulnerable	Near Endemic
***Euphorbia balsamifera* Aiton subsp. *adenensis* (Deflers) Govaerts ***		
***Euphorbia cactus* Ehrenb. ex Boiss. ***		
***Grewia erythraea* Schweinf. ***		
Grewia villosa Willd.		
Helichrysum somalense Bak.f.		
Hildebrandtia africana Vatke subsp. *arabica* Sebsebe	Least Concern	Regional Endemic
***Teucrium nummularifolium* Baker ***	Least Concern	Near Endemic
***Vernonia arabica* F.G.Davies ***		
Vernonia cinerascens Sch. Bip.		

Tree density and population structure

Ten trees were measured within each quadrat. However because of the difficulty of access only 7 and 8 trees respectively were measured in quadrats 7 and 8. The total number of trees measured was 75. The mean total tree density was 29 per 0.25ha^2 or 7.25 trees per hectare ^{2}. The age profile was dominated by mature trees. The mean number of mature trees was 23 per 0.25ha^2. Jabal Qara had the highest number of mature trees per quadrat (45 per 0.25ha^2). Quadrat 3 on Jabal Qamar recorded no mature trees but had 10 juvenile trees.

In total the mean number of juvenile trees across all quadrats was 3.1% of the total. The mean number of dead trees was 2.7% of the total, with the highest number of dead trees being recorded in a single quadrat (8) on Jabal Qara. Table 6 summarises the results.

In general the population is dominated by mature trees, suggesting the population is aging. Recruitment appears to be low as the mean number of juvenile trees across all plots was 3.1%

or 10.8% of the 231 trees counted in all quadrats. The mean number of standing dead trees was 2.7 or 9.5% of the 231 trees counted in all quadrats. In this study the total amount of juvenile trees is 1.3% greater than the total amount of standing dead trees, suggesting that in this population recruitment is marginally higher than population loss (Figure 10).

Table 6. Tree density and population structure for the 8 assessed survey plots. Mean tree density is 29 trees per 0.25ha^2. The population structure is dominated by mature trees, accounting for 79% of the 231 trees assessed. Juvenile trees account for 10.8% and standing dead trees- 9.5%.

Location	Quadrat no.	Trees / 0.25ha^2	Trees /ha^2	No. of measured trees	Total Mature trees	Total Juvenile trees	Total Standing Dead trees
Jabal Samhan	1	26	7	10	26	0	0
Jabal Samhan	2	23	6	10	23	0	0
Jabal Qamar	3	13	3	10	0	10	3
Jabal Qamar	4	35	9	10	35	0	0
Jabal Qamar	5	39	10	10	36	3	0
Jabal Qara	6	58	15	10	45	10	3
Jabal Qara	7	16	4	7	11	2	3
Jabal Qara	8	21	5	8	8	0	13
Total		**231**		**75**	**184**	**25**	**22**
Mean		**29**	**7**		**23**	**3.1**	**2.7**
Range		**13 - 58**	**3 - 15**		**0 - 45**	**0-10**	**0-13**
% of total trees					**79**	**10.8**	**9.5**

Assessing the reproductive potential

Despite extensive searching, no fresh flowers, inflorescences or seeds were recorded within or outside of the quadrats. A single old inflorescence was recorded on a plant outside of the quadrats on Jabal Samhan. No seeds were observed on this inflorescence – it was not possible to age the inflorescence but it was likely to be > 2 years old.

Figure 13. Old, persisting inflorescence (1m tall) of *D. serrulata* on Jabal Samhan, January 2018

Health status

Health status was determined by quantifying the percentage of dead branches per tree on the assumption that a high percentage of dead branches were an indication of poor health. No other measure was used to determine health status, i.e. no assessment of the presence of potential pathogens or harmful insects was undertaken. However, no obvious signs of fungal or bacterial infections were observed and no insects were recorded on any of the trees studied.

Health status results (Table 7) of the measured trees breakdown as follows - 68% of the trees had 0-25% dead branches (illustrations 7 and 8 in figure 10). 17.8% of trees had 25%-50% damage (illustrations 5 and 6 in figure 10). 8% of trees had 50% to 75% damage (illustrations 3 and 4 in figure 10). 3% of trees had 75% to 100% damage (illustrations 1 and 2 in figure 10)

Table 7. Percentage of dead branches recorded on each of the 75 measured trees.

Location	Quadrat no.	no. of measured trees	% of dead branches			
			0-25	25-50	50-75	75-100
Jabal Samhan	1	10	7	3	0	0
Jabal Samhan	2	10	4	2	2	2
Jabal Qamar	3	10	7	0	2	1
Jabal Qamar	4	10	9	1	0	0
Jabal Qamar	5	10	7	3	0	0
Jabal Qara	6	10	10	0	0	0
Jabal Qara	7	7	1	2	4	0
Jabal Qara	8	8	6	2	0	0
Total		**75**	**51**	**13**	**8**	**3**
Mean			**6.3**	**1.6**	**1**	**0.3**
% of total			**68**	**17.3**	**10.6**	**4**

Taxonomic verification of *D. serrulata* in Oman

This study was undertaken to confirm the presence of *Dracaena serrulata* in Oman. The morphological characterization as outlined below suggests there is a single taxon – *Dracaena serrulata* occurs in Oman. No evidence of an additional *Dracaena* taxon was observed in this study.

Habit and stems

Our results demonstrate that *Dracaena serrulata* is an evergreen tree up to 7 to 8m tall with a single, scaly, silvery-grey, 0.3-2.7 m diameter trunk which repeatedly bifurcates above, forming swollen branches but without forming a well-defined semi-globose crown (EGGLI, 2001). The young stems have a ring-like wood. As the old leaves die and gradually fall of they leave a distinctive leaf scales on the branches giving the tree an overall rough texture (Figure 15 A & B).

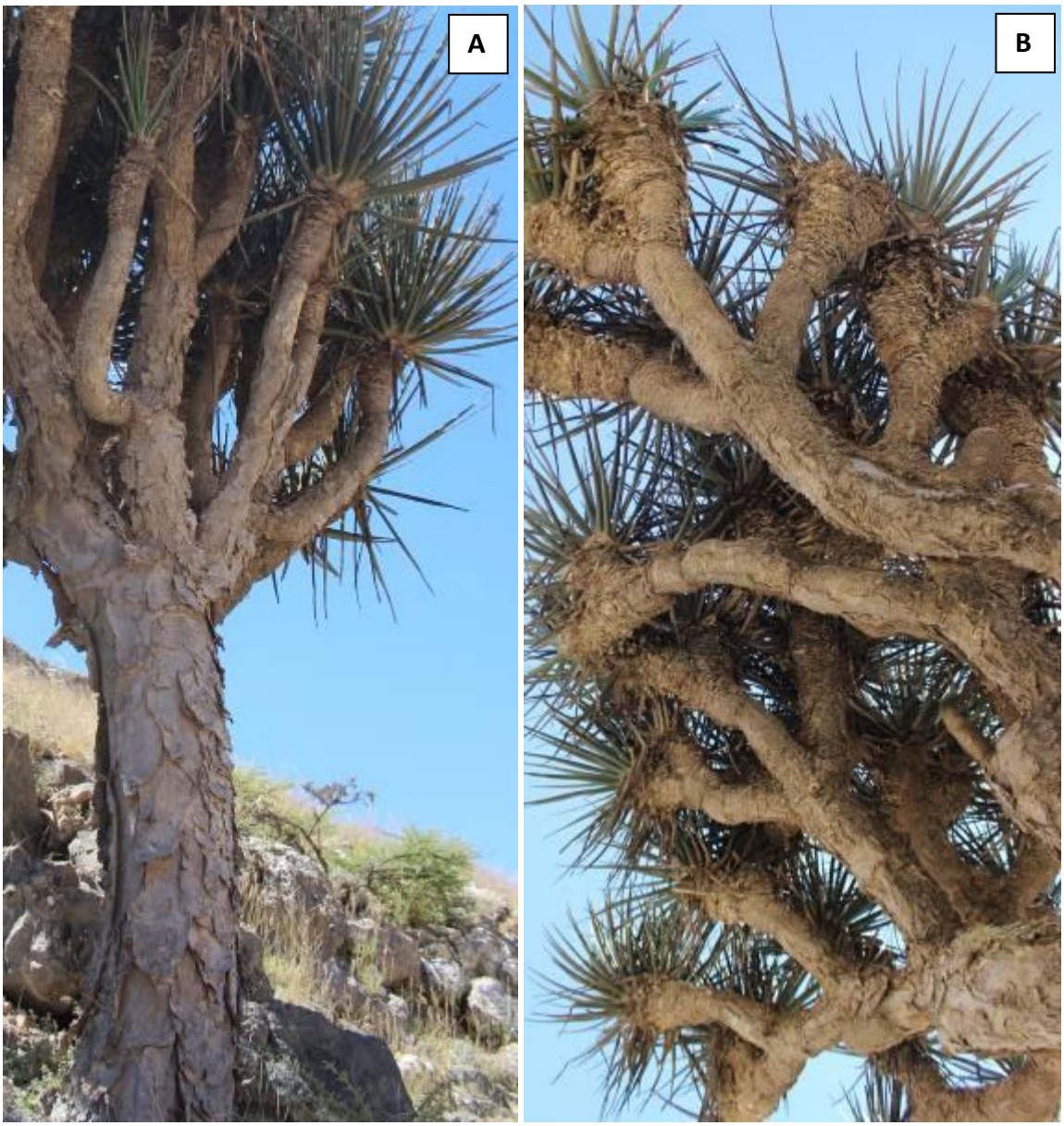


Figure 14. Images A and B show the scaly and ring-like patterns of the stems of *D. serrulata*

Leaf arrangement and morphology

The leaves are densely crowded at the ends of branches, they are sessile and glabrous. They are linear-lanceolate, with an ovate base, 24.5-90cm long × up to 2.7 cm wide, narrowing gradually to the acute tip. Leaves are thick and rigid, flat above to convex beneath on the upper side, rounded in the lower part and keeled in the upper part of the back.

Leaf margins

The leaves margins vary from serrulate to entire. The serrulation (Figure 16) gradually disappears towards the tip of the leaf. Serrulation was recorded on all 63 study trees except for six trees from Jabal Al Qamar whose leaves base were damaged and eaten.

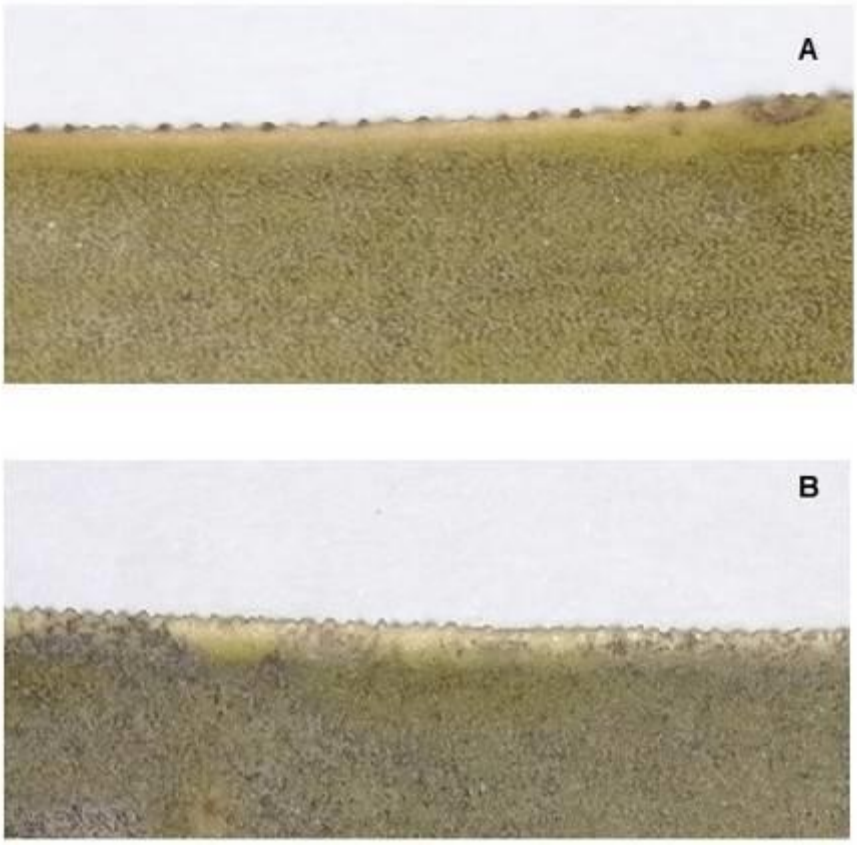


Figure 15. Images A and B show the serrulation pattern on the leaf margins

Leaf colour

The colour of leaves ranged from yellow-green to dark green (Figure 17 A, B & C). A broad spectrum of green colours, representing a continuum of shades between yellow and green was recorded. This was observed within individual trees and between adjacent and distant trees. Changes in leaf colour were attributed to the age of the leaves. Other explanations for variations in leaf colour, such as the effects of soil, exposure, and aspect are probable, however they were not examined in this study.

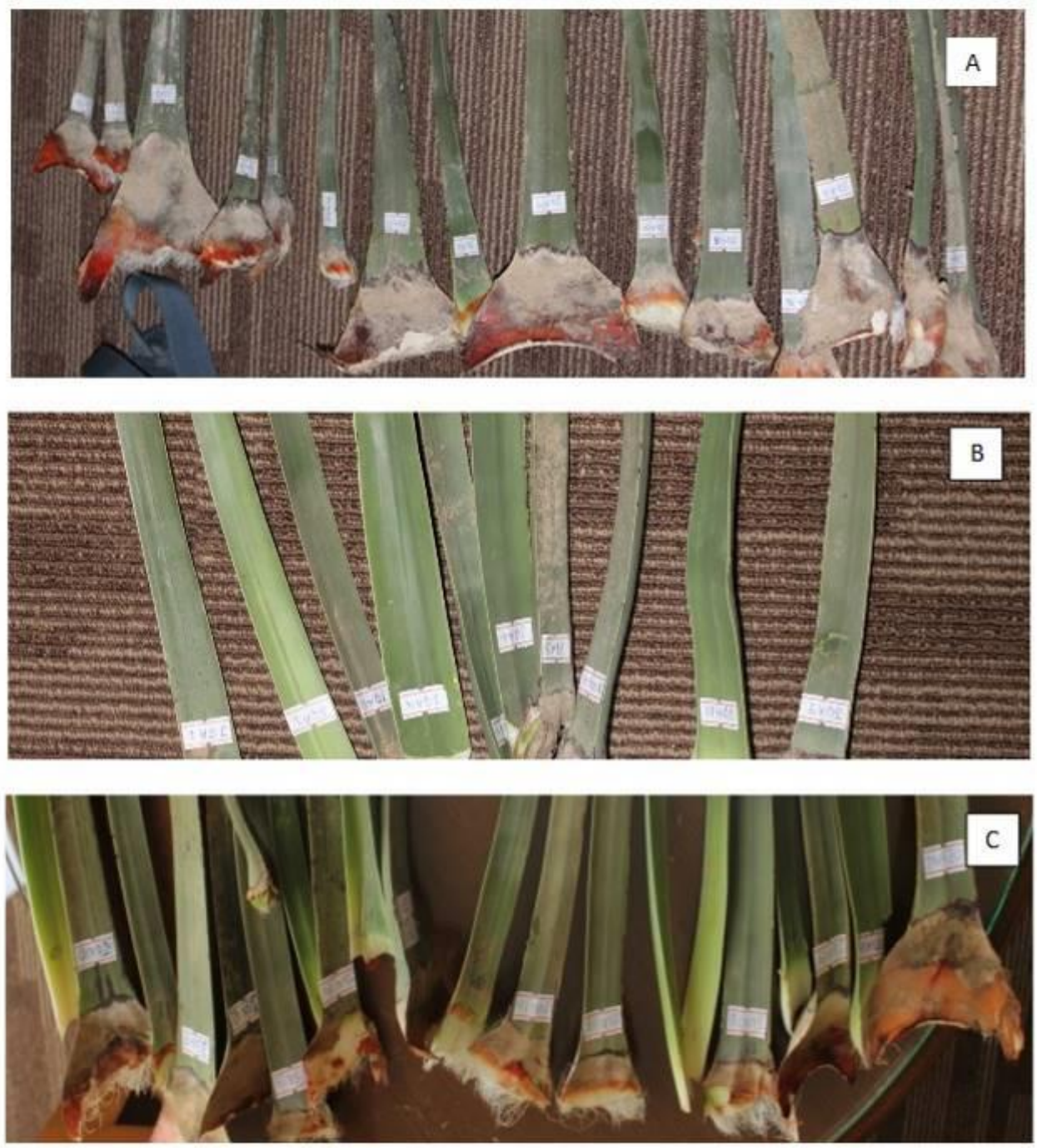


Figure 16. Images A, B, C show the range of of green shades in *D. serrulata* leaves from across the study area.

2.3.1.2 Activity 3: Propagation trials

Methods

Seed germination trials

As no seeds were found during the course of this study, germination trials were carried out on seeds stored in the Oman Botanic Garden seed bank. Two seed accessions were used in the trials. Both accessions were collected on Jabal Qamar in 2009. Accession 1, was collected in August; accession 2 was collected in December. In total 90 seeds were tested (45 seeds from each accession). Seeds were sown in pots and placed in two growth chambers and on an open propagation bench in Oman Botanic Garden propagation house. The experiment was carried out in the Oman Botanic garden over a period of 3 months (27 June- 27 September 2018). Seeds were sown on compost made up of three layers containing equal parts of peat, sand and perlite. The experimental design is outlined on table 8.

Table 8. Seed germination trials – experimental design and (%) of success (27th June to 27th September 2018)

Treatment	Temperature °C	No. of replicates (seed pots)	No. of seeds / replicate	Total seeds tested	% Successful germination
Treatment 1 - growth chamber	15 [constant]	3	10	30	0
Treatment 2 - growth chamber	25 [constant]	3	10	30	0
Treatment 3 - open bench under in glasshouse	18 (day) - 26 (night)	3	10	30	0

Vegetative propagation trials

A total of 22 vegetative shoots were used for this trial, all shoots collected from Jabal Al Qamar in February 2018. Rooting hormone (chryzoplus grey powder 0.1 %) was applied to the samples to help promote root production. The shoots were planted in individual pots according to their size and were planted in two soil media: 1) peat:perlite (1:3) 2) coco-peat:perlite (3:1). These are standard Oman Botanic Garden - vegetative propagation soil mixes. Each pot was placed on a bench in the Oman Botanic Garden propagation glasshouse. The ambient temperature was set at 23°C under natural light conditions – no supplementary light was used. The cuttings remained under observation for 12 months, between February 2018 and February 2019.

Tissue culture trials

Three healthy seedlings around 4 years old were sourced from Oman Botanic garden nursery and used in this trial. Shoot tips of about 2-3 cm long of *D. serrulata* were removed from the seedlings and washed with soap under running tap water for 5 minutes. Thin epidermal layers from the samples were removed and soaked in 100% ethanol for 5 minutes. Another thin outer layer was removed and immersed in 75% ethanol for 20 minutes. The explants were then soaked in 20 % Clorox disinfectant solution and placed on a shaker for 20 minutes then soaked again in 15% Clorox disinfectant for 10 minutes. Finally, the materials were immersed in distilled water for 5 minutes. Five samples were tested in this trial. The explants were then inoculated in the growing media (Badawy *et al*; 2005) placed in petri-dishes and then incubated at 24 °C under 16 hrs light/8 hrs. darkness. Relative humidity was maintained at 40%.

Results

Seed germination trials

No seed germinated during the course of this experiment. The experiment was stopped after 3 months as the seed showed no evidence of physical change. Possible reasons for no germination may be related to one or a combination of factors, including: age of the seed (>9years old), collection location, seed sowing date or seed storage conditions. All of these factors can influence seed viability.

Vegetative propagation trials

No rooting was observed after 12 months. Vegetative propagation of *D. serrulata* was unsuccessful.

Tissue culture trials

Tissue culture trials proved unsuccessful. The dishes became contaminated with a bacterial infection which ended the experiment. The sample size for this trial was small and probably not sufficient to fully test the potential of tissue culture as a means of propagation for *D. serrulata.* Future trials would require a bigger sample size and a broader range of in-vitro growing media.

2.3.2 Objective 2: Documenting traditional knowledge, practices and perceptions

2.3.2.1 Activity 1: Introduce the project to local communities

Methods

Local perceptions on *D. serrulata*

The team first identified a series of villages within the boundaries of the *D. serrulata* distribution. The team contacted the office of the Governor of Dhofar in order to introduce the project to the local Walis and Sheikhs. This was an essential step in order to secure the participation of local people and communities in the project survey.

Meetings were conducted using a number of interview techniques, including: presentations about the tree and the purpose of the project, and audio and video recording. If permitted each interviewee was photographed. In general, meetings involved lengthy periods of formal and informal discussions with the local leaders. All elements and expected outcomes from the project were explained in full. Three topics were raised and discussed with the interviewees, including 1) the overall status of the vegetation on Dhofar Mountains; 2) the decline and die back of the Arabian Dragon Tree; 3) the perceived threats which facing the local vegetation, *D. serrulata* in particular. Results from the interviews were tabulated (table 9) and saved in the project folder. Audio and video recordings were archived and stored on the project's external hard drive.

Figure 17. Project team meeting with the local authority managers and sheikhs from the villages.

Figure 18. Meeting with local women during one of the school visits.

Results

Local perceptions on *D. serrulata.*

The approval process took longer than anticipated – a lot of official steps, including letters of approval were required, which delayed the project by 3 months. In general the reaction of the local people was very positive; most people were willing to participate and keen to share their knowledge and awareness. People were aware of the species and had a good sense of its perceived decline. Table (9) summarizes the response by the local interviewees

Table 9. The general perceptions of local people towards the dragon blood trees

Location	No. of interviewees	Name of interviewee	General perceptions of interviewees
Jabal Qara (Titam)	16	Name of Interviewees were not recorded upon their request	The interviewees summarized the main reasons for the decline of *D. serrulata* as 'Local herders claim that the fodder supplied by the government causes the camels to hallucinate, which causes them to graze on plants in a random and haphazard way, different from their normal grazing habits. In these situations camels start to eat the trunk and crown of *D. serrulata*, which are less nutritious and often result in the plant dying'. Locals understand the impact of the decline of the tree and showed willingness to help to reduce the effect of over grazing on the overall vegetation.
Jabal Qara (Titam)	1	Bakhet bin Salim bin Bakhet Merqa Al Katheri	This interviewees opinion was that "The main purpose for the trees death is the attack by an insect (a beetle) which penetrates the tree (the same problem has been recorded on fig trees in the surrounding areas His feeling was that camels or drought have had no effect *D. serrulata* trees..
Jabal Samhan (Tawi Atair)	1	Mohammed bin Suhail bin Ahmed Hajran Al Amri	"The tree death is due to overgrazing by camels and drought due to overexploitation of water in an area where many water wells have been excavated".
Jabal Qamar (Shehib saib)	8	Name of Interviewees were not recorded upon their request	The interviewees agreed that the tree is suffering because of overgrazing. They also mentioned some uses which include the use of resin as cosmetic on the face and on gum and teeth when one has infection.

2.3.2.2 Activity 2: Interview local experts, document their knowledge relating to the traditional uses of *D. serrulata*

Methods

Documenting contemporary uses of *D. serrulata* in southern Oman

Before commencing interviews and data collection a series of site visits and meetings with village sheikhs and elders had to be arranged. This was very time consuming as it involved a considerable amount of time to arrange meetings – very often meetings were cancelled at the last minute or people did not show up. When meetings did occur, the projects aims and objectives were explained in full – we were very conscious of ensuring everyone fully understood our intentions and were comfortable with answering questions and or being recorded on audio or video – in many cases people did not want to be recorded, photographed or have their names used.

In the end two local leaders were interviewed, one from Titam on Jabal Qara and one from Tawi Atair on Jabal Samhan. Interviews were informal, no questionnaire was used as this seemed to make people uncomfortable. Results from the interviews were tabulated (table 10) and saved in the project folder. Audio and video recording were archived and stored on the project's external hard drive.

Results

Documenting contemporary uses of *D. serrulata* in southern Oman

Table 10. Summary of comments regarding *D. serrulata* in the Dhofar Mountains from two interviewees.

Location	Name of interviewee	Age	Comments
Jabal Qara (Titam)	Bakhet bin Salim bin Bakhet Merqa Al Katheri	50	*Dracaena serrulata* [Jibali: *Ayrib*] is used for making ropes. The leaves are removed and kept in rain fed water ponds for a period of 3 months (mainly during the monsoon season, June - September). The softened fibres are woven in to ropes by local women [Arabic: *hebal*]. The process of making ropes is still practiced in Al Mahra region at the boundaries with Yemen. The ropes [Arabic & Dhofari: shdad] are used to tie up the breasts of female camels to prevent their calves from drinking too much milk. The ropes are also used as a harness to help people [Arabic: asalin] climb cliffs in search of wild honey. The wood of *D. serrulata* is considered of low quality. The fibrous nature of the heart wood means it is not useful as firewood or as a building material.
Jabal Samhan (Tawi Atair)	Mohammed bin Suhail bin Ahmed Hajran Al Amri	53	*Dracaena serrulata* flowers are a well-known source for high quality honey. The honey is valued by locals and is very costly due to the rare and intermittent nature of flowering in the species. Following the same process as on Jabal Qara the leaf fibres are also used to make ropes on Jabal Samhan. The ropes are used to tie up bundles of goods for transport to and from the market - it makes a very secure harness. During dry season [Arabic: *jafaf* or *mahil*], herders give the stiff leaves to their livestock as a source of water. Because *D. serrulata* occupies the drier slopes its reasonably broad canopy provides valuable shade to locals and livestock during the hot parts of the day. The tree had no known medicinal uses in the Dhofar area.

Figure 19. Saif and Abdulrahman during one of the interviews with a local person to ask about the ethnobotanical uses of *D. serrulata*

Figure 20. Abdulrahman during one of the interviews with a local person to ask about the ethnobotanical uses of *D. serrulata*

Figure 21. Image showing rope made from *D. serrulata* and red coloured resin produced by the Dragon Blood Tree

2.3.3 Objective 3: Strengthen the capacity of key stakeholders through active participation in the project field work.

2.3.3.1 Activity 1: Empower local communities and stakeholders in practical conservation techniques.

Methods

Communication and inclusion of local stakeholders

Stakeholders were identified and invited to participate in the population-census fieldwork, which was carried out in January 2018. They were trained in field work techniques following the methodology set out in objective one. The techniques included, field observations, selecting quadrats, taking measurements from individual trees, recording data on datasheet, photographing trees, geo-referencing and team-work.

Results

Communication and inclusion of local stakeholders

Table 11 lists the stakeholders who participated in the 2018 fieldwork and includes their capacity building activities and contributions to the project.

Table 11. A list of all stakeholders and their project activities

Project Partners & Collaborators	Number of participants	Capacity building activities
The Anglo-Omani Society (AOS)	15	Designing, planning and undertaking a tree distribution survey How to identify plants Data collection and interpretation
Office of Conservation & Environment (OCE) - Dhofar Governate	3	Designing, planning and undertaking a tree distribution survey How to identify plants Establishing Long term monitoring plan Data collection and interpretation
General Directorate of Environment & Climate Affairs in Dhofar Province (MECA)	3	Designing, planning and undertaking a tree distribution survey How to identify plants Establishing Long term monitoring plan Data collection and interpretation
Oman Botanic Garden (OBG)	13	Designing, planning and undertaking a tree distribution survey Constructing GIS maps Data collection and interpretation Establishing Long term monitoring plan IUCN Red List assessment workshop Report writing Project management

2.3.3.2 Activity 2: Promote public awareness about the conservation challenges facing *D. serrulata* in Oman

Methods

Identifying local schools and establishing awareness programmes

At the beginning of the project, the team started to search for schools within or close to the study areas. 10 schools were identified as focus points for our public awareness initiative. The schools were selected to cover a range of age groups from 6-16 years old.

In order to ensure schools' participation in our survey permission from the Directorate of Education (DoE) in Dhofar had to be given and sent to selected schools. A letter was sent from Oman Botanic Garden to the DoE of Dhofar listing the schools we identified. The granting of permission took four months. In November and December, 2018, school visits and associated activities took place.

Results

Identifying local schools and establishing awareness programmes

The activities included presentations and workshop in the field to show students how a botanical conservation survey is designed, planned and undertaken. . It was emphasised that the methodology was a standard survey style and could be applied for other tree species in the area. Some students were more familiar with the tree especially those who herd their animals for pasturing.

Students appeared to well aware of the environmental threats to the vegetation in general - grazing and mining activities were mentioned as a conservation threat by many of the students. Some students noted dieback of trees because of camels eating the outer layer of bark. WE notice that the students became much more interested in the species conservation when they understood how significant the tree is to Oman's natural history. During the site visit, students were passionate and enthusiastic about the field work; each one wanted to participate. Table 12 and 13 lists the schools which were selected during the project and the different educational materials distributed with the number of students. One of the very encouraging outcomes was the establishment of an initiative which aims to raise awareness towards conservation of plants and animals on Jabal Samhan. "Twi A' tair school for girls" set up an Instagram account and started a group called 'Nawader Samhan' at the school. This group aims to raise awareness not only within the school's boundaries but also in the surrounding villages. This was really very pleasing to see and is perhaps one the highlights of the project.

Figure 22. The Instagram page of the initiative “Nawader Samhan” by one of the schools in the study area

Table 12. The selected schools in each mountain with numbers of students who participated in the project team visits

Location	School	Grade	Number of students
Jabal Samhan	Twi A'tair for boys	5 to 12	348
	Twi A' tair for girls	1 to 12	312
	Yoor for basic education	1 to 4	55
Jabal Qara	Tetam for boys	5 to 12	124
	Tetam for girls	1 to 12	198
Jabal Qamar mountain	Shahib S'aib for boys	5 to 12	191
	Shahib S'aib for girls	1 to 12	??
	Agdaroot for boys	5 to 12	133
	Agraroot for girls	1 to 12	240
Total	**9 schools**		**1,601 students**

Table 13. Educational materials and number of student participants in the public awareness initiative 2018.

Location	School	no. of posters produced per school	no. of student participants	no. of booklets	no. of students on site visits
Jabal Samhan	Twi A'tair for boys	2	50	NA	NA
	Twi A' tair for girls	2	50	50	NA
	Yoor for basic education	2	50	50	NA
Jabal Qara	Tetam for boys	2	50	NA	20
	Tetam for girls	2	50	50	NA
Jabal Qamar	Shahib S'aib for boys	2	50	NA	NA
	Shahib S'aib for girls	2	50	50	NA
	Agdaroot for boys	2	50	NA	NA
	Agraroot for girls	2	50	50	NA
Total		**18**	**450**	**250**	**20**

Figure 23. Students on Jabal Samhan and Jabal Qamar (left and bottom respectively) hanging up the project poster on their school notice board. October, 2018

Figure 24. Team member, Mohammed Al Saidi presenting the project details to school children, September, 2018

Figure 25. Team member, Mohammed Al Saidi presenting the project details to school children, September, 2018.

2.3.3.3 Activity 3: Establish a protocol for the establishment of a long-term monitoring programme

Methods

Tree long-term monitoring

Three long-term monitoring plots were established in 2018 (see table 4 for location details). The data recorded in 2018 established a baseline from which changes in the health status and demographics will be monitored. The project team will liaise with stakeholders (Table 15) to raise support for the initiative. The team will seek financial support to undertake annual monitoring of the three sites for a period of 10 years, from 2020 to 2030, using the monitoring process to train key stakeholders in long-term monitoring activities. The assessment criteria for future monitoring will follow the parameters listed in (Table 14).

Table 14. Long-term monitoring assessment criteria.

Assessment	Measurement parameters
Population changes	Density per 0.25ha^2
	Frequency per 0.25ha^2
Demographic changes	Height
	DBH
	No. of rosettes
	No. of branches
Flowering	Phenology
	Total flowers per tree
Fruiting	Phenology
	Total fruit per tree
	Germination rate of harvested seed
Recruitment	No. of seedlings / juvenile trees
Mortality	No. of dead trees
	% of damaged branches
Vegetation dynamics	Changes in associated vegetation
Plant interactions	Grazing
	Pests
	Pollinators
	Predators

Table 15. Establishment of long-term monitoring plots – proposed stakeholders and establishment activities

Steps	Activities	Stakeholders & monitoring status
1	Identify key stakeholders	Oman Botanic Garden (OBG)
		Ministry for Environment and Climate affairs (MECA)
		Office for the Conservation of the Environment (OCE)
2	Secure government and community support	Ministry for Environment and Climate affairs (MECA)
		Office for the Conservation of the Environment (OCE)
		Local community leaders in Dhofar
3	Secure financial support	On-going
4	Establish fixed monitoring sites	3 x 0.25ha^2 sites established in 2018
5	Gather baseline demographic and environmental data for long-term monitoring	Completed in 2018
6	Gather photographic details of study sites and individual trees	Completed in 2019
7	Establish monitoring protocol	Completed in 2019
8	Establish monitoring timeline and frequency	Timeline 2020 - 2030
		Monitoring frequency - once per year

2.3.4 Objective 4: Produce a range of educational materials for local schools, colleges and community groups to highlight and promote the conservation requirements of *D. serrulata* in Oman

A range of educational materials were produced and used to highlight the conservation requirements of Dragon Blood Tree in Oman. These materials included:

- **A poster**
  The poster contained information on the tree, its habitats, uses, threats and how can people contribute in conserving it. The language used was simple and direct (Figure 26).

- **7 pages Story and colour booklet**
  The story script and illustrations were done by the team members. The story was written in English and Arabic. It highlights the threats which face the tree and how important it is to save those trees. The booklets were distributed to students of grades 1-4 (Figure 27).

- **Caps and notebooks**
  The caps were produced given to students and stakeholders to promote the project. The notebooks were given to students as incentive to those who answered our questions correctly during the visits (Figure 28).

- **Project Logo**
  The project logo was designed to represent the *Dracaena serrulata* in Oman and the different rosettes represent stakeholders and partners who can conserve the tree and its habitat. The logo was used in all educational material as an identity of the project and any future related projects (Figure 29).

- **Documentary Film**
  A documentary ten minutes film was produced with an emphasis on the Dragon's Blood Tree distribution, habitats, threats and conservation values. It also includes interview with a local who explains about the cultural and social importance of the tree and its uses. The film will be on the project's social media accounts (Twitter, Instagram, YouTube). The film is in Arabic with English subtitle (found in ibackup).

Figure 26. *D. serrulata* conservation project's poster, created in October, 2018.

Figure 27. The story and colour booklet front and back cover (full booklet available in ibackup)

Figure 28. Caps and Notebooks were produced for school students to promote the project.

Conservation of Arabian Dragon Blood Tree in Oman

مشروع صون أشجار
العيريب في عمان

Figure 29. Project logo – designed by the project team

2.4 COMMUNICATION AND APPLICATION OF RESULTS

Information dissemination:

- Regular face to face and remote meetings with project partners.
- Project presentation to the staff at Oman Botanic Garden.
- Keeping our social media accounts on Twitter and Instagram up-to-date
- Articles outlining the projects aims and objectives published in 3 local newspapers in Arabic.
- Radio interview was taken on a local radio channel (Hala FM)
- Final report to be distributed to the stakeholders.
- A seminar on the project's aims and outcomes was carried out in November 2019, and the documentary film was shown on this date. Around 75 people attended the seminar and it was very well received.
- At least 3 scientific publications to be published in a peer reviewed journal.

Application of results through the following:

- Presenting at international conferences.
- Developing collaboration with other *Dracaena* researchers.
- Built trust and relationships with local communities, integral to future conservation measures.
- Formed good working relationship with local schools and teachers and will continue to develop this in the future.
- The information on conservation issues were not understood fully, this project shed lights on the importance of including conservation as a main topic in the school curriculum. This has been discussed with school principals and teachers. Further actions need to be taken by higher level authorities.
- Lack of well-trained people in plant conservation was highlighted in the project. Capacity building is required in order to strengthen the ability of local policy makers to deal with conservation issues.

2.5 MONITORING AND EVALUATION

Table 16 summarises the monitoring and evaluation activities that were carried out to assess the effectiveness of the project's activities. Table 16. **Monitoring and Evaluation Activities**

	Overarching Project Activities	**Effectiveness Evaluation Activity Outcomes**
1	Geo-reference and map c. 75% of mature trees	Tree survey completed in January 2018. Detailed maps were completed and evaluated in August 2018.
2	Gather and analyse demographic and ecological data	Data collection was completed in February 2018. Data analysis was carried out between July – November 2018.
3	Conduct propagation trials	Propagation trials were carried out between June and September 2018. Germination was monitored each week during this period.
4	Introduce the project to local communities	Three repeat visits to each school were carried out. Visit 1- Introduction and project background. Visit 2- Poster presentations and follow up. Visit 3 – Student site visit and evaluation of student and teacher understanding.
5	Interview local experts, document their knowledge	Local experts were visited twice during the project. Visit 1 – Introduction and project background. Visit 2 – Interviews – data collection and recording
6	Empower local communities and stakeholders in practical conservation techniques.	Multiple visits were conducted to XXX villages
7	Promote public awareness about the conservation challenges	Local schools and village leaders learned a lot from our discussions and presentations.
8	Establish a protocol for the establishment of a long-term monitoring programme	3 permanent plots were established in January 2018. A long term monitoring protocol was designed in February 2019 – no follow up monitoring has taken place to date.

2.6 ACHIEVEMENTS AND IMPACTS

The project set out to assess the conservation status of *Dracaena serrulata* in Oman using a range of activities and methods. The population census carried in January 2018 counted, geo-referenced and mapped a total of 43,683 trees, including mature, juvenile and standing dead individuals. The census data were used to undertake a review of the 1996 IUCN national Red List assessment. The project reconfirmed the threat status of *D. serrulata* in Oman as Endangered (EN). Demographic information – age, health, status and reproductive potential data were collected from 8 x 0.25ha^2 plots from across the species range in the Dhofar Mountains. Associated vegetation and environmental characteristics - altitude, slope and aspect were collected. These are the first quantitative census, demographic and habitat data for *D. serrulata* in Oman and provide a solid baseline from which all future conservation monitoring can be based.

The reproductive potential for *D. serrulata* was assessed – the presence of flowers and fruits was recorded within and outside of the study plots. No flowers or fruits were recorded in 2018. Seed germination trials were carried out using seed collected by Oman Botanic Garden in 2009. Despite multiple germination trials no germination was recorded. The lack of germination might be related to the age of the seed and possible loss in viability over time. It is recommended that germination trials should be carried out on freshly collected seed – Oman Botanic Garden staff have agreed to assist with this should the opportunity arise in the future.

A morphometric assessment of the taxonomy of *D. serrulata* was undertaken to verify the validity of this species in Oman. 63 individual trees from across the species range were collected and analysed. The key morphological feature – serrulated leaf margins was observed in all 63 specimens. Serrulated margins, leaf shape and colour are consistent with descriptions of *D. serrulata* in the literature. Our results suggest that the genus *Dracaena* is represented by a single taxon, *D. serrulata* in Oman.

The team met with local village elders who were very happy to share their knowledge relating to the traditional uses of *D. serrulata* in southern of Oman. The team acquired traditional products made from *D. serrulata* fibres, including, excellent examples of ropes (figure 22). In addition, intangible materials, such poetry and songs relating to *D. serrulata* were collected and archived. Artefacts, people, songs and poetry were recorded and written, audio and video formats represent a significant contribution to the conservation of ethnobotanical knowledge in southern Oman.

Relevant team members visited 9 schools and presented to the students, parents and teachers. These presentations received great support and cooperation from the audiences. Many of the people attending the presentations did not know about the tree or the threats facing its future. In general the schools were very happy to receive the team and have them present to the

students and parents. It was an unusual experience for many of the schools and teachers but one they very much welcomed.

The team organized a seminar to stakeholders and interested people and presented the projects aims and outcomes as well as the documentary film. The event was attended by 75 people and it was an excellent networking event.

To our knowledge this project represented the first native tree assessment in Oman involving multiple stakeholders. It provided an excellent opportunity for communication, knowledge sharing practical conservation. We are hopeful that it set a precedent for future interdisciplinary conservation initiatives in Oman.

2.7 CAPACITY DEVELOPMENT AND LEADERSHIP CAPABILITIES

1. **Ghudaina:** Developed project management and leadership skills though coordinating the team to complete the activities and document the results. Ghudaina learned a lot about communication and information dissemination, building team morale and setting goals and objectives.

2. **Abdulrahman:** Developed project management and leadership skills. Learnt a lot about communicating with stakeholders. The project allowed him to gain confidence in project management, time keeping, setting goals and objectives and people management.

3. **Saif:** Learned a lot about managing large groups of people in the field. He gained new experiences in field taxonomy and biological sampling. This project advanced his ethnobotanical knowledge of Dhofar and introduced him to helpful community leaders.

4. **Khadija:** Developed mapping skills using ArcMap and GIS software. Khadija built up links with the Oman National Survey Authority (NSA) and received training from their mapping team. She also developed skills in data analysis and interpretation.

5. **Hanan:** Developed her research skills in the lab by learning new technique in tissue culture. Advanced her interpersonal skills by the discussion with different members of the team.

6. **Zawan**: The project advanced her taxonomic skills by allowing her to complete a thorough taxonomic review of a single taxon, where she combined field and laboratory skills and learned to use data analysis software.

7. **Salha & Mohammed:** The project developed their communication skills and taught them how to plan and deliver education programs to school students in rural areas.

They also established several useful relationships with teachers and government people in Dhofar, which will be of benefit to them in the environmental education careers.

SECTION 3

3.1 CONCLUSION

This project is the first of its kind to carry out a detailed population census and habitat description of *Dracaena serrulata* in Oman. Project data and observations confirm *D. serrulata* as an IUCN – Endangered species. Our results, observations and information provided by local people suggest that, habitat loss and associated population fragmentation, potential impacts from predicted climate change scenarios and over-grazing all threaten the existence of *D. serrulata* in Southern Oman. Populations on Jabal Samhan appear to be most at risk from climate change – trees are confined to the steep, inaccessible slopes of the high altitude cliffs. Jabal Samhan is located at the extreme fringes of the summer monsoon (khareef, see figure 2). The area receives relatively moderate but crucial amounts of fog moisture during the summer season. Any reduction in the extent of the summer monsoon is likely to have a catastrophic impact on the trees on Jabal Samhan.

Equal to the negative impacts of climate change and habitat loss is the lack of conservation awareness and action within the project stakeholders, in particular local government agencies. The need for urgent capacity building within the responsible bodies is critical to promoting conservation for this species and other threatened taxa in the area. Local communities and NGOs (Environmental Society of Oman) showed a deeper understanding of the conservation concerns and requirements and were keen to assist in future conservation initiatives. Building on this is essential.

The project has provided new information, highlighted conservation concerns and raised awareness with regards to *D. serrulata* in Oman. The process provided a unique opportunity for the project team to plan and undertake a challenging conservation project and therefore has been of huge benefit to the team and conservation in Oman

3.2 PROBLEMS ENCOUNTERED AND LESSONS LEARNED

3.2.1 Which project activities and outcomes went well and why?

- The population census – the involvement of the AOS team allowed our team to cover a lot of ground, this made completing the field work very manageable.

- Our well planned and thoroughly prepared field survey methods allowed us to undertake a rigorous survey – maximising our time in the field.

- Good communication and regular meetings between our core project team was very successful and proved invaluable to our success to date.

- Our ethnobotany team excelled in their efforts to meet local people, gather traditional data and document a wide range of historic and contemporary associations and connections between local people and *D. serrulata.*

- Collecting and processing plant voucher specimens for taxonomic verification went very well. The methodology and field work was well planned out and executed.

- Training young stakeholders on the techniques of recording field data and making herbarium vouchers went very well. We had positive feedback from all of those people involved.

- The project team learned new skills and received training in various project management aspects. As this project was our first externally funded project and the team has little experience in conservation projects of this nature. We now have a much better understanding of the standards required to undertake such projects. The team have grown in confidence and ability since starting the project and continue to develop as the project enters its final phase.

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

Problem: The project team failed to collect seed from plants across the species range in southern Oman. No flowers were recorded in 2018. The propagation trials using vegetative material were unsuccessful. The germination trials using seeds obtained from Oman Botanic Garden seed bank also failed and no germination was reported.

Solution: It is the team's intention to continue to search for seed in the future – beyond the timeframe of this project.

Problem: The team could not video record the interviews with local experts due to busy schedule of the team photographer.

Solution: The team has recently recruited a photographer and videographer - they will be involved in the film making process for the rest of the project.

Problem: Not all of the initial stakeholders listed in the project proposal were able to participate in the population census work. This was largely due to a clash of commitments and time constraints. In spite of the lack of direct input by some stakeholders, all parties have been kept updated on the progress and remain committed to the success of our efforts.

Solution: Despite the lack of direct communication or active participation of some of the stakeholders it is the intention of the project team to keep all stakeholders informed and updated regarding the project's progress and outcomes.

3.2.3 Project methodologies and conservation tools

Table 17 describes the assessment of the project methodologies.

Table 17. Assessment of Project methodologies

Objectives	Method	Method assessment
1:To assess the conservation status of *D. serrulata* in Southern Oman by collecting and analyzing data on plant distribution, population demographics, habitat description, associated vegetation, plant reproductive capacity and produce a GIS-based map for at least 75% of *Dracaena* in southern Oman	Conduct field trips to all *D. serrulata* sites - geo-reference and map ≥ 75% of mature trees	Access to difficult sites was a limiting factor, however the team are happy that >70% of the distribution was covered.
	Gather demographic and vegetation-ecological data in all locations of *D. serrulata* in southern Oman	Establishing > 8 survey plots, however, time constraints meant this was not possible.
	Harvest and sow seed of *D. serrulata* at Oman Botanic Garden. Store seed in the Oman Botanic Seed bank	No flowers or fruits were recorded during the project field work. This was unfortunate and impacted the germination trials.
	Analyse field data, produce GIS-maps and complete final project report	The team produced informative distribution and population size maps. However we would have benefited from more expertise in GIS mapping.
2: Document and preserve traditional knowledge, practices and perceptions towards *D.serrulata*.	Introduce the project to local communities – develop an understanding of their perspectives and attitudes toward *D. serrulata* conservation.	This involved many meetings. It was very informal and took a long time. The informal approach was the right approach - it helped build up trust with the local communities.
	Carry out semi structured interviews and questionnaires with local people.	This standard technique worked very well.
	Record audio and video interviews with local people	In most instances people responded well to being photographed, filmed and recorded. Explaining the aim of the project and the outcomes was essential to gaining trust.
3:To strengthen the capacity of relevant stakeholders through participation in the project, training in conservation assessments, project management, report writing and establishing a long-term monitoring programme	Conduct workshops and meetings with local communities and stakeholders	Communication was key to this activity. It involved many meetings and clear descriptions of the project.
	Provide basic field work training for stakeholders	Stakeholders were approached and asked to join us in the field work in 2018. Unfortunately, despite the focused efforts many of the stakeholders showed only a slight interest in the project.
	Establish a protocol of the establishment of a long-term monitoring programme	This was carried out using standard long term monitoring protocols - thus far the monitoring program is on schedule
4:Produce a range of educational material for local schools, colleges and community groups to highlight and promote the conservation requirements of *D. serrulata* in southern Oman	Design and print posters for distribution in local schools and colleges. Provide seed or seedlings of *D. serrulata* for school gardens in the Dhofar region	Posters and booklets were designed and printed by the project team and distributed to local schools. This was very successful and was well received by the students and teachers.
	In conjunction with the ESO develop an outreach program to raise public awareness and promote conservation of this flagship species	

	Promote the project through the media – utilise social media outlets as a tool for highlighting conservation concerns and actions

3.2.4 Lessons learnt

- The project team were not aware of Oman's rules and regulations regarding cooperation with international organization which led to project postponed for more than 6 months until get permission. This was a challenging lesson for us but we have taken it on board and will avoid such obstacles on all future projects of this nature.

- Propagating *D. serrulata* through vegetative means was not possible. Propagation by seed is probably possible but it likely that freshly collected seeds are required.

- The involvement of stakeholders was not as expected, and lack of ownership to the project was observed. Initiating communication through meetings and direct involvement is crucial.

- Formalities hinder the progress and the involvement of schools and local community has to happen through the public authorities. We did not include the letters and the waiting time into the timeframe of the project. This took around 4 months which we did not expect and hence, requested a project extension.

- Interviews should take place throughout the year, because our interviews took place during the monsoon season and less people were available, as the locals tend to travel during the monsoon season.

3.2.5 Recommendations for the enhancement or modifications to the project activities and outcomes

Table 18 Recommended enhancement of project activities

	Overarching Project Activities	**Enhancement of Activities**
1	Geo-reference and map c. 75% of mature trees	Use a drone to photograph difficult to access areas. Model the predicted current and future distribution of *D. serrulata* using climate and geographic data.
2	Gather and analyse demographic and ecological data	Increase the number of survey quadrats.
3	Conduct propagation trials	Repeat the germination trials using freshly collected seed. The team will undertake this in the future.
4	Introduce the project to local communities	We would not change the approach used. It worked well and was agreeable to all participants.
5	Interview local experts, document their knowledge	We would not change the approach used. It worked well and was agreeable to all participants.
6	Empower local communities and stakeholders in practical conservation techniques.	Allocate more time to meeting and discussing the issues with the relevant government bodies.
7	Promote public awareness about the conservation challenges	Targeting more schools, colleges and community groups is of great importance.
8	Establish a protocol for the establishment of a long-term monitoring programme	Nothing would change in the methods. However, we would like to encourage the participation of local people and government bodies in this endeavour. We would like to organize a workshop to produce a tree monitoring programme with the contribution of all parties

3.3 IN THE FUTURE

Communication of the results and the concerns raised in the research are paramount. We will work to arranging a workshop or workshops with the Ministry of Environment and the Office for the Conservation of the Environment. It is our intention to strongly convey our concerns regarding the environmental and administrative threats facing *Dracaena serrulata* in Oman.

The project team, representing Oman Botanic Garden intend to establish themselves as focal point for tree conservation in Oman. We feel we have the skill and knowledge to push for in-situ and ex-situ conservation programs for *D. serrulata* and other potentially threatened trees on Oman. We plan and hope to establish links with international agencies, such as the Global Tree Campaign to help us in this endeavour. We will seek support in training and capacity building for the team so that we can proceed at the highest level of expertise. Our intention is to use the skills gained during this project to help us become leaders in conservation in Oman and the wider region.

Suggested next steps for the conservation of *Draceana serrulata* in Oman:

- Assess the levels and patterns of genetic diversity within and between Oman's populations.
- Establish a genetically representative ex-situ collection at Oman Botanic – including seed and plants.
- Continue with community – conservation work – promote continued interest and awareness.
- Present the projects results to relevant government bodies in Oman – push for a conservation strategy for *D. serrulata*.

3.4 FINANCIAL REPORT

Itemized expenses	Total CLP Requested (USD)*	Total CLP Spent (USD)	% Difference	Details & Justification (Justification must be provided if figure in column D is +/- 25%)	Proposed Spending (Preliminary Report Only)
PHASE I - PROJECT PREPARATION					
Communications (telephone/internet/postage)					
Field guide books, maps, journal articles and other printed materials					
Insurance					
Visas and permits					
Team training					
Reconnaissance					
Other (Phase 1)					
EQUIPMENT					
Scientific/field equipment and supplies	4,290.00	3102.61	-28%		
Photographic equipment	645.00	635.86	-1%		
Camping equipment	630.00		-100%		
Boat/engine/truck (including car hire)					
Other (Equipment)				Spent on extra equipment to be used in taxonomic verification (plant profiling work station)	
PHASE II - IMPLEMENTATION					
Accommodation for team members and local guides	700.00	260.21	-63%		
Food for team members and local guides		436.62			
Travel and local transportation (including fuel)		198.95			
Customs and/or port duties					
Workshops	450	26.18	-94%		
Outreach/Education activities and materials (brochures, posters, video, t-shirts, etc.)	1,100.00	1819.90	65%		
Other (Phase 2)		932.24			
PHASE III - POST-PROJECT EXPENSES					
Administration					
Report production and results dissemination	300.00		-100%		
Other (Phase 3)	300.00		-100%		

Total	**8,415.00**	**7,412.57**			

SECTION 4

APPENDECIES

Appendix 4.1 CLP M & E measures table

Output	Number	Additional Information
Number of CLP Partner Staff involved in mentoring the Project	2	
Number of species assessments contributed to (E.g. IUCN assessments)	1	
Number of site assessments contributed to (E.g. IBA assessments)	0	
Number of NGOs established	0	-However, an initiative by a school was established
Amount of extra funding leveraged ($)	0	
Number of species discovered/rediscovered	0	
Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)	0	
Number of species/sites legally protected for biodiversity	0	
Number of stakeholders actively engaged in species/site conservation management	0	
Number of species/site management plans/strategies developed	1	Long-term monitoring plan
Number of stakeholders reached	30	- This includes 26 individuals from the local community and 4 institutions
Examples of stakeholder behaviour change brought about by the project.	1	- A school from one of the villages within the habitat of *D. serrulata* established an initiative that aims to raise awareness among schools and villages about the plants and environment.

Examples of policy change brought about by the project	0	
Number of jobs created	0	
Number of academic papers published	0	
Number of conferences where project results have been presented	2	- Some of the project members will present the results in 2 conferences, the first is the “International Congress for Conservation Biology” in July 2019 – Malaysia and “Dragon Trees Conference” in September 2019- Czech Republic

Appendix 4.2

Quadrat field data recording sheet used in the January 2018 population survey.

SITE DETAILS **Person recording:**

Site	Quadrat	Date			GPS	Altitude (m)	Aspect	Slope

TREE DETAILS											
Tree	N	E	DBH (cm)	Height (m)	No. of main branches	No. of Rosettes	Crown Width (cm)	No. of fruiting branches	Damage status (0-25-50-75-100)%. (see scale)	Phenology	Class (Adult, Juvenile). (see scale)
1											
2											
3											
4											
5											

PLANT MATERIAL	
Seeds	
Leaves for DNA	
Herbarium	

Notes:

Location codes

Jabal Samhan - SN Jabal Qara - QA Jabal Qamar - QR

Appendix 4.3

The population census recording sheet used in January 2018

***Dracaena serrulata* population census data recording sheet**							
Location	**GPS**		**Total no. of trees**	**No. of Living**	**No. of Dead**	**No. of Juvenile**	**Date**
	N	**E**					

Location codes

Jabal Samhan - SN 1… Jabal Qara - QA 1… Jabal Qamar - QR 1….

*A*ppendix 4.4 Raw data of the quadrats

Site	Quadra	Tree	NDD	Esec	EDD	DBH (cm)	Height (m)	Terminal Branches	Rosette	Crown width (m)	Percentage damage	Class	Altitude (m)	Aspect	Slope	Date	Photo	Photograph	Leaves for DNA	Number of trees	Site_notes	Fruiting branches	Phenology
SN	1	1	17.098806	41.8	54.694944	23	2	36	38	2	0	5	1155	SSE	85	19/01/2018	296	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	2	17.098806	42.1	54.695028	30	2.5	36	40	2.5	0	6	1155	SSE	85	19/01/2018	297	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	3	17.098861	42.6	54.695167	16	1.5	16	10	1	40	4	1155	SSE	85	19/01/2018	298	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	4	17.098972	42.9	54.69525	28	3	76	60	3	35	6	1155	SSE	85	19/01/2018	299	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	5	17.099	43.1	54.695306	27	1.7	15	34	2.8	10	6	1155	SSE	85	19/01/2018	300	ASR	Y	26	Incredibly steep, only top tre	0	Sterile
SN	1	6	17.098972	43.1	54.695317	20	1.5	16	16	1	0	4	1155	SSE	85	19/01/2018	310	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	7	17.098722	42.5	54.695139	12	1.2	3	2	0.5	33	4	1155	SSE	85	19/01/2018	311	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	8	17.098806	41.8	54.694944	15	1	1	1	0.7	0	4	1155	SSE	85	19/01/2018	313	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	9	17.098806	42.1	54.695028	24	2.5	10	11	2.6	8	6	1155	SSE	85	19/01/2018	312	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	1	10	17.098972	42.9	54.69525	12	0.7	1	2	0.4	0	4	1155	SSE	85	19/01/2018	313	ASR	N	26	Incredibly steep, only top tre	0	Sterile
SN	2	1	17.0985	22.5	54.689583	45	4.4	145	82	5.5	43	6	1137	N	NA	19/01/2018	DSC5055	FWP	Y	23	NA	0	Sterile
SN	2	2	17.098139	22.7	54.689639	12	1.6	16	6	1	63	4	1145	NA	NA	19/01/2018	DSC5038	FWP	N	23	NA	0	Sterile
SN	2	3	17.098389	21.2	54.689222	39	4.5	108	53	4.7	82	6	1132	NA	NA	19/01/2018	DSC5058	FWP	Y	23	NA	0	Sterile
SN	2	4	17.098306	21.3	54.68925	14	1.8	14	16	1.8	0	5	1139	NA	NA	19/01/2018	DSC5065	FWP	Y	23	NA	0	Sterile
SN	2	5	17.09825	21	54.689167	17	1.8	8	3	1.2	63	5	1147	NA	NA	19/01/2018	DSC5069	FWP	N	23	NA	0	Sterile
SN	2	6	17.098222	21.5	54.689306	16	1	5	6	0.7	0	4	1162	NA	NA	19/01/2018	DSC5071	FWP	Y	23	NA	0	Sterile
SN	2	7	17.098139	21.3	54.68925	23	3.2	85	32	2	46	5	1166	NA	NA	19/01/2018	DSC5072	FWP	N	23	NA	0	Sterile
SN	2	8	17.098139	20.8	54.689111	16	1.9	9	8	1.1	0	5	1155	NA	NA	19/01/2018	DSC5073	FWP	N	23	NA	0	Sterile
SN	2	9	17.098167	21.7	54.689361	15	1.8	8	12	2.3	0	6	1154	NA	NA	19/01/2018	DSC5078	FWP	Y	23	NA	0	Sterile
SN	2	10	17.098167	22.4	54.689556	22	2.7	44	9	3.1	91	6	1152	NA	NA	19/01/2018	DSC5085	FWP	N	23	NA	0	Sterile
QR1	3	1	16.828778	59.7	53.666583	32	2.5	4	25	3.2	4	6	975	SSW	25	15/01/2018	NA	NA	Y	NA	NA	0	Sterile
QR1	3	2	16.828611	0.3	53.66675	13	2.2	5	18	30	25	6	975	SSW	25	15/01/2018	102-0197	ASR	N	NA	NA	0	Sterile
QR1	3	3	16.828583	59.5	53.666528	14	1.04	5	8	1.9	0	5	975	SSW	25	15/01/2018	4384-4385	FWP	N	NA	NA	0	Sterile
QR1	3	4	16.828642	59.3	53.666478	37	2	3	32	2.2	0	6	975	SSW	25	15/01/2018	4380-4381	FWP	N	NA	NA	0	Sterile
QR1	3	5	16.828694	0.1	53.666694	29	1.9	2	13	2	0	5	975	SSW	25	15/01/2018	102-189	ASR	N	NA	NA	0	Sterile
QR1	3	6	16.82875	0.2	53.666722	24	2	6	9	2.5	0	6	975	SSW	25	15/01/2018	102-0199	ASR	Y	NA	NA	0	Sterile
QR1	3	7	16.828556	59.9	53.666639	70	1.89	1	1	1.3	0	5	975	SSW	25	15/01/2018	4388-4389	FWP	Y	NA	NA	0	Sterile
QR1	3	8	16.828683	0.03	53.666675	22	2.9	1	14	2.8	0	6	975	SSW	25	15/01/2018	102-0202	ASR	N	NA	NA	0	Sterile
QR1	3	9	16.828583	0.1	53.666694	29	3.05	5	23	3	30	6	975	SSW	25	15/01/2018	4390-4391	FWP	Y	NA	NA	0	Sterile
QR1	3	10	16.828694	0.2	53.666722	14	1.7	2	5	1.1	0	5	975	SSW	25	15/01/2018	102-201	ASR	N	NA	NA	0	Sterile
QR	4	1	16.798222	42.3	53.61175	24	2	13	18	2	0	5	860	NNW	50	16/01/2018	NA	NA	Y	35	3 juveniles in quadrat	0	Sterile
QR	4	2	16.798306	42.8	53.611889	28	1.75	20	1	0.3	95	4	860	NNW	50	16/01/2018	NA	NA	Y	35	3 juveniles in quadrat	0	Sterile
QR	4	3	16.798389	41.4	53.6115	30	3	75	48	3	20	6	860	NNW	50	16/01/2018	NA	NA	Y	35	3 juveniles in quadrat	0	Sterile
QR	4	4	16.798122	41.4	53.611497	18	2.5	7	7	2.5	0	6	860	NNW	50	16/01/2018	NA	NA	Y	35	3 juveniles in quadrat	0	Sterile
QR	4	5	16.798064	41.7	53.611586	16	2.5	16	15	2.5	5	6	860	NNW	50	16/01/2018	NA	NA	Y	35	3 juveniles in quadrat	0	Sterile
QR	4	6	16.798	42.1	53.611703	18	2.5	6	6	2	0	5	860	NNW	50	16/01/2018	NA	NA	N	35	3 juveniles in quadrat	0	Sterile
QR	4	7	16.798106	42.3	53.611736	18	1.75	7	7	2	0	5	860	NNW	50	16/01/2018	NA	NA	Y	35	3 juveniles in quadrat	0	Sterile
QR	4	8	16.7981	42.3	53.61175	8	0.7	2	2	1	0	4	860	NNW	50	16/01/2018	NA	NA	N	35	3 juveniles in quadrat	0	Sterile
QR	4	9	16.798231	42.1	53.611689	8	2	39	11	2.5	75	6	860	NNW	50	16/01/2018	NA	NA	N	35	3 juveniles in quadrat	0	Sterile
QR	4	10	16.798417	42.5	53.611806	19	2.5	27	19	2	70	5	860	NNW	50	16/01/2018	NA	NA	N	35	3 juveniles in quadrat	0	Sterile
QR4	5	1	16.792056	17.4	53.604833	15	1.1	8	4	1.1	50	5	955	N	25	16/01/2018	102-214	ASR	Y	39	NA	0	Sterile
QR4	5	2	16.792083	17.3	53.604806	13	2.2	9	21	3.9	0	6	955	N	25	16/01/2018	102-215	ASR	Y	39	NA	0	Sterile
QR4	5	3	16.792028	17.7	53.604917	16	1.9	6	10	2.2	50	6	955	N	25	16/01/2018	102-216	ASR	Y	39	NA	0	Sterile
QR4	5	4	16.792056	17.5	53.604861	19	2.43	5	11	1.8	0	5	955	N	25	16/01/2018	102-218	ASR	Y	39	NA	0	Sterile

Site	Quadra	Tree	NDD	Esec	EDD	DBH (cm)	Height (m)	Terminal Branches	Rosette	Crown width (m)	Percentage damage	Class	Altitude (m)	Aspect	Slope	Date	Photo	Photograph	Leaves for DNA	Number of trees	Site_notes	Fruiting branches	Phenology
QR4	5	5	16.792139	17	53.604722	22	2.2	8	19	3	50	6	955	N	25	16/01/2018	102-219	ASR	Y	39	NA	0	Sterile
QR4	5	6	16.791861	16.3	53.604528	21	2.5	7	23	3.3	0	6	955	N	25	16/01/2018	102-220	ASR	N	39	NA	0	Sterile
QR4	5	7	16.791889	16.5	53.604583	20	2.6	4	14	3.4	0	6	955	N	25	16/01/2018	102-221	ASR	N	39	NA	0	Sterile
QR4	5	8	16.791972	16.6	53.604611	15	0.55	2	4	1.6	0	5	955	N	25	16/01/2018	102-222	ASR	N	39	NA	0	Sterile
QR4	5	9	16.792139	17.5	53.604861	18	1.5	4	5	1.1	0	5	955	N	25	16/01/2018	102-223	ASR	N	39	NA	0	Sterile
QR4	5	10	16.792278	17.9	53.604972	13	1.5	0	2	1.8	0	5	955	N	25	16/01/2018	102-224	ASR	N	39	NA	0	Sterile
QA	6	1	17.017111	40.2	53.761167	21	2.3	19	17	2.5	11	6	1071	NNE	NA	18/01/2018	102-257	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	2	17.017083	40	53.761111	24	2.8	9	12	2.6	0	6	1071	NNE	NA	18/01/2018	102-258	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	3	17.017	39.6	53.761	32	3	41	53	2.7	0	6	1071	NNE	NA	18/01/2018	102-259	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	4	17.017111	40	53.761111	14	1.7	3	13	1.5	0	5	1071	NNE	NA	18/01/2018	102-260	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	5	17.017139	39.8	53.761056	21	2.6	10	13	2.5	0	6	1071	NNE	NA	18/01/2018	102-261	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	6	17.017278	39.4	53.760944	22	2.6	7	12	2.4	0	6	1071	NNE	NA	18/01/2018	102-262	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	7	17.01725	38.7	53.76075	14	1	1	1	1.2	0	5	1071	NNE	NA	18/01/2018	102-263	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	8	17.017278	38.2	53.760611	34	3.5	53	93	4.1	11	6	1071	NNE	NA	18/01/2018	102-264	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	9	17.017361	38.5	53.760694	20	2.6	12	23	3.3	0	6	1071	NNE	NA	18/01/2018	102-265	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	6	10	17.017333	39.3	53.760917	26	3	14	22	2.9	0	6	1071	NNE	NA	18/01/2018	102-266	ASR	NA	58	10 juveniles, 3 dead, hyrax po	0	Sterile
QA	7	1	17.054144	43	53.8286	21	2.5	42	16	3	25	6	1087	SSW	10	17/01/2018	100-8519	NA	Y	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	7	2	17.054069	42	53.828339	29	3	55	47	4.2	60	6	1087	SSW	10	17/01/2018	100-8520	NA	Y	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	7	3	17.053944	43.5	53.82875	19	2.7	18	11	2.1	28	6	1087	SSW	10	17/01/2018	100-8523	NA	Y	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	7	4	17.053975	42.9	53.828589	27	3	39	18	2.7	56	6	1087	SSW	10	17/01/2018	100-8522	NA	N	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	7	5	17.053917	44.2	53.828944	26	2.7	32	15	2.8	59	6	1087	SSW	10	17/01/2018	100-8525	NA	Y	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	7	6	17.054031	43.9	53.82885	18	2.8	14	9	2.9	57	6	1087	SSW	10	17/01/2018	100-8536	NA	N	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	7	7	17.053972	44.4	53.829	21	3.4	40	21	3.7	30	6	1087	SSW	10	17/01/2018	100-8537	NA	Y	13	3 dead, 2 juveniles, Dracaena	0	Sterile
QA	8	1	17.057667	47.4	53.813167	25	2.1	13	21	1.8	NA	5	1064	NW	35	18/01/2018	DSC0958	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	2	17.05775	48.7	53.813528	29	2.2	72	58	3	19	6	1064	NW	35	19/01/2018	DSC0959	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	3	17.057667	47.5	53.813194	17	1.76	4	7	1.5	NA	5	1064	NW	35	20/01/2018	DSC0960	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	4	17.057667	47.5	53.813194	16	1.5	1	1	1.2	NA	5	1064	NW	35	21/01/2018	DSC0961	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	5	17.057889	48.4	53.813444	30	2.4	76	50	3	34	6	1064	NW	35	22/01/2018	DSC0962	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	6	17.057944	47.5	53.813194	27	2.8	133	85	3.4	36	6	1064	NW	35	23/01/2018	DSC0963	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	7	17.058028	48.8	53.813556	25	4	47	42	4.4	11	6	1064	NW	35	24/01/2018	DSC0964	CB	NA	8	13 dead, degrading extensive	0	Sterile
QA	8	8	17.057833	49.3	53.813694	20	1.9	21	25	2.3	NA	6	1064	NW	35	25/01/2018	DSC0965	CB	NA	8	13 dead, degrading extensive	0	Sterile

Appendix 4.5 Population census raw data

Location	NDD	EDD	Living	Dead	Juv	Date	Altitude m	Aspect	Notes	Jabal
C1P1	16.86786	53.716861	653	2	0	17/01/2018				Jabal Qamar
C1P2	16.86328	53.716667	940	N/A	N/A	17/01/2018			Hard to spot juveniles and dead at this distance	Jabal Qamar
QR2P1	16.86814	53.724667	180	N/A	N/A	15/01/2018		N	Mostly N aspect, Living>	Jabal Qamar
QR2P2	16.86989	53.729694	62	1	5	15/01/2018		N	Mostly N aspect	Jabal Qamar
QR2P3	16.86758	53.732972	66	N/A	2	15/01/2018		N	Mostly N aspect	Jabal Qamar
QR2P4	16.86801	53.739014	18	1	1	15/01/2018		N	Mostly N aspect	Jabal Qamar
QR2P5	16.86853	53.7415	32	0	0	15/01/2018		N	Entirely N aspect	Jabal Qamar
QR20P1	16.80119	53.602694	22	0	4	16/01/2018				Jabal Qamar
QR20P2	16.79903	53.602583	225	0	5	16/01/2018				Jabal Qamar
QR20P3	16.79739	53.602806	93	0	23	16/01/2018				Jabal Qamar
QR20P4	16.79594	53.603417	96	0	32	16/01/2018		NE	Mostly NE aspect	Jabal Qamar
QR20P5	16.79517	53.603806	480	0	96	16/01/2018				Jabal Qamar
QR20P6	16.78944	53.607417	420	0	42	16/01/2018				Jabal Qamar
QR23P1	16.81639	53.636306	36	24	1	16/01/2018				Jabal Qamar
QR23P2	16.81556	53.637889	335	35	20	16/01/2018				Jabal Qamar
QR23P3	16.81575	53.638889	342	8	5	16/01/2018				Jabal Qamar
QR5P3B	16.79397	53.614611	300	3	6	16/01/2018			Four are regenerating, Living>	Jabal Qamar
QR8P1C	16.82464	53.649694	185	15	5	16/01/2018				Jabal Qamar
QR8P2C	16.82486	53.650361	184	21	9	16/01/2018			South easterly facing slopes, found on slopes betwe	Jabal Qamar
QR8P3C	16.82797	53.662556	600	150	15	16/01/2018			Living>, Dead>	Jabal Qamar
QR8P4C	16.82594	53.663556	96	33	4	16/01/2018				Jabal Qamar
QR8P5C	16.82589	53.663667	388	20	19	16/01/2018				Jabal Qamar
QR5P1B	16.79578	53.614222	56	1	3	16/01/2018				Jabal Qamar
QR5P2B	16.79503	53.614611	443	2	12	16/01/2018				Jabal Qamar
QR8P1D	16.82825	53.660444	620	53	41	16/01/2018				Jabal Qamar
QR8P2D	16.82725	53.661639	232	24	11	16/01/2018				Jabal Qamar
QR5P1	16.79739	53.612667	120	N/A	N/A	16/01/2018				Jabal Qamar
QR5P2	16.79292	53.614889	45	N/A	N/A	16/01/2018				Jabal Qamar
QR5P3	16.79292	53.614889	142	N/A	N/A	16/01/2018				Jabal Qamar
QR6P1	16.80503	53.616222	18	8	2	16/01/2018		N		Jabal Qamar
QR6P2	16.80567	53.617153	56	4	2	16/01/2018		NNE		Jabal Qamar
QR6P3	16.80507	53.618242	198	0	13	16/01/2018		NNW		Jabal Qamar
QR6P4	16.80639	53.619386	170	1	10	16/01/2018		NNW		Jabal Qamar
QR6P5	16.80723	53.620258	125	7	0	16/01/2018		N		Jabal Qamar
QR7P1	16.82201	53.645689	14	6	0	16/01/2018		W		Jabal Qamar
QR7P2	16.82068	53.645036	13	21	0	16/01/2018		SSW		Jabal Qamar
QR7P3	16.81977	53.642153	134	8	8	16/01/2018		SE		Jabal Qamar
QR7P4	16.81793	53.642111	212	2	5	16/01/2018		W		Jabal Qamar
QR7P5	16.82142	53.64425	50	30	1	16/01/2018				Jabal Qamar
QR7P6	16.82108	53.64325	63	0	3	16/01/2018				Jabal Qamar
QR7P7	16.82033	53.641861	160	11	9	16/01/2018				Jabal Qamar
QR7P8	16.81789	53.640889	110	20	10	16/01/2018				Jabal Qamar
QR7P9	16.833	53.641111	306	16	0	16/01/2018				Jabal Qamar
QR4P1	16.79297	53.599333	15	0	0	16/01/2018		W		Jabal Qamar
QR4P2	16.78983	53.599139	36	0	2	16/01/2018		N		Jabal Qamar
QR4P3	16.78917	53.600028	25	0	7	16/01/2018		N		Jabal Qamar
QR4P4	16.78767	53.60275	47	0	3	16/01/2018			Taken from many aspects	Jabal Qamar
QR4P5	16.78569	53.603139	69	0	13	16/01/2018			Taken from many aspects	Jabal Qamar
QR4P6	16.78544	53.604444	131	0	10	16/01/2018			Taken from many aspects	Jabal Qamar
QRR1P1	16.7995	53.593944	47	0	8	16/01/2018		N		Jabal Qamar
QRR1P2	16.81306	53.593194	230	0	20	16/01/2018				Jabal Qamar
QRR1P3	16.81344	53.598417	283	0	35	16/01/2018		SE		Jabal Qamar
QRR1P4	16.81503	53.612722	15	0	0	16/01/2018		SE		Jabal Qamar
QRR1P5	16.81908	53.626167	270	30	20	16/01/2018				Jabal Qamar
QRR1P6	16.83056	53.621861	269	11	25	16/01/2018		NE	NE aspect, much more accessible plants, less steep	Jabal Qamar
QRR1P7	16.83039	53.666361	39	35	0	16/01/2018				Jabal Qamar
QRR1P8	16.83206	53.667417	135	30	0	16/01/2018				Jabal Qamar
QR5P1	16.79797	53.611864	273	1	20	16/01/2018				Jabal Qamar
QR5P2	16.79739	53.6135	120	0	N/A	16/01/2018				Jabal Qamar
QR5P6	16.79288	53.615883	291	0	34	16/01/2018				Jabal Qamar
QR5P7	16.79292	53.614889	45	N/A	N/A	16/01/2018				Jabal Qamar
QR5P8	16.79292	53.614889	142	0	N/A	16/01/2018				Jabal Qamar
QR11P1B	16.87864	53.73225	1	1	0	17/01/2018	262	S		Jabal Qamar
QR17P1B	16.88133	53.738361	4	1	0	17/01/2018		S		Jabal Qamar
QR17P2B	16.88117	53.737222	6	1	0	17/01/2018		S		Jabal Qamar

Location	NDD	EDD	Living	Dead	Juv	Date	Altitude m	Aspect	Notes	Jabal
AW1S1	16.83328	53.674333	540	15	35	17/01/2018		S		Jabal Qamar
AW1S2	16.83425	53.670611	138	40	10	17/01/2018		N		Jabal Qamar
AW1S3	16.83653	53.672444	500	110	10	17/01/2018			Many different aspects	Jabal Qamar
AW1S4	16.83781	53.674222	160	45	14	17/01/2018		N		Jabal Qamar
AW1S5	16.83639	53.673528	855	70	55	17/01/2018		N		Jabal Qamar
AW1S6	16.83892	53.6835	339	15	40	17/01/2018		NW		Jabal Qamar
AW1S7	16.84367	53.693944	170	5	10	17/01/2018		NW		Jabal Qamar
AW1S8	16.84694	53.701889	131	0	6	17/01/2018		N		Jabal Qamar
AW1S9	16.84844	53.702556	105	0	10	17/01/2018				Jabal Qamar
AW1S10	16.85094	53.707972	490	0	90	17/01/2018				Jabal Qamar
AW1S11	16.84667	53.686667	420	20	40	17/01/2018		N		Jabal Qamar
AW1S12	16.84653	53.687222	530	40	60	17/01/2018		N		Jabal Qamar
AW1S13	16.84719	53.690333	590	20	50	17/01/2018		N		Jabal Qamar
BS1P1	16.85842	53.717667	170	0	2	17/01/2018				Jabal Qamar
BS1P2	16.85769	53.720417	8	1	1	17/01/2018		E		Jabal Qamar
BS1P3	16.85258	53.715278	991	0	32	17/01/2018			View across wadi and the next to GPS location	Jabal Qamar
BS1P4	16.85044	53.705917	55	0	1	17/01/2018				Jabal Qamar
BS1P5	16.84556	53.685778	248	2	12	17/01/2018				Jabal Qamar
DP1A	16.87742	53.718278	35	0	1	17/01/2018	209	NW		Jabal Qamar
DP2A	16.87733	53.731361	48	1	0	17/01/2018	222	E		Jabal Qamar
DP3A	16.87914	53.741667	5	0	0	17/01/2018	224	E		Jabal Qamar
DP4A	16.87856	53.742722	0	0	0	17/01/2018	241	W		Jabal Qamar
DP5A	16.87844	53.741611	7	0	2	17/01/2018	215	S		Jabal Qamar
DP6A	16.87825	53.753	9	0	0	17/01/2018	200	ENE		Jabal Qamar
QAQ1P1	17.05389	53.828417	18	0	0	17/01/2018		SE		Jabal Qara
QAQ1P2	17.05411	53.828167	16	0	0	17/01/2018		SW		Jabal Qara
QAQ1P3	17.05478	53.830417	17	4	3	17/01/2018		SE		Jabal Qara
QA1EP1	17.02454	53.761708	230	42	9	18/01/2018				Jabal Qara
QA1EP2	17.02596	53.7608	21	23	0	18/01/2018				Jabal Qara
QA1EP3	17.02518	53.7592	350	16	6	18/01/2018				Jabal Qara
QA1EP4	17.02532	53.758422	3	10	N/A	18/01/2018				Jabal Qara
QA1EP5	17.02529	53.762692	539	41	21	18/01/2018				Jabal Qara
QA1EP6	17.02461	53.760833	400	0	30	18/01/2018				Jabal Qara
QA1EP7	17.02272	53.756917	50	4	8	18/01/2018				Jabal Qara
QA1EP8	17.02025	53.756944	1000	50	100	18/01/2018			>Living	Jabal Qara
QA1EP9	17.02075	53.76	270	25	20	18/01/2018				Jabal Qara
QA2EP1	17.0239	53.768936	785	80	75	18/01/2018				Jabal Qara
QA2EP2	17.02358	53.769119	13	5	3	18/01/2018				Jabal Qara
QA2EP3	17.01963	53.768939	1280	120	10	18/01/2018			>All	Jabal Qara
BQAS1	17.01186	53.775333	248	10	8	18/01/2018				Jabal Qara
BQAS2	17.01372	53.776361	2	1	0	18/01/2018				Jabal Qara
BQAS3	17.01389	53.7765	39	7	4	18/01/2018				Jabal Qara
BQAS4	17.01367	53.777944	123	4	4	18/01/2018				Jabal Qara
BQAS5	17.01664	53.778306	820	0	25	18/01/2018				Jabal Qara
BQAS6	17.05822	53.811556	110	0	0	18/01/2018				Jabal Qara
BQAS7	17.05339	53.799889	75	6	7	18/01/2018				Jabal Qara
BQAS8	17.05092	53.793389	23	0	3	18/01/2018				Jabal Qara
BQAS9	17.0645	53.834111	0	0	0	18/01/2018				Jabal Qara
BQAS10	17.06325	53.836778	17	0	0	18/01/2018				Jabal Qara
AQA1P1	17.01522	53.764444	605	29	51	18/01/2018				Jabal Qara
AQA1P2	17.01614	53.765139	1308	66	312	18/01/2018				Jabal Qara
AQA1P3	17.01683	53.763667	786	43	101	18/01/2018				Jabal Qara
AQA2P1	17.02428	53.777194	1273	35	186	18/01/2018				Jabal Qara
AQA2P2	17.02353	53.776778	189	34	18	18/01/2018				Jabal Qara
AQA2P3	17.01828	53.779944	1283	49	147	18/01/2018				Jabal Qara
AQA2P4	17.01719	53.780917	592	16	126	18/01/2018				Jabal Qara
AQA2P5	17.01692	53.780639	526	26	91	18/01/2018				Jabal Qara
AQA3P1	17.06247	53.817722	84	25	3	18/01/2018				Jabal Qara
AQA4P1	17.05669	53.823472	43	6	2	18/01/2018				Jabal Qara
AQA5P1	17.06481	53.841944	28	0	0	18/01/2018				Jabal Qara
CRP1	17.02536	53.763306	55	44	2	18/01/2018				Jabal Qara
CRP2	17.02533	53.763333	156	90	50	18/01/2018				Jabal Qara
CRP3	17.02333	53.764611	647	33	38	18/01/2018				Jabal Qara
CRP4	17.03089	53.74975	110	40	0	18/01/2018				Jabal Qara
CRP5	17.02989	53.744944	16	5	0	18/01/2018				Jabal Qara
CRP6	17.02786	53.742667	36	4	0	18/01/2018				Jabal Qara
CRP7	17.02375	53.740778	75	2	0	18/01/2018				Jabal Qara
CRP8	17.02333	53.743778	190	44	8	18/01/2018				Jabal Qara
CRP9	17.03903	53.755306	7	3	0	18/01/2018				Jabal Qara
CRP10	17.03928	53.755333	17	7	2	18/01/2018				Jabal Qara

Location	NDD	EDD	Living	Dead	Juv	Date	Altitude m	Aspect	Notes	Jabal
QAP7A	17.07694	53.854833	11	0	0	19/01/2018				Jabal Qara
QAP8A	17.07636	53.854139	5	1	0	19/01/2018				Jabal Qara
QAP9A	17.07444	53.858833	3	0	1	19/01/2018				Jabal Qara
QAP10	17.07767	53.859722	8	0	1	19/01/2018				Jabal Qara
SN1	17.09953	54.689583	220	33	0	19/01/2018				Jabal Samhan
SN2	17.09936	54.688583	72	2	13	19/01/2018				Jabal Samhan
SN3	17.09992	54.686639	27	2	0	19/01/2018				Jabal Samhan
SN4	17.10083	54.68475	11	1	3	19/01/2018				Jabal Samhan
SN5	17.10139	54.684639	28	2	5	19/01/2018				Jabal Samhan
SN6	17.10192	54.685389	33	6	6	19/01/2018				Jabal Samhan
SN7	17.10244	54.685944	17	3	3	19/01/2018				Jabal Samhan
SN8	17.10353	54.687917	9	4	2	19/01/2018				Jabal Samhan
BSN1	17.09903	54.695361	350	0	0	19/01/2018				Jabal Samhan
BSN1P1	17.09994	54.692806	9	5	0	20/01/2018	1146			Jabal Samhan
BSN1P2	17.09983	54.690778	44	25	0	20/01/2018	1139			Jabal Samhan
BSN1P3	17.09939	54.689139	193	87	11	20/01/2018	1137		Potential duplicate of Cindy on 19/01/2018	Jabal Samhan
BSN1P4	17.09939	54.688528	20	2	0	20/01/2018	1139			Jabal Samhan
BSN1P5	17.10003	54.686111	74	30	5	20/01/2018	1123			Jabal Samhan
BSN1P6	17.09508	54.684139	46	9	2	20/01/2018	1112			Jabal Samhan
BSN1P7	17.09483	54.682861	41	21	2	20/01/2018	1096	N		Jabal Samhan
BSN1P8	17.0915	54.674194	59	4	2	20/01/2018	1049			Jabal Samhan
BSN1P9	17.09169	54.671778	42	0	11	20/01/2018	1071		Juveniles on steep cliff side	Jabal Samhan
BSN1P10	17.09242	54.665444	7	1	0	20/01/2018	1001			Jabal Samhan
BSN1P11	17.09528	54.658222	0	0	0	20/01/2018	995			Jabal Samhan
BSN2P1	17.08908	54.640331	0	0	0	20/01/2018	910			Jabal Samhan
DSN1	17.11106	54.710167	143	2	2	20/01/2018				Jabal Samhan
DSN2	17.112	54.712111	246	0	4	20/01/2018				Jabal Samhan
DSN3	17.11272	54.713639	33	1	1	20/01/2018				Jabal Samhan
DSN4	17.11342	54.716472	370	0	0	20/01/2018				Jabal Samhan
DSN5	17.12119	54.734222	688	0	0	20/01/2018			Too Far to tell dead or juvenile	Jabal Samhan
DSN6	17.12483	54.744222	237	0	2	20/01/2018			Too Far to tell dead or juvenile	Jabal Samhan
DSN7	17.12689	54.750972	35	1	0	20/01/2018			Too Far to tell dead or juvenile	Jabal Samhan
DSN8	17.12767	54.754722	480	0	0	20/01/2018			Too Far to tell dead or juvenile	Jabal Samhan
DSN9	17.13536	54.773611	522	6	1	20/01/2018				Jabal Samhan
DSN10	17.1375	54.776583	139	0	0	20/01/2018	1538			Jabal Samhan
DSN11	17.13947	54.779111	28	1	2	20/01/2018				Jabal Samhan
DSN12	17.15381	54.801361	994	0	0	20/01/2018	1654			Jabal Samhan
SNA1	17.09747	54.69425	78	6	8	20/01/2018				Jabal Samhan
SNA2	17.08978	54.687361	27	1	5	20/01/2018				Jabal Samhan
SNA3	17.08714	54.684556	51	1	5	20/01/2018				Jabal Samhan
SNA4	17.08344	54.679361	5	0	0	20/01/2018		NW	Inland	Jabal Samhan
SNA5	17.07667	54.674694	16	0	0	20/01/2018				Jabal Samhan
CSN1	17.13461	54.714278	0	0	0	20/01/2018				Jabal Samhan
CSN2	17.13619	54.714083	1	0	0	20/01/2018				Jabal Samhan
CSN3	17.13944	54.714139	2	0	0	20/01/2018				Jabal Samhan
CSN4	17.14064	54.715833	2	0	1	20/01/2018			View from wadi floor	Jabal Samhan
CSN5	17.14081	54.716694	1	0	0	20/01/2018			View from wadi floor	Jabal Samhan
CSN6	17.14103	54.718639	2	0	0	20/01/2018			View from wadi floor	Jabal Samhan
CSN7	17.14283	54.715222	2	0	0	20/01/2018				Jabal Samhan
CSN8	17.14461	54.713944	1	0	0	20/01/2018			In wadi	Jabal Samhan
CSN9	17.144	54.711306	2	0	0	20/01/2018				Jabal Samhan
CSN10	17.14344	54.709139	5	0	0	20/01/2018			In wadi	Jabal Samhan
CSN11	17.14428	54.707889	8	0	2	20/01/2018			View from wadi floor	Jabal Samhan
CSN12	17.14414	54.705694	9	0	2	20/01/2018			View from wadi floor	Jabal Samhan
CSN13	17.14569	54.729806	0	0	0	20/01/2018	1345			Jabal Samhan
CSN14	17.14861	54.729639	0	0	0	20/01/2018	1340			Jabal Samhan
CSN15	17.15086	54.729306	0	0	0	20/01/2018	1344			Jabal Samhan
CSN16	17.15142	54.728917	0	0	0	20/01/2018	1340			Jabal Samhan
CSN17	17.15217	54.729361	0	0	0	20/01/2018				Jabal Samhan
SNP1A	17.12367	54.707056	3	0	0	21/01/2018				Jabal Samhan
SNP2A	17.12322	54.702639	3	0	3	21/01/2018				Jabal Samhan
SNP3A	17.12342	54.701472	3	0	0	21/01/2018				Jabal Samhan
SNP4A	17.12458	54.699639	2	0	0	21/01/2018				Jabal Samhan
SNP5A	17.1255	54.697778	3	0	1	21/01/2018				Jabal Samhan
SNP6A	17.12581	54.700306	0	0	0	21/01/2018				Jabal Samhan
SNP7A	17.12528	54.696611	4	0	1	21/01/2018				Jabal Samhan
SNP8A	17.12431	54.695806	7	0	3	21/01/2018				Jabal Samhan

Location	NDD	EDD	Living	Dead	Juv	Date	Altitude m	Aspect	Notes	Jabal
SNP9A	17.12375	54.694861	11	0	6	21/01/2018				Jabal Samhan
SNP10A	17.12333	54.693972	5	0	2	21/01/2018				Jabal Samhan
SNP11A	17.12278	54.692611	3	0	3	21/01/2018				Jabal Samhan
SNP12A	17.12167	54.692333	5	0	0	21/01/2018				Jabal Samhan
SNP13A	17.12121	54.691428	2	1	1	21/01/2018				Jabal Samhan
SNP14A	17.12042	54.693944	1	0	0	21/01/2018				Jabal Samhan
SNP15A	17.11924	54.694458	5	0	1	21/01/2018				Jabal Samhan
SNP16A	17.11776	54.694986	6	0	2	21/01/2018				Jabal Samhan
SNP17A	17.11692	54.696639	4	0	1	21/01/2018				Jabal Samhan
SNP18A	17.11669	54.696961	5	2	3	21/01/2018				Jabal Samhan
MESN1P1	17.16022	54.786306	0	0	0	21/01/2018	1462			Jabal Samhan
MESN1P2	17.16128	54.784528	0	0	0	21/01/2018	1429			Jabal Samhan
MESN1P3	17.16189	54.782722	0	0	0	21/01/2018	1418			Jabal Samhan
MESN2P1	17.146	54.775167	0	0	0	21/01/2018	1492			Jabal Samhan
MESN2P2	17.14822	54.774083	0	0	0	21/01/2018	1471			Jabal Samhan
MESN3P1	17.14536	54.760306	0	0	0	21/01/2018	1405			Jabal Samhan
MESN4P1	17.15366	54.758083	0	0	0	21/01/2018	1392			Jabal Samhan
1	17.06453	54.645917	1	0	1	21/01/2018			Found on top of ledge above us	Jabal Samhan
2	17.0645	54.650917	1	0	0	21/01/2018				Jabal Samhan
3	17.06406	54.659639	6	0	0	21/01/2018				Jabal Samhan
4	17.07628	54.650333	2	0	0	21/01/2018				Jabal Samhan
SN	17.206792	54.94444	10	2	0	24/01/2018	1153		One juvenile lower down, coordinates on Thom's wa	Jabal Samhan
QR4			520	0	26	16/01/2018			>Living, 360 degree view	Jabal Samhan
total			38620	2332	2731					

Appendix 4.6 Characteristic matrix for taxonomic verification of Dracaena serrulata

No.	Tree code	Location	Quadrat	Altitude (m)	GPS (N)	GPS (E)	stem diameter (m)	Tree Length (m)	Stem color	No. of main branches	Leaf shape	Leaf base	Leaf average length (cm)	Leaf average width (cm)	Leaf averag	Leaf width-t	Leaf tip	Leaf margin	Leaf color
1	JQA 1	Jabal Al Qara/Titam (1)	Yes	1070	17°06.459'	54°40.995'	0.6	2	light	12	Lanceolate	wide ovate	64.4	1.4	90.16	0.02	acute	serrulate	PaleGreen(4)
2	JQA 2	Jabal Al Qara/Titam (1)	Yes	1070	17°06.459'	54°40.995'	0.65	2.2	light	8	Lanceolate	wide ovate	58.3	1.5	87.45	0.03	acute	serrulate	SeaGreen(4)
3	JQA 3	Jabal Al Qara/Titam (1)	Yes	1070	17°06.459'	54°40.995'	1	3	light	12	Linear	wide ovate	64.3	1.4	90.02	0.02	acute	serrulate	MediumSeaGreen
4	JQA 4	Jabal Al Qara/Titam (1)	Yes	1070	17°06.459'	54°40.995'	0.7	2.5	light	5	Linear	wide ovate	58	2.3	133.4	0.04	acute	serrulate	ForestGreen
5	JQA 5	Jabal Al Qara/Titam (1)	Yes	1070	17°06.459'	54°40.995'	0.6	2.2	light	12	Linear	wide ovate	53.4	1.8	96.12	0.03	acute	serrulate	MediumSeaGreen
6	JQA 6	Jabal Al Qara/Titam (1)	Yes	1070	17°06.459'	54°40.995'	0.6	2.25	light	8	Linear	wide ovate	60	2.2	132	0.04	acute	serrulate	MediumSeaGreen
7	JQA 7	Jabal Al Qara/Titam (2)	Yes	1065	17°03.489'	53°48.816'	0.9	4	light	12	Linear	wide ovate	60	1.8	108	0.03	acute	serrulate	SeaGreen(4)
8	JQA 8	Jabal Al Qara/Titam (2)	Yes	1065	17°03.489'	53°48.816'	1.1	3.5	light	13	Linear	wide ovate	65	2	130	0.03	acute	serrulate	MediumSeaGreen
9	JQA 9	Jabal Al Qara/Titam (2)	Yes	1065	17°03.489'	53°48.816'	2.4	2.4	dark	12	Linear	wide ovate	44	1.6	70.4	0.04	acute	serrulate	MediumSeaGreen
10	JQA 10	Jabal Al Qara/Titam (2)	Yes	1065	17°03.489'	53°48.816'	1	2.9	light	10	Linear	wide ovate	52.5	2	105	0.04	acute	serrulate	MediumSeaGreen
11	JQA 11	Jabal Al Qara/Titam (2)	No	1065	17°03.489'	53°48.816'	1.1	4	light	8	Linear	wide ovate	61	1.5	91.5	0.02	acute	serrulate	ForestGreen
12	JQA 12	Jabal Al Qara/Titam (2)	No	1065	17°03.489'	53°48.816'	1.9	3	light	6	Linear	wide ovate	57	1.8	102.6	0.03	acute	serrulate	ForestGreen
13	JQA 13	Jabal Al Qara/Titam (3)	No	1121	17°03.510'	53°48.596'	1.05	2.3	light	4	Linear	wide ovate	51	1.7	86.7	0.03	acute	serrulate	SeaGreen(4)
14	JQA 14	Jabal Al Qara/Titam (3)	No	1121	17°03.510'	53°48.596'	0.9	1.9	light	7	Linear	wide ovate	41	1.6	65.6	0.04	acute	serrulate	SeaGreen(4)
15	JQA 15	Jabal Al Qara/Titam (3)	No	1121	17°03.510'	53°48.596'	1.5	0.8	light	1	Lanceolate	wide ovate	52	2.5	130	0.05	acute	serrulate	PaleGreen(4)
16	JQA 16	Jabal Al Qara/Titam (3)	No	1121	17°03.510'	53°48.596'	1.2	2.8	light	13	Lanceolate	wide ovate	56	1.6	89.6	0.03	acute	serrulate	SeaGreen(4)
17	JQA 17	Jabal Al Qara/Titam (3)	No	1121	17°03.510'	53°48.596'	1	1.8	light	3	Lanceolate	wide ovate	74	2.7	199.8	0.04	acute	serrulate	SeaGreen(4)
18	JQA 18	Jabal Al Qara/Titam (4)	No	1084	17°03.730'	53°49.060'	0.8	3.1	light	7	Linear	wide ovate	34	1.3	44.2	0.04	acute	serrulate	SeaGreen(4)
19	JQA 19	Jabal Al Qara/Titam (4)	No	1084	17°03.730'	53°49.060'	0.8	3.2	light	7	Linear	wide ovate	40	1.6	64	0.04	acute	serrulate	MediumSeaGreen
20	JQA 20	Jabal Al Qara/Titam (4)	No	1084	17°03.730'	53°49.060'	0.5	1.1	dark	1	Linear	wide ovate	78	2.3	179.4	0.03	acute	serrulate	SeaGreen(4)
21	JQA 21	Jabal Al Qara/Titam (4)	No	1084	17°03.730'	53°49.060'	0.7	2.4	light	8	Linear	wide ovate	33	1.6	52.8	0.05	acute	serrulate	MediumSeaGreen
22	JQR 1	Jabal Al Qamar/above Al Fazaya (1)	No	857	16°49.778'	53°40.195'	1.2	2	light	3	Lanceolate	wide ovate	64	1.7	108.8	0.03	acute	entire	DarkGreen
23	JQR 2	Jabal Al Qamar/above Al Fazaya (1)	No	857	16°49.778'	53°40.195'	0.7	1.8	light	3	Lanceolate	wide ovate	53	1.6	84.8	0.03	acute	serrulate	SeaGreen(4)
24	JQR 3	Jabal Al Qamar/above Al Fazaya (2)	No	898	16°49.668'	53°40.010'	1.3	2.2	light	8	Lanceolate	wide ovate	63	1.6	100.8	0.03	acute	entire	DarkOliveGreen
25	JQR 4	Jabal Al Qamar/above Al Fazaya (2)	No	898	16°49.668'	53°40.010'	1	1	light	1	Linear	wide ovate	82	2.2	180.4	0.03	acute	serrulate	DarkOliveGreen
26	JQR 5	Jabal Al Qamar/above Al Fazaya (2)	No	898	16°49.668'	53°40.010'	1.1	2.5	light	8	Linear	wide ovate	88	1.4	123.2	0.02	acute	serrulate	SeaGreen(4)
27	JQR 6	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	0.9	3	light	5	Linear	wide ovate	59	1.4	82.6	0.02	acute	serrulate	DarkOliveGreen
28	JQR 7	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	0.6	7.8	light	5	Linear	wide ovate	75	2	150	0.03	acute	entire	DarkOliveGreen
29	JQR 8	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	1.2	1.3	light	7	Linear	wide ovate	82.5	1.7	140.25	0.02	acute	serrulate	DarkOliveGreen
30	JQR 9	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	2.7	1.4	light	5	Lanceolate	wide ovate	54	1.8	97.2	0.03	acute	entire	DarkOliveGreen
31	JQR 10	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	1.3	2.5	dark	6	Linear	wide ovate	84	2.3	193.2	0.03	acute	entire	DarkOliveGreen
32	JQR 11	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	1.1	2.1	light	6	Linear	wide ovate	31	1.2	37.2	0.04	acute	serrulate	DarkOliveGreen
33	JQR 12	Jabal Al Qamar (3)	Yes	983	16°49.784'	53°39.999'	0.7	2.1	light	4	Linear	wide ovate	30	1.6	48	0.05	acute	serrulate	DarkOliveGreen
34	JQR 13	Jabal Al Qamar (3)	No	983	16°49.784'	53°39.999'	0.6	2.4	light	3	Linear	wide ovate	89	2.2	195.8	0.02	acute	entire	DarkOliveGreen
35	JQR 14	Jabal Al Qamar (4)	Yes	1036	16°49.056'	53°39.620'	2.5	2.3	light	4	Linear	wide ovate	81	2.4	194.4	0.03	acute	serrulate	SeaGreen(4)
36	JQR 15	Jabal Al Qamar (4)	Yes	1036	16°49.056'	53°39.620'	0.7	2.9	light	5	Linear	wide ovate	36	1.4	50.4	0.04	acute	serrulate	DarkOliveGreen
37	JQR 16	Jabal Al Qamar (4)	Yes	1036	16°49.056'	53°39.620'	0.7	1.2	dark	1	Linear	wide ovate	66	2.5	165	0.04	acute	serrulate	DarkOliveGreen
38	JQR 17	Jabal Al Qamar (4)	Yes	1036	16°49.056'	53°39.620'	0.9	1.8	light	8	Lanceolate	wide ovate	54	1.8	97.2	0.03	acute	serrulate	DarkOliveGreen
39	JQR 18	Jabal Al Qamar (4)	Yes	1036	16°49.056'	53°39.620'	2.3	4	light	4	Linear	wide ovate	66	1.2	79.2	0.02	acute	serrulate	DarkOliveGreen
40	JQR 19	Jabal Al Qamar (5)	No	1032	16°47.919'	53°35.631'	1	2.1	light	10	Lanceolate	wide ovate	65	2	130	0.03	acute	serrulate	DarkOliveGreen

No.	Tree code	Location	Quadrat	Altitude (m)	GPS (N)	GPS (E)	stem diameter (m)	Tree Length (m)	Stem color	No. of main branches	Leaf shape	Leaf base	Leaf average length (cm)	Leaf average width (cm)	Leaf averag	Leaf width-l	Leaf tip	Leaf margin	Leaf color
41	JQR 20	Jabal Al Qamar (5)	No	1032	16°47.919'	53°35.631'	1.9	2.3	light	12	Linear	wide ovate	70	1.6	112	0.02	acute	serrulate	SeaGreen(4)
42	JQR 21	Jabal Al Qamar (5)	No	1032	16°47.919'	53°35.631'	0.6	1.3	light	6	Linear	wide ovate	55	1.8	99	0.03	acute	serrulate	SeaGreen(4)
43	JQR 22	Jabal Al Qamar (5)	No	1032	16°47.919'	53°35.631'	1.1	2.3	dark	5	Linear	wide ovate	90	2.3	207	0.03	acute	serrulate	DarkOliveGreen
44	JSN 1a	Jabal Samhan/Above Tawi Ateer (1)	No	1205	17°06.528'	54°40.931'	1.1	3.9	light	8	Linear	wide ovate	55	1.7	93.5	0.03	acute	serrulate	DarkOliveGreen(4)
44	JSN 1b	Jabal Samhan/Above Tawi Ateer (1)	No	1205	17°06.528'	54°40.931'	1.1	3.9	light	8	Linear	wide ovate	56	1.8	100.8	0.03	acute	serrulate	MediumSeaGreen
45	JSN 2a	Jabal Samhan/Above Tawi Ateer (1)	No	1205	17°06.528'	54°40.931'	1.2	3.4	dark	7	Linear	wide ovate	55.5	1.4	77.7	0.03	acute	serrulate	MediumSeaGreen
45	JSN 2b	Jabal Samhan/Above Tawi Ateer (1)	No	1205	17°06.528'	54°40.931'	1.2	3.4	dark	7	Linear	wide ovate	43	1.1	47.3	0.03	acute	serrulate	MediumSeaGreen
46	JSN 3a	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	1	4.4	light	6	Linear	wide ovate	51.2	1.8	92.16	0.04	acute	serrulate	DarkOliveGreen
46	JSN 3b	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	1	4.4	light	6	Linear	wide ovate	50.5	1.8	90.9	0.04	acute	serrulate	DarkOliveGreen
47	JSN 4a	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	0.6	2	dark	5	Linear	wide ovate	36.5	1.7	62.05	0.05	acute	serrulate	MediumSeaGreen
47	JSN 4b	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	0.6	2	dark	5	Linear	wide ovate	35.7	1.6	57.12	0.04	acute	serrulate	MediumSeaGreen
48	JSN 5a	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	1	4	light	5	Linear	wide ovate	55.5	1.7	94.35	0.03	acute	serrulate	MediumSeaGreen
48	JSN 5b	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	1	4	light	5	Linear	wide ovate	53	1.7	90.1	0.03	acute	serrulate	DarkOliveGreen(4)
49	JSN 6a	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	0.9	3.8	light	4	Linear	wide ovate	44.8	1.6	71.68	0.04	acute	serrulate	MediumSeaGreen
49	JSN 6b	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	0.9	3.8	light	4	Linear	wide ovate	44.5	1.4	62.3	0.03	acute	serrulate	MediumSeaGreen
50	JSN 7a	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	0.56	1.9	light	3	Linear	wide ovate	46.2	1.7	78.54	0.04	acute	serrulate	MediumSeaGreen
50	JSN 7b	Jabal Samhan (2)	No	1168	17°06.088'	54°41.414'	0.56	1.9	light	3	Linear	wide ovate	25	0.7	17.5	0.03	acute	serrulate	MediumSeaGreen
51	JSN 8a	Jabal Samhan (3)	Yes	1161	17°05.907'	54°41.386'	1.21	4.3	light	5	Linear	wide ovate	57.5	1.7	97.75	0.03	acute	serrulate	MediumSeaGreen
51	JSN 8b	Jabal Samhan (3)	Yes	1161	17°05.907'	54°41.386'	1.21	4.3	light	5	Linear	wide ovate	54.7	1.7	92.99	0.03	acute	serrulate	DarkGreen
52	JSN 9a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.8	3.4	light	3	Linear	wide ovate	49	1.3	63.7	0.03	acute	serrulate	DarkGreen
52	JSN 9b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.8	3.4	light	3	Linear	wide ovate	38.2	1.3	49.66	0.03	acute	serrulate	DarkOliveGreen
53	JSN 10a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.6	1.6	light	5	Linear	wide ovate	49.6	1.8	89.28	0.04	acute	serrulate	DarkOliveGreen
53	JSN 10b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.6	1.6	light	5	Linear	wide ovate	40	1.5	60	0.04	acute	serrulate	DarkOliveGreen
54	JSN 11a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.4	1.8	light	2	Linear	wide ovate	53.2	1.9	101.08	0.04	acute	serrulate	DarkOliveGreen(4)
54	JSN 11b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.4	1.8	light	2	Linear	wide ovate	43.5	1.1	47.85	0.03	acute	serrulate	DarkGreen
55	JSN 12a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.6	3	light	5	Linear	wide ovate	37.5	1.6	60	0.04	acute	serrulate	DarkOliveGreen
55	JSN 12b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.6	3	light	5	Linear	wide ovate	18.7	1.1	20.57	0.06	acute	serrulate	DarkOliveGreen
56	JSN 13a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	1.2	3	light	7	Linear	wide ovate	43	1.5	64.5	0.03	acute	serrulate	MediumSeaGreen
56	JSN 13b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	1.2	3	light	7	Linear	wide ovate	26	1.3	33.8	0.05	acute	serrulate	MediumSeaGreen
57	JSN 14a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.3	0.8	light	1	Linear	wide ovate	25	1.6	40	0.06	acute	serrulate	DarkOliveGreen
57	JSN 14b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.3	0.8	light	1	Linear	wide ovate	19.4	0.9	17.46	0.05	acute	serrulate	DarkOliveGreen
58	JSN 15a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.8	2.7	dark	3	Linear	wide ovate	24.5	1	24.5	0.04	acute	serrulate	MediumSeaGreen
58	JSN 15b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.8	2.7	dark	3	Linear	wide ovate	33	1.3	42.9	0.04	acute	serrulate	MediumSeaGreen
59	JSN 16a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	1	2.2	light	6	Linear	wide ovate	40.9	1.7	69.53	0.04	acute	serrulate	DarkGreen
59	JSN 16b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	1	2.2	light	6	Linear	wide ovate	43.5	1.4	60.9	0.03	acute	serrulate	DarkOliveGreen
60	JSN 17a	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.6	1.1	light	4	Linear	wide ovate	42.4	1.4	59.36	0.03	acute	serrulate	DarkGreen
60	JSN 17b	Jabal Samhan (3)	Yes	1154	17°05.892'	54°41.367'	0.6	1.1	light	4	Linear	wide ovate	34.3	1	34.3	0.03	acute	serrulate	DarkGreen
61	JSN 18a	Jabal Samahan/close the quadrat (4)	No	1138	17°05.931'	54°41.361'	0.6	2.2	light	5	Linear	wide ovate	38	1.8	68.4	0.05	acute	serrulate	DarkGreen
61	JSN 18b	Jabal Samahan/close the quadrat (4)	No	1138	17°05.931'	54°41.361'	0.6	2.2	light	5	Linear	wide ovate	37.1	0.9	33.39	0.02	acute	serrulate	MediumSeaGreen
62	JSN 19a	Jabal Samahan/close the quadrat (4)	No	1133	17°05.955'	54°41.388'	1	2.6	light	5	Linear	wide ovate	32.4	1.5	48.6	0.05	acute	serrulate	DarkOliveGreen
62	JSN 19b	Jabal Samahan/close the quadrat (4)	No	1133	17°05.955'	54°41.388'	1	2.6	light	5	Linear	wide ovate	33	1	33	0.03	acute	serrulate	DarkGreen
63	JSN 20a	Jabal Samahan/close the quadrat (4)	No	1161	17°06.068'	54°41.360'	1.8	4.6	light	6	Linear	wide ovate	65	2	130	0.03	acute	serrulate	DarkOliveGreen(4)
63	JSN 20b	Jabal Samahan/close the quadrat (4)	No	1161	17°06.068'	54°41.360'	1.8	4.6	light	6	Linear	wide ovate	42.6	1.8	76.68	0.04	acute	serrulate	MediumSeaGreen

Appendix 4.7 List of Traits Used for Draceana Characterization, with the Used Units (Ut) , Sample Size (Ss), Measurement tool and Measurement Method/Character stats.

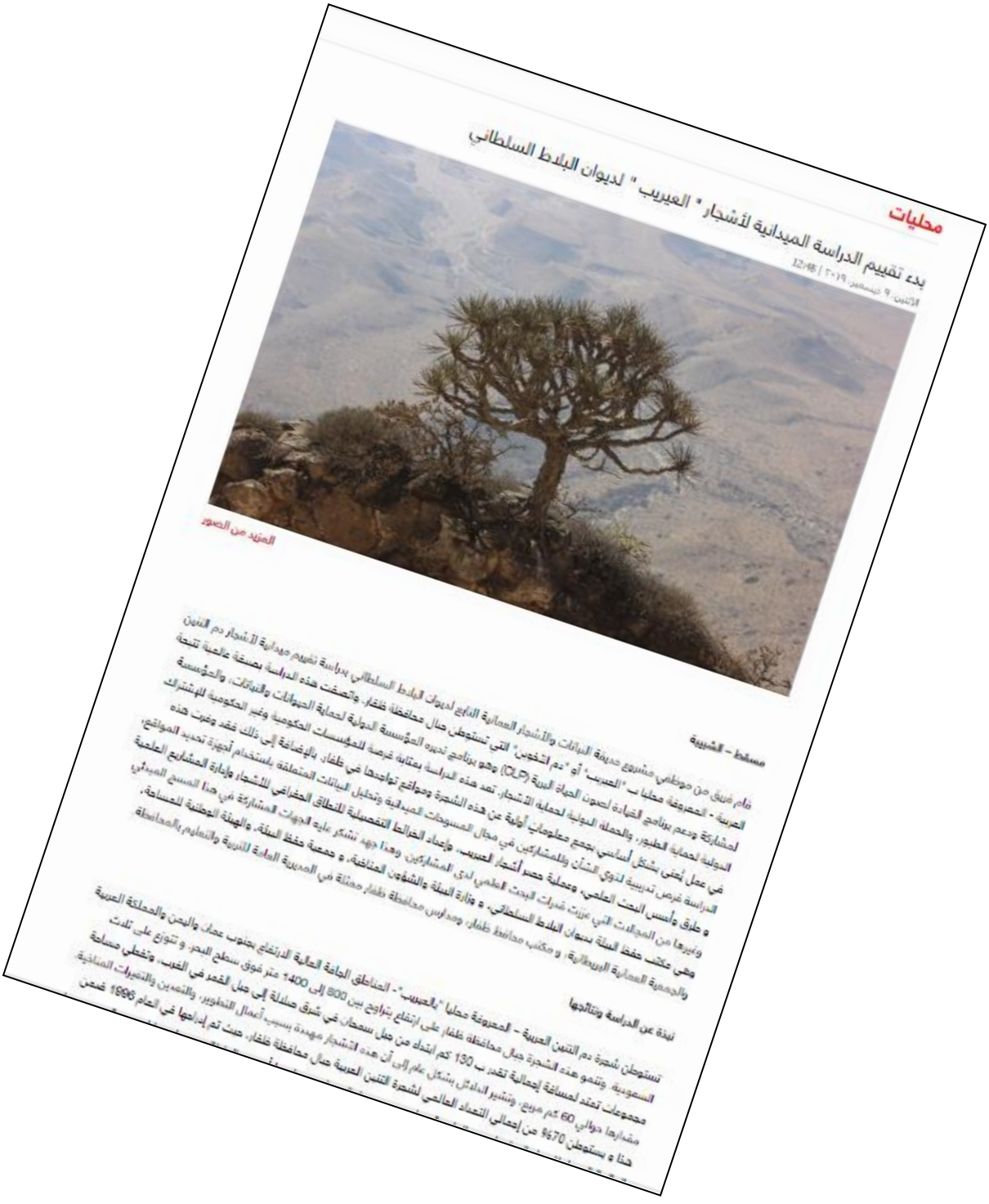
Organ	Trait	Abv	Ut	Ss	Measurement tool	Measurement Method /Character stats
Trr	Height	TH	m	1	Metric bar	Measured from 1 mm after the root zone to longest tip
Stem	diameter	TD	m	1	Metric bar	Diameter of a tree trunk at its widest point
	color	TC	-	1	-	0: Light;1: Dark
	No. of main branches	NMB	-	1	-	Calculating the number of main/primary branches spreading from the main trunk
Leaves	Leaf shape	LS	-	5	The Kew Plant Glossary, (Figure 4)	0: Lanceolate; 1: Linear
	Leaf base	LB	-	5	The Kew Plant Glossary, (Figure 5)	0: wide ovate
	Leaf tip	LT	-	5	The Kew Plant Glossary, (Figure 5)	0: acute
	Leaf margin	LM	-	5	The Kew Plant Glossary, (Figure 6)	0:serrulate 1:entire
	Leaf color	LC	-	5	"Netscape" chart (Figure 7)	0: PaleGreen(4); 1: MediumSeaGreen; 2: ForestGreen; 3: DarkGreen; 4: DarkOliveGreen; 5: SeaGreen(4)
	Leaf average length	LAL	cm	5	Metric bar	Length and width were measured at the largest point
	Leaf average width	LAW	cm	5	Metric bar	
	Leaf average area	LAA	cm^2	5	-	Leaf length multiply by its width
	Leaf width-to-length ration	LAR	-	5	-	Leaf width divided by its length

4.8 Copies of the articles published in local newspapers

- https://www.shabiba.com/article/236653/

- http://alwatan.com/details/363290

-https://www.omandaily.om/?p=750487



محليات

بدء تقييم الدراسة الميدانية لأشجار " العبريب " لديوان البلاط السلطاني

الاثنين ٩ ديسمبر ٢٠١٩ | 12:48

المزيد من الصور

مسقط – الشبيبة

قام فريق من موظفي مشروع حديقة البيئات والأشجار العمانية التابع لديوان البلاط السلطاني بدراسة تقييم ميدانية لأشجار دم الثعبان العربية - المعروفة محليا بـ "العبريب" أو "دم الأخوين" التي تستوطن جبال محافظة ظفار. واتصفت هذه الدراسة بصفة علمية تتيحها مشاركة ودعم برنامج القيادة لصون الحياة البرية (CLP) وهو برنامج تديره المؤسسة الدولية لحماية الحيوانات والنباتات، والمؤسسة الدولية لحماية الطيور، والحملة الدولية لحماية الأشجار. تعد هذه الشجرة وحواقع تواجدها في ظفار، بالإضافة إلى ذلك فقد وقعت هذه الدراسة فرص تدريبية لذوي الشأن والمشاركين في مجال المسوحات الميدانية وتحليل البيانات المتعلقة بالنطاق الجغرافي للأشجار وإدارة المشاريع العلمية وغيرها من المجالات التي عززت شراكات البحث العلمي بين ديوان البلاط السلطاني، و مكتب محافظ ظفار، ومجلس محافظة ظفار ممثلة في المديرية العامة للتربية والتعليم بالمحافظة والجمعية العمانية البريطانية، و مكتب محافظ ظفار، ومجلس محافظة ظفار ممثلة في المديرية العامة للتربية والتعليم بالمحافظة

نبذة عن الدراسة ونتائجها

تستوطن شجرة دم الثعبين العربية – المعروفة محليا "بالعبريب" - المناطق الجافة العالية الارتفاع بجنوب عمان واليمن والمملكة العربية السعودية. وتنمو هذه الشجرة جبال محافظة ظفار على ارتفاع يتراوح بين 800 إلى 1400 متر فوق سطح البحر. و تتوزع على تلك مجموعات تمتد لمسافة إجمالية تقدر بـ 130 كم ابتداء من جبل سمحان في شرق صلالة إلى جبل القمر في الغرب. وتغطي مساحة مقدارها حوالي 60 كم مربع، وتشير الدلائل بشكل عام إلى أن هذه الأشجار مهددة بسبب أعمال التطوير، والتعدين والتغيرات المناخية. حيث تم إدراجها في العام 1996 ضمن حنا ء يستوطن 70% من إجمالي التعداد العالمي لشجرة الثنين العربية حال محافظة ظفار.

عمان اليوم

حصر حوالي ٤٢ ألف شجرة موزعة على جبال ظفار

دراسة ميدانية لأشجار دم التنين العربية «العيريب» تؤكد وجود تأثيرات عمرانية ومناخية على نموها

■ شجرة دم التنين العربية تتصف بشاهقتها على جبل سمحان

الرئيسية / المحليات / دراسة تقييم ميدانية لأشجار دم التنين العربية (العيريب) المستوطنة بجبال ظفار

دراسة تقييم ميدانية لأشجار دم التنين العربية (العيريب) المستوطنة بجبال ظفار

في المحليات 20 ديسمبر 2019

نسخة للطباعة

مشاركة

Like 0

عام فريق من موظفي مشروع حديقة النباتات والأشجار العطرية التابع لديوان البلاط السلطاني بدراسة تقييم ميدانية للأشجار دم التنين العربية المعروفة محلياً بالعيريب) أو (دم الأخوين) التي تستوطن جبال محافظة ظفار.

وانصبت هذه الدراسة بصيغة عالمية نتيجة لمشاركة ودعم برنامج القيادة لصون الحياة البرية والحملة الدولية لحماية الطيور، والمؤسسة الدولية لحماية الحيوانات والنباتات، والمؤسسات الحكومية وغير الحكومية الدولية لحماية الطيور.

حيث تعد هذه الدراسة بمثابة فرصة ومواقع تواجدها في ظفار، بالإضافة إلى ذلك فقد وفرت هذه الدراسة فرص تدريبية لذوي معلومات أولية عن هذه الشجرة وتحليل البيانات المتعلقة باستخدام أجهزة تحديد المواقع، وطرق، وأسس المسوحات الميدانية، وإعداد الخرائط التفصيلية لنطاق الجغرافي للأشجار وإدارة المشاريع العلمية وغيرها الشأن والمشاركين في مجال أشجار العيريب، وإعداد المشاركين.

البحث العلمي، وعملية حصر أشجار البحث العلمي لدى المشاركين.

من الحالات التي عزرت ضدرات البحث المعروفة محلياً بـ (العيريب) في المناطق الجافة المالية الارتفاع بجنوب السلطنة والبيمن ونستوطن شجرة دم التنين العربية السعودية، حيث تنمو هذه الشجرة جبال محافظة ظفار على ارتفاع يتراوح بين 600 إلى 1400 متر فوق سطح والمملكة العربية السعودية، حيث تنمو مجموعات تمتد لمسافة إجمالية تقدر بال(130) كم ابتداء من جبل سمحان في شرق صلالة إلى جبل القمر البحر، وتتوزع على تلدن مجموعات مقدارها حوالي 60 كم مربع، وتتغير الدلائل بشكل عام إلى أن هذه الأشجار مهددة بسبب أعمال في الغرب، وتغطي مساحة مقدارها حوالي 70% من إجمالي التعداد العالمي لشجرة التنين العربية جبال محافظة ظفار، التطوير، والتعدين والتغيرات المناخية، ويستوطن حيث تم إدراجها في العام 1996 ضمن القائمة الحمراء للاتحاد الدولي لصون الطبيعة كنبات مهدد بخطر الانقراض، ولاحظ أن هذه الدلالة ترتكز على بيانات نوعية معتمدة على العينات القليلة الموجودة في المستحطات النباتية وملاحظات الباحثين، ولم

Appendix 4.9 Bibliography

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Walker, Colin C. (2017). CactusTalk: More dragon tree tales. CactusWorld, 35(4) p. 288.

Appendix 4.10 Address list and web links

An annotated list of useful names, addresses and websites

Item	link
Conservation assessment of Arabian dragon tree (Dracaena serrulata) in Oman (@cadtoman)	www.instagram.com/cadtoman/
Conservation OF Arabian Dragon Tree in Oman (CADT) (@CADTOman)	www.twitter.com/CADTOman/
Environmental Society of Oman (NGO)	www.eso.org.om
Office for Conservation of the Environment	https://omum.gov.om/
The awareness page established by one of the schools within the habitat of Dracanae serrulata (@nawader_samhan)	www.instagram.com/nawader_samhan/

Distribution list

Hard copies will be distributed to:

- Office for Conservation of the Environment
- Ministry of Environment and Climatic Affairs
- Environmental Society of Oman
- Anglo Omani Society
- Office of the Minister Of State & Governor Of Dhofar

Digital copies will be distributed to everyone who have contributed in any way to this project. Anyone who's interested in getting the report can contact Ghudaina via e-mail alissai.g@gmail.com