CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Twenty-fifth meeting of the Plants Committee
Online, 2-4, 21 and 23 June 2021

Species specific matters

ADDENDUM TO BOSWELLIA TREES (*BOSWELLIA* SPP.)

1. This document has been submitted by the regional representative of Europe (Ursula Moser), as the Plants Committee's co-lead for Decision 18.207 on *Boswellia trees (*Boswellia *spp.).*[*]

Progress since May 2020

2. Following the postponement due to the COVID-19 pandemic of the 25th meeting of the Plants Committee (PC25), scheduled to take place from 17 to 23 July 2020, the Committee took several intersessional decisions (see Notification no. 2020/056 of 21 September 2020), including the approval of its workplan for 2020-2022 as outlined in document PC25 Doc. 7.2. Through its workplan, the Plants Committee agreed on the leads for the implementation of Decision 18.207 on *Boswellia trees (*Boswellia *spp.)*, as follows: Ursula Moser, representative of Europe; Rosemarie Gnam, representative of North America; and Beatrice Khayota, alternate representative of Africa.

3. PC leads reached out to Parties (Eritrea, Ethiopia, Germany, India, Kenya, Netherlands, Somalia, Sudan, and United States of America) and non-Party stakeholders (American Herbal Products Association AHPA, Botanical Survey of India BSI, Centre for Middle Eastern Plants (Royal Botanic Garden Edinburgh), Global Frankincense Alliance GFA, International Fragrance Association IFRA, Neo Botanika, TRAFFIC) to gather their perspectives on

   a) the information in document PC25 Doc. 25 and its Annexes, and other relevant information regarding the status, management, and trade in *Boswellia* species available to it or provided through information documents; and

   b) key gaps in knowledge and recommendations for further efforts to address the sustainable use and conservation of these species, including whether any of the species meet the criteria for listing under CITES.

4. The outcomes of these consultations are available in Annexes 1 and 2 to this Addendum, and summarized below:

   4.1 Preliminary views from *Boswellia* spp. range States:

      a) Many of the *Boswellia* populations in Kenya occur in private land or woodlots and some are communally owned. Kenya considers that this is a concern as the cultural protection systems can

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[*] *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

change quickly and the land can be converted to other uses (e.g. irrigated farms). In addition to the pressure at county level to exploit the 'green gold', *Boswellia* species are also fodder for livestock. The Gum Arabic and Resin Association (GARA), formed to help develop the industry and advise the government, could support sustainable utilization of the species. Kenya considers that there still is a lack of policy and infrastructure support in the drylands to allow for proper supervision of production and quality control. Kenya stresses that without establishment of the population status and trends it will be difficult to assure sustainable future production. Since mature trees will reach senesce at one point, Kenya sees the need to establish *Boswellia* plantation farms. The increasing demand demonstrates the importance of urgently assessing the wild population of these species and understanding the inherent status, threats, and management practices to establish a long-term and sustainable conservation model. Control of species in commerce must be based on new biotechnology, including DNA barcoding of products.

b) India expressed concern about a potential genus listing of *Boswellia*, which India finds premature. It would also have a major impact on Indian tribal communities. India finds the listing of Indian populations of *B serrata* unjustified because biological data are available and protective measures are in place. Furthermore, the species can be artificially propagated and identification methods are available.

4.2 Preliminary views from non-range State Parties

a) Germany considers that the main *Boswellia* species in trade suffer from a combination of overharvest and other threat factors, while management, monitoring and regulation is considered poor or even absent in some export countries. Germany considers Appendix-II listing criteria at least for *B. papyrifera* to be fulfilled. Germany considers the available information to be sufficient for a listing, and sees a need for conservation measures, including monitoring of trade at the international level. Germany is aware of possible effects of a CITES listing on traditional sourcing systems and on livelihoods that depend on tapping of *Boswellia* trees and collecting frankincense. It is equally uncertain how trade controls would be implemented and how retail chains would respond. Look-alike issues in the context of a potential Appendix-II listing are also unresolved. Therefore, either better information on the identification of specimens in trade or a genus listing might be necessary to avoid look-alike issues. A genus listing could also address the high risk that trade in CITES-listed species would get substituted by species not yet regulated, and possible conservation problems due to shifts of harvesting pressure.

b) The United States of America identified several gaps. Around six *Boswellia* species are known to dominate international trade. Yet, the potential to switch to other species is not fully worked out, nor the extent of viable alternatives in the market, market trends, and look-alike issues. Population estimates are lacking and some status assessments provide inadequate reference points. Information from some key range States is still lacking. The process and role of "vegetative propagation" is poorly evaluated and species/product market value needs further attention. Data on plantations is inadequate, lacking information on key benchmarks (number of trees, when they were planted, size classes, how many are harvested/how many were harvested, potential/actual yield). Reforestation data are weak in terms of number and age of plants, extent of reforestation efforts, monitoring of reforestation success. Overall, the USA note that conclusions in the document do not appear to be supported by data and recommends that information be supported with citations, expertise, etc. Further data analysis on a species-by-species basis and evaluation of identification methods should follow. Further synthesis and expertise to understand existing trade data, market value, processing volumes, and sourcing, with country-specific follow-up is needed, as well as research on production potential of plantations and potential vulnerabilities due to loss of genetic diversity through vegetative propagation. Further analysis should include existing regulations related to species conservation and management by species and by country.

4.3 Preliminary views from non-Party stakeholders

a) The Centre for Middle Eastern Plants (CMEP) notes that many of the reports on trade are informal and not supported by reliable or official figures, and the sources of the estimates are usually unknown or not cited. An Appendix-III listing could also have positive effects to gather targeted information. Some voices fear that with a CITES listing, trade and associated conservation measures would be jeopardized and trade would be driven underground, especially in Somalia/Somaliland/Puntland. From there, it would be important to also discuss alternative measures and creative thinking could help at this stage. To date, very few recommendations have been made for actions aimed at concrete positive outcomes. The CMEP hopes that their work will

address this perspective and thereby recommend and drive action, such as green status assessment or Appendix III listing, and thus provide measurable goals to work toward.

b) The Global Frankincense Alliance (GFA) provided a detailed and precise paragraph-by-paragraph response to the Secretariat document PC25 Doc. 25. GFA also provided two reports with additional details on *Boswellia* harvest and trade in Somaliland, as well as an invitation and an agenda for a three-day interactive online seminar on *Boswellia*, which took place in March 2021.

c) NeoBotanika considers that evidence to support a listing of any *Boswellia* species is lacking. To carry out a comprehensive and comparative study to fill information gaps, ample time would be needed. The trading pattern of *Boswellia* is very complex and probably the most underestimated element.

External resources in support of Decision 18.205

5. Additionally, the Secretariat received funding to commission a short consultancy for additional research on specific aspects of Decision 18.205, which were not yet covered by the information presented in document PC25 Doc. 25. At the time of writing, the Secretariat is finalizing the procurement process to undertake this work.

Revised recommendations

6. The Plants Committee is invited to

a) consider the information in document PC25 Doc. 25 and its Annexes and the present Addendum and its Annexes;

b) discuss key gaps in knowledge and propose recommendations for further efforts to address the sustainable use and conservation of these species, including whether any *Boswellia* species could meet the criteria for listing in the Appendices;

c) consider the pertinence of extending or revising Decisions 18.205 to 18.208; and

d) report to the Conference of the Parties.

Information submitted to the informal working group on *Boswellia* trees

Input by Germany:

Germany considers it proven that the main species in trade within the genus Boswellia suffer from a combination of overharvest and other threat factors, while management, monitoring and regulation is considered poor or even absent in some export countries. This applies specifically to *Boswellia papyrifera*, the most important source of frankincense oleo-resin. While seemingly not all species and all sourcing regions are affected from overexploitation, the information available on *B. papyrifera* is definitely concerning, with populations of this species being reportedly in a process of collapse on large scales and the important biological resource being generally dwindling (see e.g. Bongers et al 2019). Overexploitation of oleo-resin for commercial trade is not the only threat, but is known to play a significant role in the decline of *B. papyrifera* and other frankincense-producing species.

According to the information compiled in PC25 Doc. 25, PC25 Inf. 7 and the underlying literature and information, Germany would consider the two criteria in Res. Conf 9.24 (Rev. CoP17) Annex 2 a in accordance with Article II, paragraph 2 (a), of the Convention for listing in App. II fulfilled at least for *B. papyrifera*, and the available information sufficient to be supportive to a listing. In order to keep this important biological resource available for livelihoods of harvesters, but also for consumers around the world, conservation measures are needed, which, with regard to the reportedly high international trade volumes, should include monitoring of trade at the international level.

For Germany it is clear that a CITES listing alone would not be capable of solving all problems related to the decline of populations in *B. papyrifera* and, potentially other *Boswellia* species, but that measures on the national and local scale would have to be implemented as well, e.g. protection of populations from grazing and fire and measures to facilitate regeneration in wild population but also in the context of different forms of cultivation (enrichment planting and/or plantations). Nevertheless, even though the implementation of conservation measures on the local and national scale is uncertain, the toolbox CITES can provide to safeguard this wild resource should definitely add value. A CITES listing is likely to raise awareness about the severe conservation issues in *Boswellia* species, which are co-driven by overharvest due to a yet unmonitored trade in frankincense products. With regard to the high global demand for frankincense Germany considers the potential that increased awareness along the entire product chain, in combination with trade controls, will lead to better management and implementation of sustainable sourcing systems bigger than the risk of collapsing income opportunities for local harvesters and a possible drift of trade into illegal channels.

It is shown by some examples in PC25 Doc. 25 and underlying references that locally or nationally well-managed *Boswellia* populations and harvesting systems can sustain local livelihoods and an overall sourcing of frankincense. The FairWild certification of harvests of *Boswellia sacra* in Somaliland also demonstrates opportunities towards sustainable exploitation of *Boswellia* populations and beneficial integration of indigenous communities with international trade chains.

Germany is, nevertheless, aware of uncertainties: Effects of a potential CITES listing on traditional sourcing systems and on livelihoods that depend on tapping of *Boswellia* trees and collecting frankincense as a significant income are, of course, not foreseeable, generally.

Also, with regard to poor implementation capacities in some of the important range states and sometimes unclear national status and/or open administrative jurisdictions, it is uncertain how trade controls would be implemented and how trade chains would react.

Further on, consequences of look a-like issues in the context of a potential App. II listing are unresolved. Frankincense products from different species are not entirely impossible to differentiate but distinct species identification would at least be difficult in common CITES enforcement settings. Therefore, either better information on the identification of specimens in trade or a genus listing might be necessary to avoid look a-like issues, in accordance with Res. Conf 9.24 (Rev. CoP17) Annex 2 b criterion A. A genus listing could also address the high risk that single CITES-listed species would get substituted in global trade by species not yet affected by

CITES controls and possible consequential new conservation problems due to shifts and increases in harvesting pressure.

In case an inclusion of *Boswellia* spp. in CITES App. II becomes conceivable, the concerns regarding *B. serrata* that India has indicated, would have to be evaluated and thoroughly addressed.

Input by India:

India expresses its concerns if a listing of *Boswellia* trees at genus level would be considered or proposed, according to paragraph 21 of the document. A listing at genus level would have a major impact on Indian tribal communities that use extracts of B. serrata as part of their livelihood. More importantly, the biological data available for B. serrata in India and the conservation measures already in place for the species clearly do not justify listing the Indian population in Appendix II. India also emphasizes that the species can be successfully artificially propagated and that identification methods are available to distinguish its extracts.

Paragraph 5 of Annex 1 describes the available identification methods for distinguishing Boswellia species. While several methods appear to be available, including simple gustatory and visual methods, India believes this is a knowledge gap that should be further worked on. Standardized and simple identification methods to distinguish specimens of different species would ensure that only endangered species and populations are listed and that well-managed and abundant populations can continue to be sustainably traded for the benefit of the species and the rural and indigenous communities that harvest its resin.

Input by Kenya:

The fact that many of the *Boswellia* species populations occur in private land or woodlots and some are communally owned, is an immediate concern as the cultural protection systems are quickly changing and the land can be converted to other uses (e.g. pockets of irrigated farms are emerging in the *Boswellia* dominated north eastern) meaning the populations can be lost. In addition, *Boswellia* species are fodder for livestock, this combined with the fact that there is a potential increase in production of the resins and gums following the pressure and awareness at county level on the need to exploit the 'green gold'.

On a different note, the Gum Arabic and Resin Association (GARA), formed to help develop the industry and advice the government on developing an enabling platform could be seen as an important effort towards putting checks and balances for sustainable utilization of the species used for this purpose, but there still lacks policy and infrastructure support in the drylands to allow for proper supervision of the production and quality control practices, especially that benefit both the local and export marketing. This lack is evidenced by information put in some online platforms like https://www.selinawamucii.com/product/kenya-white-frankincense-resin-boswellia-caterii/ that purports to sell "Kenya white frankincense resin" from *Boswellia carterii (*which does not occur in Kenya and thus the need to know which species they collect from). A statement from their website reads "The Kenya frankincense producing tree in Northern Kenya was nothing more than a source of wood, fodder and shade until buyers came knocking. This was in the 1980s when investors from different companies dealing in soft drinks, cosmetics, and paint discovered the hidden wild gem in, Northern Kenya. Frankincense is grown in Marsabit, Wajir, and Mandera counties."

Similarly, the people in the Northern parts of Kenya have a strong attachment to gums and resins, which they have conserved and traded in for a long time. With the collapse of the Somali Republic in the 1990s, many traders relocated to Nairobi (Gachathi & Eriksen, 2011), a move that saw an increase in gums and resins knowledge exchange and a surge in collection and local demand for the products. While this presents an opportunity to link the utilization with international programs on conservation, it also presents an opportunity for heavy exploitation including by natural products bio prospectors and the NGO world in pretense of implementing this programs. This is evidenced by the mushrooming of NGOs working in the northern Kenya, many of which claim to help conserve the species by developing nurseries, evidence and status of which need to be established if overexploitation was to be avoided.

Without establishment of the population status and trends it will be difficult to assure sustainable future production. The same is also supported by the understanding that there is an observed regeneration and only mature individual trees have been harvested overtime. Since these trees will reach senesce at one point, it will be urgent to establish *Boswellia* plantation farms.

Besides conservation challenges, it should be recognized that there are only two main *Boswellia* exploited for aromatic resins. These include *B. neglecta* S. Moore and *B. ogadensis* Vollesen. To increase the volumes, the harvested from *Boswellia* species are often blended with *Commiphora* species e.g. *C. myrrha* (Nees) Engl.,

C. habessinica (Berg) Engl., *C. holiziana* Engl., *C. guidotti* Chiov., *C. erythraea* (Ehrenb) Engl., *C. foliacea* Sprague, *C, playfairii* (Hook. fil.) Engl. and *C, serrulata* Engl as observed by (Chikamai et al., 1996).

Going by the case of *Osyris lanceolata* and *Prunus africana*, the continued demand for *Boswellia* products will no doubt continue to grow and countries or counties where the species occur are increasingly showing interest of establishing industries. This is an obvious case of urgent evaluation of the wild population of these species and understand the inherent status, threats and management practices in order to establish a longtime and sustainable conservation model. Control of species in trade must be based on emerging biotechnology including DNA bar coding of the products.

Boswellia species grow in areas of low tree cover and therefore provide the much needed plant cover as well as shade. They are also good fodder including for bees. However, there is limited information on the species occurring in Kenya, as well as herbarium collections, many of which were collected long time ago, and therefore current status is unknown.

Collection of gums and resins provide the much needed off farm employment for many rural farmers in the drylands, but there is lack of information on status of conservation efforts of the species, that promote natural regeneration. There is need to carry out silviculture studies and assess nursery practices in the Kenyan north, establish appropriate cultivation sites for the various species, and probably the need to introduce other high yielding and market performing species that have been well studied in neighboring countries, in order to sustain the Gums and Resin industry in Kenya.

There is need to assess the tapping methods in use by the collectors, an activity that would help develop regulations to minimize damage to trees during harvesting.

There is need to establish whether *B. papyrifera*, included in the TRAFFIC list among species that need to be prioritized in conservation, occurs in Kenya as documented by Beentje (1994). It is recorded as occurring in K2 at the Kenya, Uganda, South Sudan border, but there are no collections at EA of the same. Studies done in Ethiopia (Gebrehiwot *et al*, 2003) established a decline in the population of *B. papyrifera* as well as lack of regeneration, both of which were related to (i) use of inappropriate tapping methods by unskilled labourers (ii) lack of tapping supervision,(iii) grazing and(iv) land conversion to agricultural lands, among others. All these factors are replicable in Kenya, especially as more pastoralists settle and as the county governments identify gums and resins as “Green Gold”.

There is need to assess the period allowed for a tree to rest after tapping (establish tapping practices which would help assess regeneration potential of species tapped from the wild). This is important because it is likely that more accessible trees are often tapped continuously with no resting periods. From studies done in Ethiopia and Eritrea (Gebrehiwot *et al*, 2003) it was established that seeds from untapped stands had higher germination rates compared to those from tapped stands, and that 3 to 5 years is necessary for wound healing, though other studies (Ogbazghi, 2001) suggest a period between 4 to 14 years for a tree to regain full potential for viable seed production. These are very long periods for species harvested with no supervision or regulations to govern their utilization, and probably reason for more action plans to protect the species from being driven to critically endangered status.

Input by the United States of America:

Below, the U.S. provide brief remarks to highlight gaps and needs but they would first like to acknowledge the Parties, nongovernmental organizations, and other stakeholders that submitted information to enrich their understanding of the status of these species and the impact of international trade on them. And special thanks and recognition to the Secretariat given the enormity of the task and the considerable effort involved in synthesizing, translating, and consolidating the input, as well as the Co-Chairs of our Working Group.

Overall: PC25 Doc 25 and PC25 Inf 3 contain a wealth of information. There would be tremendous value to further analysis of this and other information, follow through on seeking additional information to fill gaps and provide additional trade data, and synthesis of the information provided, which they assume will be undertaken by the consultant hired to assist in completing the tasks directed in Decision 18.205 on Boswellia trees (*Boswellia* spp.). The U.S. note the following specific gaps or recommendations:

The information appears to confirm that approximately 6 species currently dominate the international trade, but the potential to shift to other species is not fully elaborated, including an assessment of the extent to which other species would be viable alternatives in the market, which might include, as relevant, assessing relative species-specific product properties (e.g., relative industry perceptions as to qualities of resin from species to species),

market trends in terms of supply and demand, and look-alike issues such as those identified in Resolution Conf. 9.24 (Res. Conf. CoP17) Annex 6, paragraph 9.

There is a lack of population estimates or insufficient reference points provided with status evaluations (e.g., estimates of the number of trees per hectare but no indication as to the total hectares of actual or suitable habitat).

Although the U.S. are pleased to see that several range countries provided responses to the Notification, they still lack information from some key range countries engaged in international trade as well as information on harvest/exploitation levels, including both domestic and international consumption.

The process and role of "vegetative reproduction" in reforestation/replanting efforts is not well evaluated, including what level of demand/harvest/trade is or could be fulfilled from these trees.

Species-specific/product market value needs further attention. If the resin from *Boswellia* species to the next is considered or perceived by the industry as possessing the qualities that would make it equally useful/valuable/desirable, this could inform the potential impact of international trade in a positive way (i.e., potentially distributing the harvest pressure across more than just a handful of species), or in a negative way (i.e., as resin becomes less available from one species, the harvest pressure may shift to other species in the genus).

Plantations data are weak. Among the information needs are numbers of trees, when planted, size classes, how many are harvest-age/how many harvested, yield (potential/actual)

Restoration data similarly weak in terms of numbers and age of plants, volume of restoration efforts, monitoring of restoration success.

Overall, the U.S. note some inferences or conclusions in the document (e.g., as it pertains to status information or threats to the species) do not appear to be supported by data, as noted in the gaps above and as elaborated to some extent in the following recommendations. To the extent possible, information should be substantiated with citations, subject matter expertise, etc.

Further analysis of data that were submitted on a species by species basis, and further evaluation of identification methods, including by enforcement authorities.

Information such as population estimates or trends, and potential or actual production should be supported by data or an explanation of the assumptions and basis for the values used or calculations made to arrive at these estimates.

Further synthesis and subject matter expertise to understand existing trade data, market value (e.g., is it species-dependent?), and processing volumes and sourcing, with country-specific follow-up.

The role and production potential of plantations and vegetative reproduction with supporting data or information to substantiate underlying assumptions -- numbers of trees, when planted, size classes, how many are harvest-age/how many harvested, yield (potential/actual), vulnerabilities possible as a result of loss of genetic diversity caused by vegetative reproduction, etc.

Further analysis of existing regimes as they pertain to species conservation and management, including but not limited to allowable harvest, and export quotas/volumes – by species and by country.

Better understanding of restoration efforts as they relate to survival of the species.

Another very important issue that the U.S. would flag for the working group's awareness concerns the discussion around whether certain range countries have the ability to implement a CITES listing if adopted by the Parties. While they think it would be important to discuss any potential implementation challenges and capacity building needs related to the adoption of a new listing, they do not believe that those considerations are appropriate in determining whether a taxon meets the biological and trade criteria for listing and indeed, including them in such discussions would be inconsistent with Resolution Conf. 9.24 (Rev. CoP17) on Criteria for amendment of Appendices I and II. Accordingly, they think in any future work it should be clarified that these "additional observations" while potentially relevant to CITES implementation issues are not relevant to CITES listing decisions.

Input by the Centre of Middle Eastern Plants (CMEP):

Below a brief response by the CMEP to PC25 Doc. 25 summarizing a data gathering exercise about *Boswellia* spp.

Para 7 – Although the Global Trees Campaign (GTC) have indicated they will provide updated Red List assessments of *Boswellia* species, this has been in discussion with Alan Forest at the Centre for Middle Eastern Plants (CMEP) at the Royal Botanic Gardens, Edinburgh. Mats Thulin provided provisional assessments in his monograph, but he requested that CMEP check and submit the assessments to the Red List Unit. This was communicated to GTC who indicated that (a) they might upload Mats Thulin's provisional assessments to SIS in the short term, and (b) that CMEP would be running data gathering, workshops, and assessments for all taxa at both national and global level by the end of 2021.

Para 8 – although the material presented to the Secretariat was extensive, the majority of it was already published and publicly available. Further, only 5 out of 22 range States responded to the request for information, and very few of the numerous States that import *Boswellia* products responded. Several stakeholders provided a range of information.

Para 15 – targeted data gathering for conservation assessments is required and underway. Despite some comments, gathering data for such assessments locally is possible given the right tools and resources, and has been achieved in other conflict and disaster affected States for alternate taxa.

Para 16 – a full report on the subject of identification is almost complete. Tools exist for identification of trees in the field that are straightforward to develop and test but are generally not suitable for untrained individuals. Chemical analyses can distinguish among some species, but their application is limited by a lack of systematic sampling within species and across the genus. The capacity, resources and relevant localities to conduct such tests on the traded products requires addressing, bearing in mind that there are currently few regulations requiring such tests to be carried out as trade is not directly tracked at the species level.

Para 18 - it should be taken into account that any mention of *B. neglecta* may treat this as a single taxon, whereas in fact it is recognised as two distinct taxa: *B. neglecta* and *B. microphylla*. Any information on distribution, harvesting and trade should be therefore treated with caution unless specific clarification is cited.

Para 19 – trade estimates are unreliable, as there is currently no global species-specific HS customs code for Boswellia, or for frankincense. The trade data contained in many published reports are extremely out of date and appear very conservative given recent research into trade in the cosmetics industry alone. Further, the relationship between domestic consumption and international trade is virtually unknown – therefore making it extremely difficult to assess whether international trade is a significant threat to any species of *Boswellia* compared to other threats. This is further exacerbated by the fact that these species are threatened by multiple factors, which are yet to be fully documented.

Para 21 – listing of specific *Boswellia* species could potentially have two effects – stockpiling prior to listing and shifting to alternate taxa and range States. As a number of *Boswellia* taxa are threatened by multiple factors and many are narrow range endemics this is an important factor to consider.

Para 23 – there is a distinction to be made in the proposals to cultivate *Boswellia* taxa. Three options exist: restoration of wild unharvested woodlands, establishment or reinforcement of existing *Boswellia* populations assuming sustainable harvesting, or establishment and management of pure stands intended for commercial harvesting only.

Para 25 – there is a good amount of published information on different harvesting practices on a range of taxa in different places. A more systematic approach would be informative.

Para 26 – hosting and facilitating online and remote workshops and events has become more pertinent over the last 12 months but was already prominent in project management when working in remote or conflict and disaster affected areas. Hosting global workshops and events in person for the foreseeable future runs the risk of excluding individuals, States and organisations that are unable to travel. A blended approach remains a viable option.

Additional comments by CMEP concerns a review of range State legislation and regulations that is necessary. This will go some way to assess the capability to regulate and enforce legal and sustainable trade effectively. The CITES Secretariat rightly considers CITES listing for taxa that are considered to be potentially under threat

of extinction due to international trade. However, as noted, the situation with *Boswellia* is complex and comprises domestic use, a range of threats, and a diverse range of States and societal backgrounds as well as international trade. Monitoring the possible positive outcomes of a CITES listing, if adequately implemented, is of the highest importance.

Input by NeoBotanika:

NeoBotanika has clear picture of the situation in Somaliland. However, it seems that the most glaring conclusion from the contents of the document is that the available information does not support the listing of any of the varieties of *Boswellia*.

If a decision was made to carry out a comprehensive and comparative multi-disciplinary, non-partisan and un-biased study in order to fill the in-formation gaps, it would need to be given ample time to achieve its objectives.

The most underestimated element is the trade patterns of *Boswellia*. For example, the production in Yemen or Oman is to a large extent imports from Somalia. In Sudan most of the production is smuggled into Ethiopia and Egypt. Similarly, Djibouti has no production.

Input by the Global Frankincense Alliance – summary of the response to document PC25 Doc. 25

Paragraph of PC25 Doc 25	GFA response
Main document	
11	The habitats are described in general terms and surely there is large variation within each of the species, in terms of soils, rainfall, elevation, and community. For instance, *B. papyrifera* is found along an altitudinal gradient from lowland (500 – 1850 m asl) and with rainfall between 375 and 1200mm per year (possibly even wider), and grows in steep rocky areas, flat deep soil areas, forests, woodlands, and savannas. This variation also occurs for other species (*B. sacra* in Oman and Somalia, *B. serrata* in India, *B. dalzielllii* in Sahel zone.
12	What is meant with "intrinsic vulnerability of *Boswellia* species"? In Sudan the largest production is from North Sudan, especially from Kordofan and Darfur regions. Regulations and guidelines are present for *B. papyrifera* in Ethiopia but not well implemented (yet), as clear incentives are missing. Infestation of *B. papyrifera* trees by bark beetles (mostly longhorns) is severe is some areas and is intensified after heavy tapping, with devastating impact on tree health and tree survival (Abiyu et al 2010, Negussie et al. 2018, Negussie et al in press). Insect infestations have also been reported for B serrata and to a lesser extent for *B. sacra*.
13	Several scientific studies on *B. serrata* in specific localities show that the situation of the species is not so good: degraded, weakly managed. However, the vastness of the area where the species is found can lead to regionally or even locally specific results and situations.
14	A thorough review would be needed to assess this, based on all available information (which is vast, the recent review of Brendler et al 2018 is a good start, together with the information provided in report PC25 Inf. 7).
15A	Threats to *B. neglecta* and *B. rivae* differ from those faced by *B. papyrifera*. Neither species is actively tapped, unlike *B. papyrifera*, and therefore over-harvesting/inappropriate tapping practices are not a threat. Furthermore, agriculture is not common in the rangelands in the Ogaden where these species are abundant (at least in some areas), so the threat of land clearance (significant for *B. papyrifera*) is limited for *B. neglecta* and *B. rivae*. Grazing, and fire, is likely a common threat across all species.
15B	It is untrue that no scientific research has been conducted in Somaliland since the 1980's; in fact, there has been on-the-ground qualitative sustainability research, which have indicated recent supply chain changes, potential sustainability concerns, and relative opacity of the frankincense supply chains (DeCarlo and Ali 2014, DeCarlo et al. 2020, Johnson et al. 2019). There have not been quantitative surveys to determine population sizes, trends, or health, which is the critical next step; for this reason, it's premature to make judgements about the overall health of the populations.
15C	Oman does not have populations of *B. frereana*, as this species is strictly endemic to Puntland (Somalia) and Somaliland. *B. sacra* in Oman grows in two broad zones, the windward side and the leeward side of the mountain range. Water availability in these two zones is very different and so is most probably the health and the status of the populations.

	Cyclones from the south (Arabian Sea) have large impact on survival of trees at the windward side, with occasionally many trees being wiped out by such hurricanes (pers. obs. 2018). This is similarly to the situation for *B. elongata*, and probably other *B.* species, on Socotra (Lvoncik et al 2020). Regeneration status and replacement of trees is hardly formally studied, but is weak on Socotra (Lvoncik et al 2020), and unclear yet for *B. sacra* in Oman.
17	Currently there is an increase in the number of commercial enterprises, especially after the scaling down of a government based company. Community based farmer organisations, and participatory forest management organisations are increasing.
18	Ethiopia and Somalia/Somaliland are the main exporters (Bongers et al 2019, Supplementary materials), but exports vary largely over the years.
19	Ethiopia exports ca. 3500 tons per year, Somalia maybe 2000, so the total numbers should be higher. Total production potential of all species may be high, but the question here is which assumptions were used for estimating it, and what these assumptions imply for long term harvest sustainability. For Ethiopia there are many vague estimations based on rough estimates of areas with *Boswellia*, tree densities in those areas, and per tree production levels. All of these are overestimations, based on very local data and rough and unrealistic guestimates. This surely needs further investigation.
20	USA, and especially some large USA based companies, import increasing amounts of resin / essential oils and may be the largest importer of several species (maybe after China?). These numbers vary large over the years.
21	This largely depends on the particular types of use. For incense burning the species does matter less, for medicinal use of Boswellic acids it may be confined to some species. This also accounts for (some) aromatherapeutic uses. But yes, the trade surely will shift from one species to another and from one state to another, as they see fit and opportune.
22	The threats faced vary by species. Direct observations in Somaliland, Puntland, and Oman suggest that *B. sacra* and *B. frereana* are actively regenerating, in large part because grazing animals are excluded from many areas where the trees grow, and the fact that fires are extremely rare (fire and grazing are the key factors limiting regeneration in Ethiopia and Eritrea and most probably in several other countries such as Sudan and probably India). Increased pressures of forest fragmentation due to human encroachment have been observed. Climate change refugees have also been observed impacting forest integrity. For Ethiopia and Eritrea seed production and seed germination is not the issue, but transition from seedling to sapling and to adults, where grazing and fire are the main drivers. Pressure for food also makes that farmers prefer no new trees on their land, as tree use rights not always belong to them. (What is “biological vulnerability of the genus”?). Vegetative reproduction is relatively easy for *B papyrifera* but insect infestation on sprouting individuals is a serious issue. Habitat loss is a major issue in some regions. Development of *Boswellia* dominated system into other systems is occurring in several regions of *B papyrifera*. In many locations (also for *B. serrata* in India) the wet season presence of seedling is reported but overall lack of saplings (and therefor lack of new adults). With older adults senescing this will create decrease in densities in the near future. Information on max tree ages for *B papyrifera* (Tolera et al 2013, Bongers et a 2019) and *B elongata* (Lvoncik et al 2020) show that hardly any tree is older than 125 years. *B neglecta* in Borana, Ethiopia was found to be not older than 3 decades (Mokria et al 2017). Care has to be taken with the widely held confusion between the presence of seedlings and/or saplings and the sufficient transition into adult trees. Monitoring field studies hardly exist (only few for *B papyrifera*).
23	*Boswellia* IS largely harvested from the wild. Reproduction by seeds is successful in greenhouses, but survival of field transplanted 1-3 years old seedlings is challenging. The “relatively large scale” of “enrichment planting and artificial propagation” is doubtful. Insect damage is a serious issue on out-planted cuttings of *B. papyrifera* in Ethiopia. Commercial plantations (e.g. Oman) have started in the past few years.
24	Little is protected in formally protected areas such and national parks.
25	But that they differ between species (and within species between populations or broad regions) is to expected. Guidelines are available for some species and range states. Monitoring of implementation in the field is not reported.
26	The Global Frankincense Alliance organises a large online workshop mid-March 2021 with many stakeholders.

Annex 1	
1A	There are 23 recognized species of Boswellia, with a 24th species provisionally described (Thulin 2020).
2A	*Boswellia odorata* is a synonym for *B. papyrifera* (Thulin 2020).
3A	Northern Cameroon is a range state for both *B. papyrifera* and *B. dalzielii*. As *B. odorata* is a synonym of *B. papyrifera*, it is certainly a misidentification, but could be either of those species.
4, Table 1 *B. frereana*	*B. frereana* is endemic exclusively to Somalia (Somaliland and Puntland). Observations suggest that the total population of *B. frereana* is indeed large, and successful regeneration has been observed in multiple locations. Field monitoring is needed to show is regeneration is sufficient to replace adults.
4, Table 1 *B. neglecta*	Hido et al. (2019) reports a density of 142 individuals per hectare in South Omo, Ethiopia. Regeneration is reported as hampered, but not absent. Worku et al. (2012) reported a density of 162 individuals per hectare in Borena, southern Ethiopia, with regeneration present. Mokria et al (2017) report max tree age of 3 decades in Borana, Ethiopia.
4, Table 1 *B. ogadensis*	Very little is known about this species, but it is only reported from one small area in Ethiopia, and is presumed to have a very small population. It is presumed Critically Endangered for this reason by both Alemu (2018) and Thulin (2020).
4, Table 1 *B. papyfera*	Surprising that Ethiopia (2020) reports the population status, population trends and habitat trends as unknown. For this species many studies have been done on these issues, in Tigray, Amhara, and Benishangul-Gumuz, reported in MSc and PhD thesis and in many publications. The general picture is summarized in Bongers et al. 2019 (covering 23 locations in Ethiopia, Eritrea and Sudan). Very few trees in populations in the three main regions in Ethiopia reach over 100 years. Insect damage is having strong impacts on tree health and survival (Negussie et al 2018).
4, Table 1 *B. pirottae*	This species is found in areas dominated *by B. papyrifera* and has extremely low density.
4, Table 1 *B. sacra*	A) Quantitative surveys have not been undertaken, and many populations are remote and difficult to observe. It is unclear how Schippman (2018) would have established that half the population is damaged. This figure is mentioned by Farah (1994) as a casual estimation based on fieldwork in the 1980's in Puntland; it is not a strong quantitative estimate and should not be taken as one. B) The total population size in Somaliland is unknown, but presumed large. However, there is not quantitative data on population trends, and direct observations on the ground (DeCarlo et al. 2020) did find intensive harvesting in some populations. While some production is FairWild certified (5 metric tons of resin), this represents only a small fraction of the total estimated production of resin in Somaliland and Puntland (see below), and therefore cannot be taken as an indication of overall sustainable harvesting across all populations. C) As stated above, it is inaccurate that no research has been conducted since the 1980's. Studies including multiple on-the-ground visits and observations in multiple field sites were undertaken by DeCarlo and Ali (2014) and DeCarlo et al. (2020). D) The trees are heavily browsed in some areas in Oman (such as Wadi Dowkah), but there are other locations (north Samhan mountains, Wadi Mughsayl, etc.) where browsing is limited or absent. Regeneration is present in these areas, but transitions to adults needs further study. E) In Oman many studies have been done but monitoring of populations needs attention. Tapping guidelines are available. In Yemen hardly anything is not except for some plant collections.
5	This question is complicated by the common use of unvouchered commercial resin samples for many scientific studies. Studies such as Mikhaeil et al. 2003, Basar 2005, Marongiu et al. 2006, Chen et al. 2013, etc. analyze commercial resin samples that are stated to be *B. sacra*, but are much more likely to be *B. papyrifera* based on the chemical results. Research on confirmed, vouchered specimens from the country of origin is needed to definitely confirm the species identification. For morphological species identification Thulin (2020) is most updated, with photos, drawings, and identification key.

Annex 2	
1C	Current production of *B papyrifera* is by private companies, farmers cooperatives and participatory forest management groups. Current *B. papyrifera* production is by private companies, farmers cooperatives and participatory forest management groups. The former strong dominance of the government based National Gum Enterprise is dwindling in favor of other forms of organised collection. In the field impact is not evaluated yet.
1D	There was reported to be a registry of frankincense landowners in British Somaliland, but it has since been lost. In the Ministry of Trade, the Dept. of Gums and Resins now issues export permits which can contribute data if compelled. In the past, frankincense harvesting was only undertaken during part of the year, and harvesters would re-join their families to conduct livestock herding or other livelihood activities for the rest of the year. However, there has been a trend in recent years to people living in permanent settlements near the harvesting areas and increasingly relying on frankincense year-round. As a result, a good proportion of collectors, at least in Somaliland, are no longer nomads. Overexploitation may exist in some *B. frereana* populations, but it is not common across all populations. Demand has recently shifted for various reasons from *B. frereana* to *B. sacra*. Quantitative surveys are needed to determine the population trends for these populations, but anecdotal field observations indicate that there are multiple intact, healthy populations being left to regenerate with decreased demand. Also note that the FairWild certified material is a total of 5000kg of resin (once distilled, this resin represents 300kg of oil and 2,400L of hydrosol).
1G	Data from 2000 should not be relied upon too extensively; there has been a significant increase in the market demand for frankincense since then. Furthermore, whether collection increases or declines is not inherently tied to the health of the resource base; anecdotal observations suggest that the *B. sacra* trees in some areas are healthy and regenerating.
3	The yield figure of 1-4kg per tree per year has been commonly repeated (Coppen 1995, Langenheim 2003, Gebrehiwot et al. 2003, etc.), but the origin of this figure seems to be from interviews with harvesters or other informants, rather than weighing the amount of resin coming from each individual tree. However, ethnobotanical informants are notoriously bad at supplying accurate quantitative figures (Cunningham 2001), which is why this technique shouldn't be relied upon. Scientific studies that have weighed the resin harvested from individual trees have found significantly lower yields in *B. papyrifera*, *B. sacra*, and *B. serrata*. Exceptional individual trees may produce up to 2kg annually, but the average yield across all trees is consistently found to be between 0.2-0.7kg per tree per year (Ali et al. 2009, Cherenet et al. 2020, Eschete et al. 2012, Al-Aamri 2014, Soumya et al. 2019, Mishra et al. 2012, Tilahun et al. 2011).
4	It is possible that *B. ogadensis* is harvested to some degree, but it is only known from an extremely small population in one location, so it is likely that reports of harvesting are based on a misidentification of *B. rivae*, which grows and is harvested in the same region.
6	The yield figure stated here of 3kg per tree per year is likely inaccurate (see comments on yield above, point 3). While studies on *B. serrata* yield have been limited, two have found yields of significantly less than 3kg (Soumya et al. 2019, Mishra et al. 2012), and studies in other species have found average yields rarely exceeding 0.5kg per tree per year. Therefore, if 1,000 tons is being produced, it implies a harvested population of ~2 million trees.
8	It is unclear whether Puntland or Somaliland is the larger producer of resin, for two reasons. First, both entities claim a section of Sanaag region that produces significant amounts of frankincense resin, so the answer depends somewhat on whether you accept Somaliland's or Puntland's border claims. Second, resin is commonly transported between the two entities before export; as a result, one or other may be exporting more, but it doesn't mean that the resin was produced there. The largest exporter in Somaliland exported almost 1,000 tons of frankincense in 2018 alone, suggesting that the true export figure is likely closer to 1,500-2,500 tons annually (across Somaliland and Puntland). The export figure given by Neo Botanika (500 tons from 60,000 trees) implies that each tree produces an average of 8.3kg annually. This is extremely unlikely, given the repeated findings in scientific studies across multiple species that average yields rarely exceed 0.5kg (no study found an average exceeding 0.7kg per tree per year), and even the highest yielding individual trees rarely exceed 2kg. Considering the estimate of 1,000-2,500 tons of annual export and an average yield close to 0.5kg per tree, this implies a harvested population (not including immature trees, seedlings, inaccessible trees, etc.) of ~2-5 million trees. A Somaliland Ministry of Environment report in preparation for the USAID meeting in 2018

	estimated 90% of adult trees were being actively tapped. The values presented are not so clear as some use a comma, others do not. The sentence, for example, "The last available data from Oman reports 66,707 tons of imports in 2008". Does this mean that Oman imports over 66 *thousand* tons, or over 66 tons? Similarly, the import statistics for Yemen for 2011-12 total 863 *thousand* tons? Or should these be 863 tons, which seems more reasonable.
9	It should be noted that a large amount of frankincense may be brought across the border informally into Ethiopia and sold through Ethiopian traders. This has been reported by multiple traders and would be relatively easy considering that major Sudanese and Ethiopian production sites are located right on the border. There surely is more information available also for recent years. And many details for many years for separate regions in Ethiopia (MSc theses, local papers), and also for Eritrea and Sudan. Not much published only for the early 2000's.
11	The United States of America also has a large market for frankincense essential oils, and there is local distillation of resin into essential oil. More than 1,000 tons of frankincense resin is distilled into essential oil annually, and the United States of America is largest market for this essential oil for its use in aromatherapy.
Annex 3	
1	See comments on earlier issues regarding grazing and fire and sufficient regeneration to replace resin producing adults.
2	Soumya et al. 2019b also found negative effects of harvesting and Lantana camara invasion in *B. serrata* populations in southern India.
3A	Although there may be isolated incidents of actively tapped *B. neglecta* trees, the vast majority of harvesting for this species is by collecting naturally exuded resins. Thus, harvesting has a neutral effect on the species and continuous harvesting has no negative impact (beyond the fact that collectors may also be herding animals, which do limit regeneration by grazing *Boswellia* seedlings).
3C	Land conversion for agriculture and use of Boswellia sacra wood for fuelwood it is limited, as this species rarely grows in areas where agriculture is possible and it is most often protected vigorously by local harvesters/landowners, who use other species for fuelwood. While this may happen in limited instances, it is not a significant threat to the species. Gravel mining is a threat in Oman, but not in Somaliland or Puntland. Grazing by livestock (camels) does occur in Oman, but only in some areas (e.g. Wadi Dowkah) and not in others (e.g. north Samhan mountains); grazing is rare in Somaliland except during times of extreme drought, as landowners protect their trees from animals. Recent qualitative field research (DeCarlo et al. 2020) has suggested that some populations in Somaliland are under pressure and quantitative surveys are needed before any conclusions can be drawn (this is true for populations across all range states).
Annex 5	
2A	Traditional knowledge across most species states that trees should be rested periodically. Recent years have seen frankincense represent a much larger share of local livelihoods in some places (such as Somaliland), which has reduced the ability of communities in these areas to allow resting (in the absence of alternative economic activities). Interviews with landowners and harvesters indicate that continual tapping leaves the trees vulnerable to boring insects (locally called Xare) that can kill the tree (DeCarlo et al. 2020).
2D	It is true that there is deep local knowledge of frankincense harvesting, and locally appropriate tapping practices are transmitted generationally in Somaliland. However, the ability of local harvesters to adhere to these practices depends on their economic and livelihood conditions. For instance, Farah (1994) reported that in the 1980's, harvesters regularly exceeded traditional guidelines and that up to half of the trees may have been damaged, in large part because of the economically exploitative conditions of the frankincense supply chain that tended to trap poor harvesters in cycles of debt. As a result, despite the local knowledge of appropriate practices, it may be difficult for harvesters to adhere to less intense, sustainability-oriented practices if there are no or limited other economic options and prices are so low/unstable that they feel pressure to produce as much as possible each year. Therefore, both the presence of the knowledge base and the conditions to adhere to sustainable practices must be considered.

3C	For Somaliland and Puntland, it is important to consider the ability of governmental entities to enact these laws/management plans. Despite the territorial claims, both Somaliland and Puntland have limited local control in the majority of areas where frankincense grows, especially in the Sanaag region. Instead, local control is primarily in the hands of the clans, which are the key governance entities to engage with when attempting to implement any management plan.
Annex 6	
1	We concur with the concern over the implementation of a CITES listing in Somaliland and Puntland. It is very unlikely that there would be successful cooperation between Somaliland and the central Somalia government. Furthermore, while the expanding market for frankincense has subjected some trees to increased harvesting pressure, it also plays a key role in conservation. As a result of the economic value of frankincense, the trees are protected from grazing animals (with active regeneration as a result), they are almost never cut down, and the most damaging harvesting practices (such as bark stripping) are discouraged. If a listing significantly disrupted trade (which is possible), then these protections may be degraded, or, more likely, the resin would be traded underground across national borders. This would also increase market instability (making it more difficult for harvesters to adhere to sustainable practices, see above) and limit the ability of the private sector to make positive improvements and protections.

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Frankincense in Peril

Analysis of the Resin Economy in Somaliland

Preliminary Findings and Executive Summary

November 28th, 2016

Authors:

Anjanette DeCarlo, Ph.D.
Ahmed Derei Elmi, M.Sc.
Stephen Johnson, B.A.

For more information and for the completed study, contact us at conservethecalmadow@gmail.com

Publication of Anjanette DeCarlo, PhD, LLC

Executive Summary

Background:

In 2010, frankincense prices were low (<$1/kilo of resin), there was relatively little market for the resin, causing harvesters to underbid each other in an attempt to sell product, and the main market was wholesale frereana to Arab middlemen (DeCarlo and Ali 2011). The trees were being overharvested to attempt to sell more volume to make up for the low price. In 2016, we had planned to work on designated test site to conduct analysis on tree health. We used qualitative interview and focus group methods along with applied tree health and direct observation field methods and data collection from site visits. We were able to revisit 3 locations visited in 2010, as well as 2 new locations. To effectively conduct analysis, we formed a consortium of organizations and received support from the government along with forming a team including an expert Somali forester and academics from the University of Erigavo and University of Hargeisa.

Major Findings:

1. Significant changes in the frankincense supply chain, with increasing complexity
In 2010 there was a relatively simple supply chain, with Somali harvesters supplying resin to Somali sorting houses, where it was cleaned and then sold via Somali middlemen to Arab wholesalers. These wholesalers then sold the product onwards to importers in the USA, EU, and China (Figure 1). For the Somalis the industry was largely primary resource extraction, with secondary manufacturing and value added later in the supply chain, with the majority of profits going to non-Somalis (DeCarlo and Ali 2011).

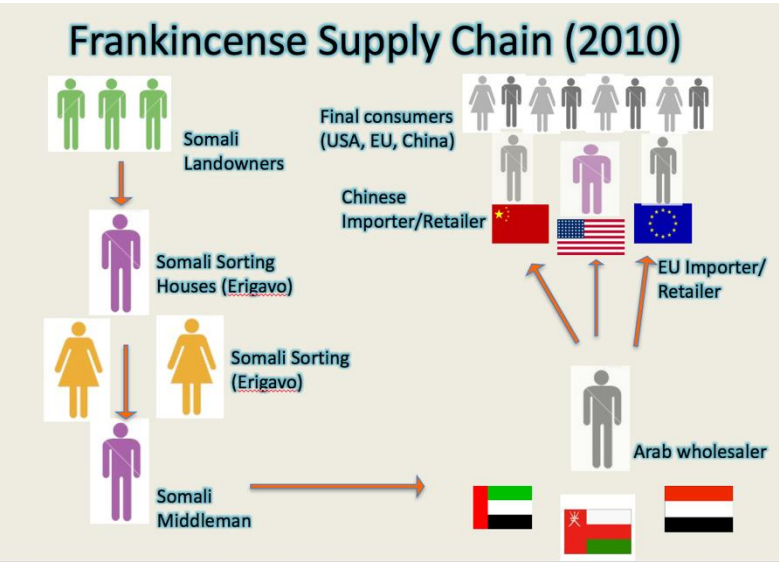

Figure 1. Frankincense supply chain in 2010.

Today, the supply chain has become more dynamic and complex. Somali-owned and international frankincense exporting businesses are major actors that negotiate directly with landowners, control Somali supply for the international market, and significantly influence price and harvesting practices. Consequently, the exporter-landowner relationship is critical to achieving sustainability in the supply chain.

Since 2010, there has been an increase in demand for resin. Over the last five years, Asli Maydi has become the largest exporting company (based on preliminary analysis of Maersk shipping records). The exporters, including Asli Maydi Ltd., Som Gum Trading Ltd. (Internationally Maydi Frankincense), NeoBotanika, Ismael Imports (Internationally Böswellness) and Luban Aromatics typically purchase resin directly from the landowners via middlemen they employ. A number of these companies also harvest resin from their own private lands.

Some of the companies clean the resin at sorting houses they own or rent. In 2010, most of the sorting activity took place in Erigavo, while in 2016 it has shifted to Burao. The resin is then shipped to exporter-owned or partner distilleries in the UK, UAE, USA, and EU where it is distilled into essential oil, a process that adds significant value. In an attempt to benefit the local economy, NeoBotanika has recently constructed a steam distillery in Hargeisa, though it is not yet operational. Additionally, there has been an increase in the sale of bark, both sorted from resin and stripped directly from the tree, to Ethiopia.

After distillation, oils and other byproducts are largely sold to companies that typically use them in cosmetics, perfumes, medicines, and aromatherapy applications (Figure 2). International demand for essential oils has increased as research and marketing have branded frankincense as the 'King of Essential Oils' (Moussaieff and Mechoulam 2009; Prakash et al. 2014; Carmarda et al. 2007; Banno et al. 2006; DoTerra 2016).

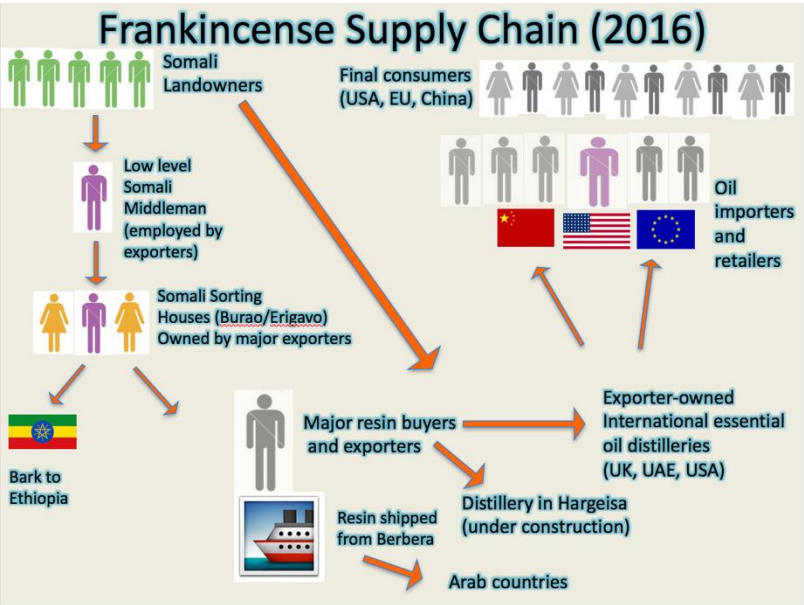

Figure 2. Frankincense supply chain in 2016.

2. Changes in demand and prices for resin

In 2010, the price for resin was approximately $1 or less per kilo, with limited markets and low demand. Consequently, harvesters were underbidding each other in an attempt to sell their resin to exporters, who were sending it primarily to the Middle Eastern market for incense and gum. The economy was based more on Boswellia frereana which is culturally popular in the middle east, while Boswellia carterii had less of a market (DeCarlo and Ali 2011).

We observed dramatic changes in 2016. First the frereana market has declined due to fighting in Yemen and disruption of traditional trade routes, while demand for carterii oils has increased drastically in other international markets. Today, the price of a kilo of raw resin is on average $6, with some of the best quality resin selling for $9 per kilo. The carterii market for Somali frankincense has expanded to include high-value products such as essential oils for cosmetics and medical applications. A rise in demand has led to an increase the price for a limited resource. In fact, demand has outstripped supply and we observed that rather than harvesters underbidding each other, the exporting companies are competing against each other to get access to the resin.

3. High levels of overharvesting and damage to trees

Despite the increased price of the resin, no controls to regulate harvesting practices have been implemented. Consequently, many harvesters have been capitalizing on the dramatic price increase by harvesting as much resin as possible. Illegal harvesting which was already an issue has increased as well. Exporters themselves have also used price war tactics to secure supply ie offering a higher price to landowners. This situation has led to using highly destructive practices including:

A. Overwounding both carterii and frereana trees. We were told in interviews with clan elders that traditional practices call for 6-12 wounds on a tree, depending on the size of the tree. We routinely observed trees with up to 70 wounds, and some with as many as 120 wounds. This practice is highly damaging as it saps the tree's metabolic reserves, limits its ability to defend itself against pests, and exposes the tree to pests and disease (Lemenih and Kassa 2011; Corroborating photograph from findings, Appendix, Figure 3).
B. Bark stripping of Commiphora and carterii trees. We observed that many trees were completely stripped of their bark, which kills the tree. Stripping may temporarily increase resin yield, and the bark is sold to Ethiopia for low-grade incense. However, after a single harvest the tree usually dies (Figure 4).
C. Continuous harvesting/illegal harvesting of carterii and frereana trees. Clan elders told us that tradition calls for a harvest cycle of 2 years of harvesting, May-October (carterii), and then one year of resting. However, our interviews revealed that trees are now harvested every year, and that moreover a double-harvest system has been implemented: when carterii resin is collected in October, the harvesters begin cutting the trees immediately again for a second harvest. This practices drains trees of their metabolic resources, increases their susceptibility to pests, and leads to high rates of tree death (Lemenih and Kassa 2011; Rijkers et al. 2006).

D. Harvesting of immature trees. We observed that harvesters had begun cutting immature trees, which were not yet at a tappable age, in an effort to get more resin. Tapping these immature trees will likely stunt their growth and lead to increased juvenile tree death (Lemenih and Kassa 2011; Corroborating photograph from findings, Appendix, Figure 5).
E. These stress factors have been linked to an inability of the trees to produce seeds (Rijkers et al. 2006). There are also preliminary findings that resin quality is in decline.

4. Rapid dying of adult trees

As a result of these harvesting practices, we observed high rates of adult tree morbidity and mortality across the growing region in areas we visited. We did not observe a single site during the September-October 2016 trip that had well-managed trees or a majority of healthy trees despite repeatedly asking to see healthy areas. This was blatantly obvious at the non-viable study site in Ga'ab where the adult trees were dead and dying (long: 46.83553492, Lat: 10.30832756).

Based on a transect analysis at Madar Moge, less than 25% of the trees observed were in good to fair condition. By contrast, at least 30% of the trees were dead or almost dead, and the remaining 65% were in poor condition (out of 173 adult and adolescent trees, excluding seedlings). Trees that were tagged in Ruqus in 2010 were found dead in 2016. A harvester told us he was losing 20-30 trees per square kilometer per year—a significant percentage of the tree population. In every place we visited, harvesters told us the same cause for the death: overharvesting and a boring worm, most likely a longhorn beetle, called "xare" (Strumia et al. 2007, Groenendijk et al. 2012; Corroborating photograph from findings, Appendix, Figure 6).

5. Animosity towards NGOs, the government, and companies, and the importance of trust-building with local communities

In every place we visited, local people and elders expressed anger towards the government for a lack of representation or services, NGOs for promising aid and failing to deliver, and to the exporting companies for their lack of investment into the communities. The harvesting communities that we visited, without exception, are impoverished and economically dependent upon frankincense. We observed food insecurity, lack of access to clean water, lack of access to medical care, lack of access to education. We were told time and again that if the frankincense trees die, there is no other livelihood available to the people.

These communities are caught in a vicious cycle: they need to harvest less to keep the trees alive, but they have to harvest as much as they can to feed their families. A disturbing increase in the use of a drug known as Qat is driving some of the illegal harvesting and is exacerbating the poverty trap as well. This situation is causing depression, hopelessness and anger. Furthermore, the harvesters know how wealthy the exporting companies have become, and they are angry about the lack of investment back into their communities. They feel that the government, NGOs, and companies have abandoned them, and consequently they are extremely wary of outsiders.

It was critical for us to sit with the elders and in broad community meetings to hear their concerns, discuss our objectives, and not raise expectations about what we were trying to do. We had to build trust with communities in order to be allowed into their territory and to see their trees. Only after they had thoroughly vetted and interviewed us did that allow us into their land, with the following conditions: 1) That we make our research available to everyone, 2) That we would continue to work with the local University, 3) That we did not work with only one company or visit only one elder's territory, 4) That we commit to working in the region long-term, including being in the field and working abroad, and 5) That we did not work for the World Bank. One of our goals was to interview as many people as possible on traditional harvesting practices, tree health, challenges, etc. We interviewed a total of 152 people in 30 focus groups and interview. We incorporate much of the initial findings in this executive summary and further academic publications are forthcoming…Moreover, half of the focus groups involving community leaders specifically expressed a real need to meet with the central government to discuss challenges, and all such groups expressed frustration with their lack of government representation. The Sanaag stakeholders have expressed a clear desire for a series of meetings with decision makers in Hargeisa, to facilitate greater cooperation.

6. The necessity of further ground analysis, use of hand flown drones and remote sensing.
We observed (and were told in interviews, also supported by findings of academic literature review) a disturbing amount of overharvesting, adult tree mortality, and economic conflict within the growing region. However, because of turmoil, time limitations, terrain, having to switch gears in the field and not having a drone, we have not done as much ecological monitoring as the situation warrants. We were told in several interviews with exporting companies, including middlemen, that there are harvesting sites with well-managed trees. Some of these conditions include highly protected private lands, more remote locations, communities that have received education on sustainability and in Puntland. We need to return for a second round of ground analysis to verify these claims. We also must use drones and possibly remote sensing technology in the future. It is also critical to return to continue to hold the trust of the communities: we were told multiple times that we would be allowed into the communities, on the condition that we return and not only visit once.

7. Creation of a Sustainable Resin Supply Chain
Based on our findings in the field and the preliminary analysis of interviews with 152 stakeholders, we can conclude at this time that it is not possible for any landowner or exporting company to verify or make claims that they have a sustainable supply of resin. However, there are companies that care about maintaining the integrity of the trees and the industry. Therefore, to ensure the continued survival of the frankincense forests and the communities that depend on them, a key priority is determining and establishing a certification process for sustainability of the supply chain. This certification process is currently being constructed.

8. Effects of Drought
Currently there is a state of emergency due to severe drought in Somaliland. Based on the fact that rains are shifting and are not as predictable as they were in the past, understanding the links between drought and forest health are imperative. The Cal Madow is a rain producing

forest ecosystem and protecting the vegetation, including the frankincense trees, provides a critical ecosystem service by increasing rainfall in the form of the precipitation-stimulating evapotranspiration cycle (Spracklen et al. 2012). Furthermore, our preliminary assessment indicates that people are cutting deeper and deeper into the tree, to get the olibanum out because the trees are not well hydrated and cannot produce olibanum efficiently. Well hydrated trees require only a shallow surface cut for the olibanum to come out

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https://www.youtube.com/watch?v=atwp2H0AqkM
https://www.youtube.com/watch?v=q1b0i-06mV0&feature=youtu.be

https://www.facebook.com/conservethecalmadow/

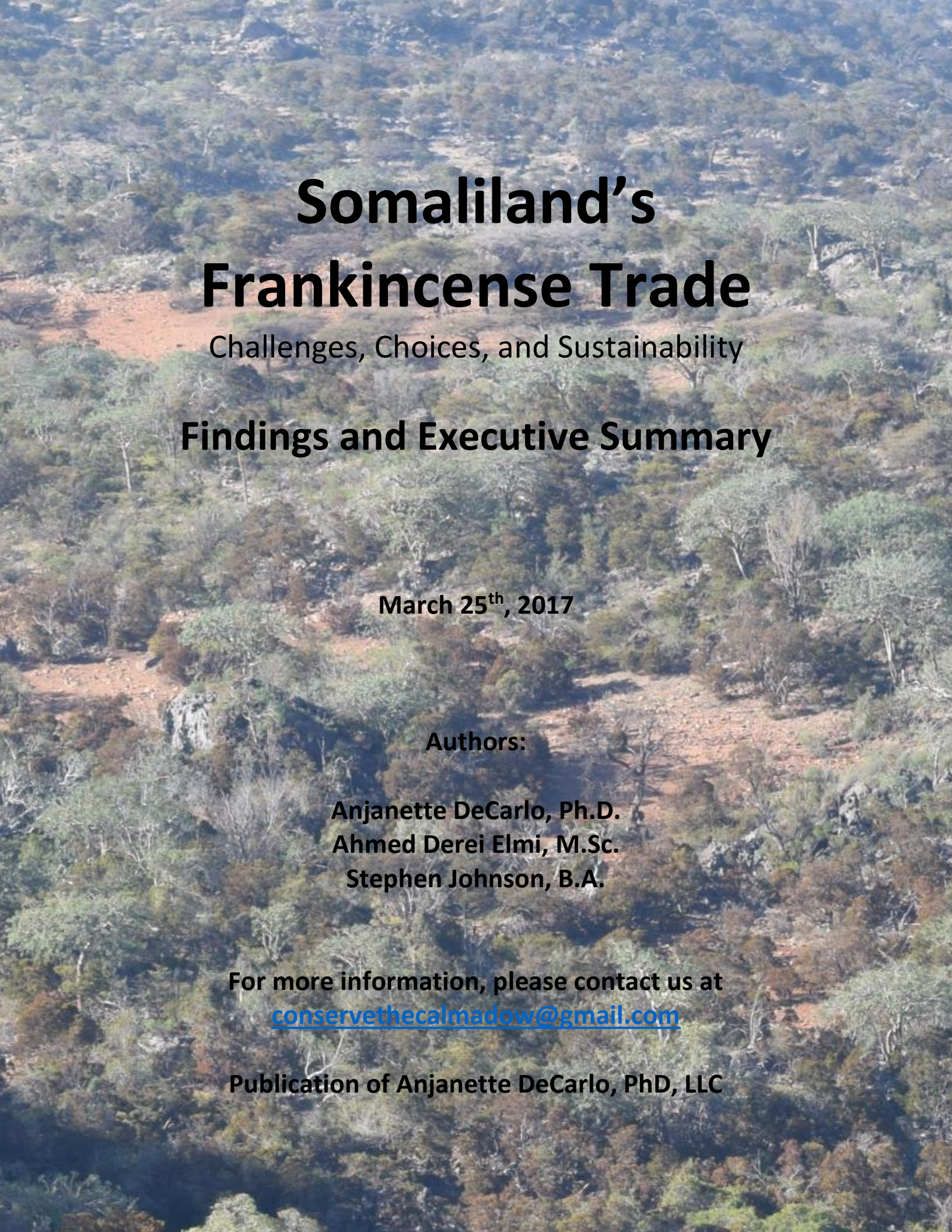
Appendix:

Figure 3. Overwounding on a *B. carterii* tree.

Figure 4. Bark stripped *B. carterii* tree in the Cal Madow.

Figure 5. Immature trees being tapped.

Figure 6. Dead *B. carterii* tree in the Cal Madow.



Somaliland's Frankincense Trade

Challenges, Choices, and Sustainability

Findings and Executive Summary

March 25th, 2017

Authors:

Anjanette DeCarlo, Ph.D.
Ahmed Derei Elmi, M.Sc.
Stephen Johnson, B.A.

For more information, please contact us at
conservethecalmadow@gmail.com

Publication of Anjanette DeCarlo, PhD, LLC

This is the second of the 2016-2017 reports on the status of the frankincense economy and Boswellia forests. It covers the field analysis conducted by the Conserve the Cal Madow team during January 2017. The first report, of the field analysis in October 2016, can be found here: http://www.conservecalmadow.org/wp-content/uploads/2016/12/Frankincense_Major_Findings_October_2016-1.pdf

Map of the growing region:

Below is a map of the growing region, with pins indicating where analysis has been conducted. These areas represent approximately 400 tonnes of resin production per year. Somaliland production is approximately 800 tonnes, with 400 additional tonnes from Puntland for a total Somali production of approximately 1200 tonnes. Thus, we have been at sites representing approximately 50% of Somaliland's production (based on key informant interviews with exporters, distilleries, and international buyers).

Figure 1. Map of the growing region. Pins indicate locations we have visited.

Map of surveyed harvesting locations. Between September 2016-January 2017 we conducted field analysis in and around the locations marked by the red pins. During January 2017 we visited four new locations, three of which were roadless areas and extremely remote (minimum 20km hike to trees). In addition to the core scientific team we also added two technicians from the Ministry of Environment who worked on these locations with us.

We have visited areas with roads and areas that are road less; areas with and without permanent settlements; areas close to human settlements and areas that are extremely remote; extremely arid areas and areas with relatively high levels of precipitation and/or fog; areas with high and low density of frankincense trees. We have also examined differences between carterii and frereana trees. The areas that we've conducted analysis on represent more than half of the carterii resin production in Somaliland.

2. Well Managed Areas

During the January-February 2017 analysis in the growing region, we assessed 2 sites that are actively well-managed. These areas are vibrant and have robust, healthy frankincense carterii trees. These areas can and do provide a wealth of high quality resins for the international market. Their ecological and economic significance is of major importance to the coninuation of the frankincense trade. The existence of these well managed areas is encouraging for the health of Somaliland's frankincense trade.

The two sites differ ecologically and offer an ideal comparison of appropriate management in different ecological zones. Location one is in the western growing region, on the western edge of the escarpment, with a largely arid climate and less vegetation. The density of Boswellia trees here is low, and mists, while present, are limited. Location two, by contrast, is in the eastern growing region, north-facing, just below the escarpment. It experiences higher levels of precipitation and frequent mists, leading to higher levels of biomass and a greater density of Boswellia trees. Trees were fully foliated with turgid, high-chlorophyll leaves, in contrast to the marginal leaf loss characteristic of overstressed trees.

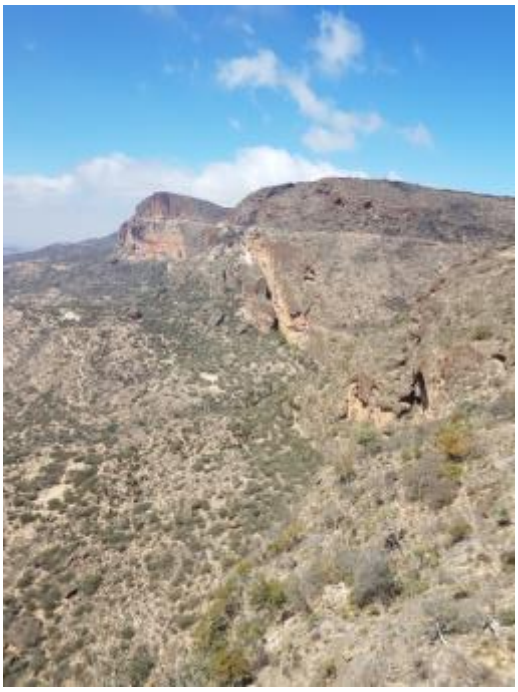


Figure 2. Location One. This area is dry and lower elevation.

Figure 3. Location Two. This area is higher in elevation and much wetter than Location One.

Figure 4. Well-managed tree in Location Two.

Figure 5. Well-managed tree in Location Two.

“Well-managed” here indicates that the harvesters were treating trees either in accordance with, or in close approximation to, the traditional knowledge standards of care that we have determined through literature review and interviews with knowledgeable elders (Appendix 1). We can state that an area is well-managed if it meets the following standards:
1). A harvesting period that does not exceed 6 months
2). Only harvesting for a single season per year
3). Rarely or never placing more than 12 cuts on a single tree
4). Allowing trees to rest periodically
5). Harvesting only adult trees, not seedlings
6). Making only shallow cuts into the bark

We assessed the health of a site both visually and through interviews with the harvester(s) and landowner(s) who work in the area. Interviews entailed discussing harvesting and tree care practices as well as environmental social, and economic issues in the industry. While not necessarily a metric for assessment, we have noticed a correlation between good management of the trees and extensive knowledge and a sense of cultural pride in the harvesters.

Visual assessments were performed both in person and technologically. We assessed both the evidence of harvesting (the number of new and old wounds, open wounds, etc.) and the condition of the tree. Trees that are healthy and well-managed have thick, full canopies with open leaves on every branch. Trees that are being overharvested or are in poor health display branches without leaves and leaves that are smaller and curled. Frankincense trees are hardy, and can remain healthy through 1-2 rounds of overharvesting if large amounts of water are available. However, long-term overharvesting will cause leaf loss and tree decline (Al-Aamri 2014). We observed that well managed areas have higher densities of seedlings, indicating that trees that are less stressed can reproduce and regeneration better than trees stressed by overharvesting (Rijkers et al. 2006).

Figure 6. An appropriate first cut on a Carterii tree.

3. Knowledge and Best Practices

The frankincense trade in Somaliland is ancient, potentially stretching back as far as 6,000 years as a supply for ancient Egypt. As a result, there is a long-standing body of cultural knowledge on how to properly manage the trees. This knowledge has been codified through the traditional legal system, called Xeer law. These laws provide a comprehensive set of rules guiding how and when trees are harvested, how harvesters and traders must treat each other, and how disputes may be resolved. These laws have kept the harvesting sustainable and the trading ethical for thousands of years. In the well-managed areas, the harvesters are still adhering to these rules. We noted that in these areas, the landowners/leaders tended to be older, and were the people doing the harvesting. In the areas with higher levels of overharvesting and greater breakdown of the traditional practices, harvesters tended to be younger and less experienced, newer to the job.

Promoting sustainable management means reviving the traditional sustainable practices while using scientific knowledge and techniques to augment these efforts under a climate change scenario. Support from external buyers will be critical to ensuring that market incentives are provided to help maintain these practices. Luckily, the traditional knowledge provides detailed

guidelines for harvesting techniques, which establishes Best Practices to follow for sustainable resin production.

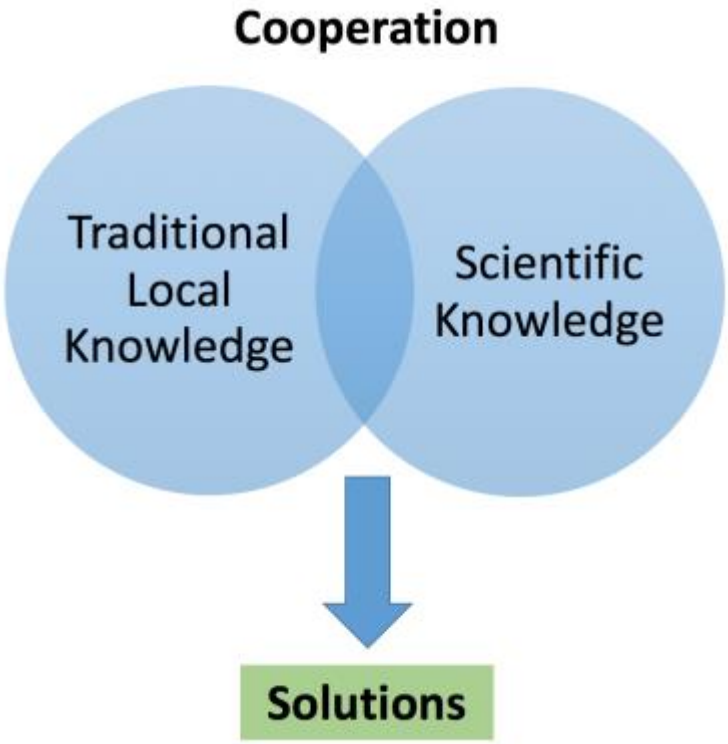


Figure 7. Cooperation between elders holding traditional knowledge and scientists is required to come up with solutions for sustainable management of the trees.

Through literature review of documented practices, studies from Oman and Ethiopia, and interviews with elders and older harvesters, we have determined the following key practices to follow (Appendix 1 for references). This chart is an excerpt from the full report on Best Practices.

Best Practices for Resin Harvesting

	B. Carterii (Beeyo)	**B. Frereana (Maydi)**
Age of First Harvest	First tapping at 15-40 years old Only tap trees greater than 10cm DBH	First tapping at 15-40 years old Only tap trees greater than 10cm DBH
Harvesting Season	April-October (Xagaa) Harvesting outside this season is highly damaging to the trees.	September-June (Deyreed) Harvesting outside this season is highly damaging to the trees.

Resting of Trees	Tap trees for 2 years, then rest for 1 year. Rotate the trees being tapped, so some are tapped each year and some are rested each year. Not all trees produce good resin If the milk does not immediately come out when cut, the tree should be rested. If the resin is red, the tree should be rested.	Tap trees for 2 years, then rest for 1 year. Rotate the trees being tapped, so some are tapped each year and some are rested each year. Not all trees produce good resin If the milk does not immediately come out when cut, the tree should be rested. If the resin is red, the tree should be rested.
Cutting Cycles	8-10 cutting cyles First 3-5 cycles produce little resin. High resin production on cycles 6-8. 15-20 day intervals between cutting cycles	8-12 cutting cycles Best resin produced in the later cycles 15-30 day intervals between cutting cycles
Number of Wounds	Trees should receive 3, 6, or 9 cuts depending on size Young trees should not have more than 3 cuts The largest, oldest trees should not have more than 10-12 cuts	Trees should receive 3, 6, or 9 cuts depending on size Young trees should not have more than 3 cuts The largest, oldest trees should not have more than 10-12 cuts
Size of Wounds	The first cut should not be bigger than 3cm x 4cm Each cutting cycle makes the wound slightly larger The final would should not be bigger than 6cm x 10cm	The first cut should not be bigger than 3cm x 4cm Each cutting cycle makes the wound slightly larger The final would should not be bigger than 6cm x 10cm
Placement of Wounds	Wounds should be made in a channel along opposite sides of the trunk only Wounds should be at least 30cm apart At low elevations, wounds should be made on sides opposite winds and sun. At high elevations, wounds should be made on sides facing winds.	Wounds should be made in a channel along opposite sides of the trunk only Wounds should be at least 30cm apart
Gathering Resin	Resins should be removed at each 15-20 day cutting interval Resins should only be removed when they are no longer sticky Resin should be harvested at each interval	Resins should be removed at each 15-30 day cutting interval Resins should only be removed when they are no longer sticky Resin on the wound should be harvested at each interval, but resin running down to form tears should be harvested on the final cycle

4. Challenges of Overharvesting

The overharvesting and mismanagement we have observed is due to myriad factors, social, economic, and environmental. Rising prices for the resin and an ever-increasing population has resulted in many young, relatively untrained harvesters cutting trees aggressively to take advantage of the prices. However, while these young harvesters may lack the knowledge to properly care for the trees, such traditional knowledge is held by local elders.

The market for carterii resin has dramatically risen over the last decade due to both international demand and to the war in Yemen, which impeded the trade in frereana. This resulted in harvesters focusing their attention on the carterii, and harvesting of these trees is higher than it has ever been. Carterii prices have historically been low, and have recently risen by 600% as a result of this shift, without formal environmental controls. This can understandably encourage people to cut as much as possible, in order to take advantage of the higher prices. Simultaneously, families have continued to grow, resulting in larger numbers of young people in need of jobs. Few opportunities exist outside of frankincense harvesting, and consequently many of these young people become harvesters. The rush to take advantage of high resin prices has resulted in many untrained young harvesters working, and thus a consequent loss of traditional knowledge amongst the younger generation. This has not been aided by an influx of the addictive narcotic khat, which has further increased a desire for quick income.

Untrained harvesters often think that over wounding and cutting deeply will cause the trees to produce more resin, but according to both elders and scientific studies, this is not true and will lead to a decline in tree health. Moreover, this leads to a decline in the quality and chemical composition of the resins, often making them unsuitable for oil production. In recent years, harvesters have been performing a second, winter harvest, which yields lower quality resin and damages the trees' ability to protect themselves. Most of these unsustainable practices are banned by traditional knowledge and xeer law.

Figure 8. Trees that are being overharvested, with far too many wounds. These trees have likely survived because it is only the second time being overharvested and the area is exceptionally wet.

5. Carterii and Frereana differences

Despite both being referred to broadly as frankincense, Boswellia carterii and Boswellia frereana are distinct entities both ecologically and economically. Until the last decade, frereana was the most harvested Boswellia species in Somaliland and the largest resin export. Currently, the market has shifted and now carterii is the most harvested Boswellia species in Somaliland and the most exported.

Figure 9. Boswellia carterii tree.

Figure 10. Boswellia carterii leaves.

Boswellia carterii grows as low in elevation as 5 meters above sea level, but is generally found between 500 and 1400 meters, with the middle of that range preferred in a specific niche along the Gollis mountain range (Thulin and Warfa 1987; pers. obs.). Carterii trees grow on dark, volcanic rock, though they occasionally put roots down into adjacent soil, and have a stronger affinity for water than frereana trees. The carterii trees prefer areas with high rainfall and frequent mists, and produce resin best when in these areas. In good conditions the trees often grow with a single trunk, and have flat, dark green leaves. These trees are harvested between the major rainy seasons (broadly May-September) as hot weather is said to improve the resin quality. Carterii trees produce a resin locally known as *Beeyo,* which has a lighter, sweeter scent than frereana resin and is most commonly distilled into essential oils for cosmetic and aromatherapy applications. The carterii market has dramatically increased over the past 6-7 years, resulting in higher levels of harvesting than previously seen in Somaliland.

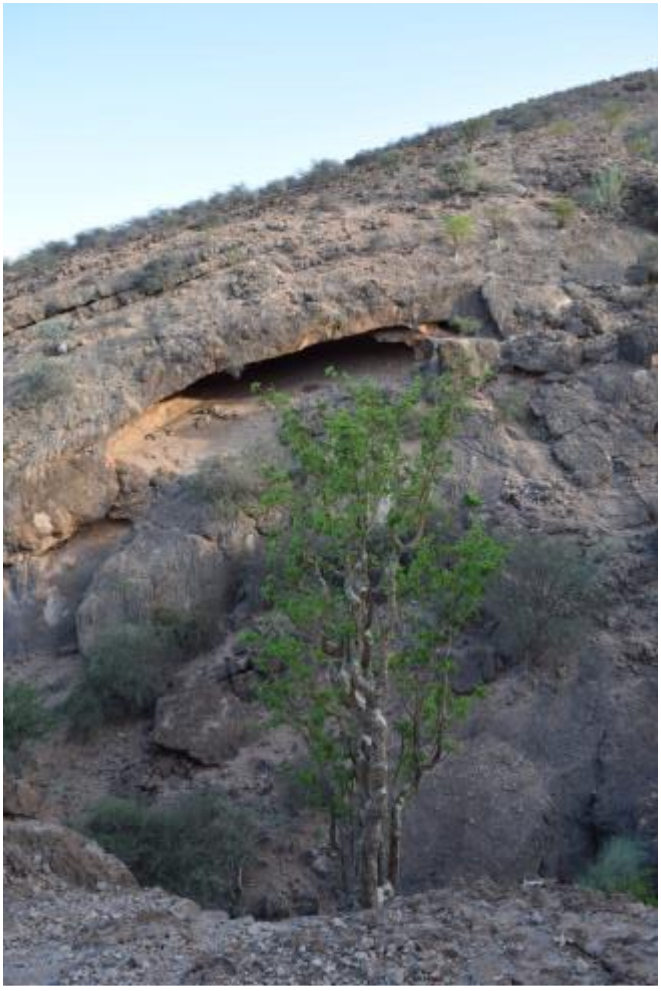


Figure 11. Boswellia frereana tree.

Figure 12. Boswellia frereana leaves.

By contract, Boswellia frereana trees grow from 5-750 meters in elevation, preferring the 5-500m band, in hotter, drier climates (Thulin and Warfa 1987). They prefer red volcanic rocks and are generally hardier than carterii trees. They form many trunks and have light green, undulating leaves. In contrast to carterii, frereana is harvested after the second rainy season, generally October-April. The frereana trees produce a resin that has a deeper, earthier smell than carterii resin. While it is distilled into essential oil as well, the main frereana market is for the resin itself. The frereana resin—unlike the carterii resin—forms large tears which are prized as chewing gum in Saudi Arabia. Historically, the resin was shipped to Yemen and then on to Saudi Arabia. The civil unrest and subsequent war in Yemen has blocked this trade route, and in the absence of alternative routes the frereana market has significantly decreased, resulting in lower levels of harvesting of the frereana trees and greater harvesting pressure on the carterii trees.

6. Bans

During the January 2017 field assessment it came to our attention that false rumors were being circulated that the scientific team was in favor of banning the sale of Somaliland's frankincense. This is false. The team has never conducted any analysis aimed at a ban. Furthermore, there are no discussions with the United Nations, foreign governments or the government of Somaliland to ban. There is no movement to ban Somaliland's frankincense. In fact, conservation bans, in this type of situation have been tried and have proven to be unsuccessful in many cases. A ban could potentially create negative consequences such as a strong informal economy, reduce tax revenue for the government, lower the price per kilo for harvesters, accelerate conflict and corruption and worsen environmental conditions and tree health. Thus we support sustainable forest management and harvesting methods, job creation and community development. Thousands of people rely on the trees for their livelihoods. A sustainable balance and increased prosperity is possible if the stakeholders in this industry cooperate (Mamba 2015, Duffy et al. 2003, Portela 2011)**.**

7. Understanding new markets and empowering landowners

There is a lack of understanding of the international market among many Somali landowners. The increased demand for Carterii in a short period of time has shifted the market. The international buyers especially in the essential oils or natural cosmetics industries require high quality, non-contaminated, and well-managed trees to produce the resins they require for their products. This is less of a concern for companies that adulterate the oils such as the synthetic perfume industry.

What is emerging in the data, from distilleries and independent laboratories, is that not all resins are equal. Some resins contain high levels of chemicals not suitable for oil production. Moreover, overharvested trees often do not have the right ratio of resin to oil to gum for cost-effective oil distillation. There are also cases of resins that are not Carterii (or Frereana) being mixed with the Carterii. This may be difficult for exporters to spot but it becomes clear once the resins are tested in the laboratory; the mixed chemical profile indicates multiple species and the shipment is rejected. In fact, some laboratories report chemical profiles of resins they have never been seen before and could be a new or unidentified species but are clearly not produced by Boswellia carterii. Lastly, many distillers report a general decrease in resin and oil quality over the last few years.

Ultimately, landowners need to be educated about the market and buyers need to:

1. Encourage sustainability and tree health
2. Ensure they are receiving a fair price
3. Have knowledge about what type of resin their trees produce
4. Identify best markets for their product
5. Consider types of production other then only resins for oils or limited resins for the middle east.

8. International Buyers and collaborative efforts

It is clear that the exporting companies and the international buyers have an important role in ensuring this trade continues, equitably, long term and sustainability. This is especially the case in Somaliland where the government has limited resources to be able to regulate. Landowners and harvesters who may be caught in a poverty trap cannot be expected to carry the responsibility for protection of these trees and forests alone. The international demand comes with a responsibility to invest back into communities, not only through a fair price but also through strategic community investments.

Furthermore, the exporters and buyers must account for their demand and the impact that it is having on tree health and forest as a whole. Companies can take advantage of their buying power by demanding and stewarding sustainable management of the trees through continued research, education and outreach, incentivizing sustainability monetarily, supporting

diversification of economic activities, and cooperation/collaboration with stakeholders including landowners, communities, chiefs, government, researchers and other companies.

9. Next Steps

With support from the international buyers who accept responsibility for the demand that they create, we have support to roll out these next steps.

- Release of best practices
- Awareness raising and training on best practices for harvesters
- Analysis of potential development investments in communities
- Verification process that monetarily rewards harvesters that manage their trees sustainably
- Continued research on tree health and ways to make the trees more productive

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Appendix 1
Summarized version of statements provided by interviewees on issues and traditional practices. Complete table available upon request.

	Total Participants: 179		
Row	**Issue**	**Participants**	**Sources**
1	High levels of overharvesting	49	12 (EFE/CF 10/9; GB 10/8; MMH 10/11; GBC 10/12; RQ 10/13; AJC 10/13; BWP 10/15; GE 10/10; BH 9/30, HSH 10/23; BOS 11/2; GBCH 10/12; NBC 10/20; AMW 10/12)
2	Adult trees are dying	38	8 (IJ 10/6; EFE/CF 10/7; GB 10/8; MMH 10/11; RQ 10/13; BWP 10/15; GBC 10/12; GE 10/10)
3	Lack of industry regulation/cooperation causing conflict	49	13 (BH 9/30; EFE/CF 10/9; GB 10/8; MMH 10/11; GBC 10/12; IJ 10/6; BWP 10/15; NBC 10/20; AJC 10/13; AD/A 10/5; HSH 10/23; AMW 10/14; BOS 11/2)
4	Distrust of the World Bank and other NGOs	86	5 (BAM 10/6; MMC 10/11; GBC 10/12; RQ 10/13; AJC 10/13)
5	Distrust of Central (Hargeisa) government	76	6 (BAM 10/6; GBC 10/12; RQ 10/13; MP 10/19; HSH 10/23; AJC 10/13)
6	Feel that companies have abandoned them	25	3 (MMC 10/11; RQ 10/13; AJC 10/13)
7	Communities need projects (Infrastructure, education, clinics, etc.)	52	3 (EFE/CF 10/9; GBC 10/12; RQC 10/13)
8	Dwindling resin output and quality	42	6 (MMC 10/11; MH 10/16; NBC 10/20; GBC 10/12; HSH 10/23; BOS 11/2)
9	Multi-level cooperation necessary to protect trees	26	5 (GBC 10/12; NBC 10/20; BH 10/20; HSH 10/23; AJC 10/13)
	Total Participants: 23		
	Traditional Practices	**Participants**	**Sources**
10	Age of first harvest is 40 years or ~ 10cm	3	3 (Al-Aamri 2014; GE 10/10; MSM 1/27)
11	Tapping cycle is May-Oct for carterii and Sept-May for frereana	9	4 (IJ 10/6; GB 10/8; HSH 10/23; GE 10/10) + Farah 1994; PDRC 2003
12	No more than 6 months of tapping; 3 months is ideal	6	MMS 1/16, MK 1/17, MSM 1/27

13	8-12 tapping cycles for frereana, 8-10 for carterii; 15-30 day intervals	7	PDRC 2003; Farah 1994; MSM 1/27; MK 1/17; HSH 10/23; MK 1/20; Al-Aamri 2014
14	Last cycles yield best resin	3	PDRC 2003; Farah 1994; MSM 1/27
15	Trees must be rested after 2 years of tapping	5	PDRC 2003; Farah 1994; MSM 1/27; GE 10/10; Al-Aamri 2014
16	No more than 10-12 wounds/tree	11	EFE/CF 10/9, GE 10/10, MSM 1/27, Al-Aamri 2014; Eshete et al. 2012
17	Wounds should be small and shallow	9	MMS 1/16, GE 10/10, MSM 1/27, Al-Aamri 2014, Eshete et al 2012, Farah 1994
18	Wounds in a channel on opposite sides of the tree	5	GE 10/10, CF 10/9, Al-Aamri 2014; Eshete et al. 2012, MSM 1/27
19	Gather resin at each cutting interval, when non-sticky	7	PDRC 2003; Farah 1994; MSM 1/27; MK 1/20; HSH 10/23; MK 1/17; Al-Aamri 2014