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

Eighteenth meeting of the Conference of the Parties
Colombo (Sri Lanka), 23 May – 3 June 2019

Species specific matters

TRADE IN *BOSWELLIA* SPP. (BURSERACEAE)

1. This document has been submitted by Sri Lanka and the United States of America.*

Overview

2. The genus *Boswellia* is the source of the aromatic resin known as frankincense, a semi-solid, yellow-brown substance derived from the gummy sap of the tree. Also known as olibanum, this resin and resin-derived essential oils and alcohol extracts are widely traded internationally and are incorporated into a variety of healthcare, home care, aromatherapy, cosmetics and toiletries, and dietary supplement products. Bark, extracts of bark, wood products, and live plants of these species may also be traded internationally. *Boswellia* species provide economic and ecological benefits across their range. However, there is growing concern that increasing demand and unregulated international trade of this high value commodity might threaten the survival of these species. This document provides background information to serve as a background and seek input from Parties and insights from the Plants Committee for further information gathering, review, and discussion to better understand the impact of international trade on these species.

The species and their status

3. *Boswellia* species are the sole source of frankincense, also known as olibanum (Coppen 1995; Hassan Alaamri 2012). The genus includes includes about 18 small to medium tree species that are native to the arid tropical regions of Africa, the Middle East, and South Asia. These trees grow in harsh and arid rocky desert-woodland habitats, often on steep or rocky slopes and are patchy in distribution (Orwa *et al.* 2009; Sultana 2013). They may be the dominant species on ridges, hilltops and drier areas (Orwa *et al.* 2009; Shahabuddin *et al.* 2006). Although the genus occurs in about 21 countries, all but a handful are endemic to single countries (See Annex 1 for a list of species and their distribution) (Abdoul-Latif *et al.* 2012; Coppen 1995; MOE 2012; Orwa *et al.* 2009; Thulin & Warfa 1987; World Checklist of Plant Families 2018).

4. There is considerable morphological variation among the species in terms leaf shape, flowers, fruits, branching, size, and trunk shape (Thulin & Warfa 1987). The trees are deciduous and are leafless much of the year (Mugah *et al.* 1997), and they flower in the dry season, before the leaves come out (Mengistu 2011). Lacking spines, the flaky or papery bark has prominent resin ducts and a reddish brown resinous layer (Abiyu *et al.* 2010; Mugah *et al.* 1997; Thulin & Warfa 1987). Trees begin producing resin at approximately 8-10 years or when the trunk reaches approximately 38cm diameter at breast height (Omani Sites on the World Heritage List 2008; Paramanik *et al.* 2012). Generation length varies by species and is estimated to be 10-15 years for *B. pirottae* (Awas *et al.* 2018) and 20-30 years for *B. ovalifoliolata* (Saha *et al.* 2015).

5. There appear to be no quantitative global or national level population estimates across the entire range of most *Boswellia* species. An exception is *B. sacra* in **Oman**, estimated to be 400,000-500,000 trees (Hassan Alaamri 2012). Some data are available at the subpopulation level (e.g., Abiyu *et al.* 2010; Adam 2008;

---

* *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.*

Bantihum & Tesema 2018; Eshete 2002; Gessmalla *et al.* 2015; Groenendijk *et al.* 2012; Ogbazghi 2001; Ogbazghi *et al.* 2006). However, this information has not been collated or analyzed at the national or global level. See Annex 1 for some population information for various species. Of the 13 species that have been globally assessed by the International Union for Conservation of Nature (IUCN), nine have a threat status of Vulnerable or higher, including Critically Endangered for *B. ogadensis* (Alemu *et al.* 2012), and Vulnerable for *B. bullata* (Miller 2004b), *B. nana* (Miller 2004e), *B. ovalifoliolata* (Saha *et al.* 2015), *B. popoviana* (Miller 2004f), *B. pirottae* (Awas *et al.* 2018), and *B. socotrana* (Miller 2004g). A national assessment in Sri Lanka ranked *B. serrata* as Critically Endangered-Possibly Extinct (MOE 2012).

6. *Boswellia* species are limited by several intrinsic biological factors. *Boswellia* is a sexually reproducing tree that regenerates naturally from the seeds (Eshete 2002). The plants are dioecious, having separate male and female individuals (Sunnichan *et al.* 2005). These trees are self-incompatible, meaning it requires pollen from other individuals for fertilization, and thus *depends on outcrossing* (Vaishnav & Janghel 2018). In a 4-year study of over 675 *B. serrata* trees in three locations in **India**, Sunnichan *et al.* (2005) noted sterile flowers in three trees in one population during the entire study. *Unfertilized flowers do not develop into fruit.* Flower sterility may be caused by insect infestation (see below) or may be a mechanism to enhance pollination. Under open pollination, fruit-set is low, only about 10%. *Poor fruit set limits the number of offspring.* Endosperm is lacking upon maturity of the embryo (seed) (Judd *et al.* 2008), which means that the fleshy food-storing cotyledons nourish the embryo as it germinates. *Seed establishment appears to be a limiting factor and may differ within a species.* A germination study of *Boswellia papyrifera* seed collected from three locations in one population in **Sudan**, yielded *low viability of seeds* (only 4-7%); the other 55% were infested and the remaining seeds 39% were empty (Adam & El-Tayeb 2008). In contrast, significantly higher germination rates were reported for *Boswellia papyrifera* populations in **Eritrea**, with 80-94% germination from untapped trees and 14–16% for seeds from tapped stands (Ogbazgahi 2001). Note that Ogbazgahi (2001) only looked at *healthy* seeds, and the high germination rate implies that germination is not a limiting factor. Whereas Adam & El Tayeb (2008) calculated viability based on the *total* number seeds collected at the study sites, indicating that *a large number of seeds are lost to insect damage or sterility*. Groenendijk *et al.* (2012) looked at survival rates of *B. papyrifera* in **Ethiopia** and found poor regeneration and high adult mortality in both tapped and untapped populations. *Low regeneration* rates have been reported across several species (See Annex 1) (Abiyu *et al.* 2010; Adam & El-Tayeb 2008; Bantihum & Tesema 2018; Eshete 2002; Gessmalla *et al.* 2015; Groenendijk *et al.* 2012; Nour 2008; Ogbazghi 2001; Ogbazghi *et al.* 2006; Sagar & Singh 2005).

7. There is little information on the current status of these species within protected areas, *ex situ* collections or in plantations. There may be plantations in **India** and **Somalia**, although resin production may be lower in cultivated plants (Abdoul-Latif *et al.* 2012; Brendler *et al.* 2018; Thulin & Warfa 1987). The plant can be propagated from seed and cuttings. However, Thulin & Warfa (1987) noted that the characteristic swelling of the trunk does not occur in plants propagated from cuttings. Vaishnav & Janghel (2018) are investigating clonal propagation methods of *B. serrata*, following techniques developed in 1972 for *B. papyrifera* in the **Sudan**. Negussie *et al.* (2018) recently reported a process to enhance rooting of *Boswellia papyrifera* stem cuttings, drawing upon **Ethiopian** traditional knowledge to treat the *Boswellia* cuttings with the milky latex from *Euphorbia abyssinica*. *Boswellia frereana* is reportedly hard to propagate outside its native range of **Somalia** (DeCarlo & Ali 2014).

Utilization and trade

8. These multipurpose species provide ecological and economic benefits. *Boswellia* trees grow in areas unsuitable for traditional agriculture, stabilize soil and hillsides, and provide shade and cover (Hassan Alaamri 2012). They are drought resistant and continue to grow in marginal areas, produce resin used for incense, flower, and grow leaves even under harsh and unpredictable conditions (Abdoul-Latif *et al.* 2012). They serve as nurse trees for other species and seem to resist fire better than some other associated plant species (Orwa *et al.* 2009). Associated animals include yellow-winged bat (*Megaderma frons*) and common cuckoo (*Cuculus canorus*) (Ackroyd & Harvey 2016). Camels eat the fruit in **Djibouti** (Abdoul-Latif *et al.* 2012) and the fruits, seeds, and succulent young stems are used as fodder for goats and camels in **Oman**. Flowers are a source of pollen for native honeybees (Hassan Alaamri 2012).

9. The trees are valued as a source of income for communities living in marginal lands where other plants cannot grow (Bantihun & Tesema 2018; Eshete 2002; Gebrehiwot *et al.* 2003; Hassan Alaamri 2012; Judd *et al.* 2008). *Boswellia* species yield the aromatic resin known as frankincense or olibanum, which is incorporated into a variety of healthcare, home care, aromatherapy, cosmetics and toiletries, as well as dietary supplements. Tapping the trees generally involves making a repeated incision in the bark over a series of months (Abiyu *et al.* 2010; Gebrehiwot *et al.* 2003). The semi-solid, gummy, yellow-brown exudate seeps from the bark and hardens upon exposure to air, often in the shape of a tear drop (Abdoul-Latif *et al.*

2012; Coppen 1995; Ogbazghi 2001). Harvest is mainly seasonal, generally with periods where no harvest occurs during the year (Coppen 1995; Hassan Alaamri 2012).

10. The average resin yield per tree varies across the landscape and among species, and will also depend on whether the trees are tapped continuously or allowed to rest. Recent estimates of production potential and actual production are scant. In **Sudan**, *B. papyrifera* yields an average of 175g/tree (upon the first tapping). A population of *B. papyrifera* in the Nuba Mountains of **Sudan** was recorded as yielding 60-80kg/hectare (Alemu *et al.* 2011). Some researchers estimate an average of 3kg of resin yield annually per tree (Eshete 2002; Hassan Alaamri 2012). In **Oman**, the potential annual resin production has been estimated at ~230 tonnes/year (based on a potential yield of 3kg per tree) (Hassan Alaamri 2012). Whereas the potential production of olibanum in **Ethiopia** was estimated to be 23,000 tonnes in 1981 (Coppen 1995), more recently, Eshete (2002) estimated the annual potential production in the Amhara Region of **Ethiopia** *alone* would be 203,975 tonnes annually (based on 3kg/tree average). It is not clear whether the 10-fold difference is due to better census data, a better understanding of yield, or if the 1981 estimate was based on a narrower area of production. Production volumes also vary by region within a range country. **India** is the main supplier of frankincense derived from *B. serrata* (Brendler *et al.* 2018). Most frankincense is harvested in the Sheopur district in Madhya Pradesh, with an estimated 5,302 quintals (530 tonnes) of frankincense resin harvested annually (Bhattacharya & Hayat 2004), whereas only 99.8 and 27 tonnes from Gujarat and Andhra Pradesh, respectively, were harvested in 2008-2013 (Yogi *et al.* 2014). Brendler *et al.* (2018) provide a synthesis of frankincense production in **India**.

11. Domestic uses abound. In **Djibouti**, **Eritrea**, **Ethiopia**, **Somalia**, and **Sudan**, the resin from *B. papyrifera* and *B. sacra* is chewed and is used in rituals (Abdoul-Latif *et al.* 2012). In **Ethiopia**, *B. papyrifera* paste is used as an antifungal and in perfume and incense (Abdoul-Latif *et al.* 2012; Cassou *et al.* 1997, Lulekal 2008 *as cited in* Kandari *et al.* 2015). In **Kenya**, the smoke of burning *B. neglecta* resin is believed to smoke to repel snakes and flies (Mugah *et al.* 1997). Similarly in **Oman**, *B. sacra* may be used as an insect repellent (Hassan Alaamri 2012). In **India** wood pulp is used for paper; and it makes a good fuel and charcoal that is favored in iron smelting (Orwa *et al.* 2009; Saha *et al.* 2015). In **India** and **Ethiopia**, *Boswellia* wood is also used for fencing, agricultural implements, inexpensive furniture, packing crates, matches, plywood and veneers (Eshete 2002; Orwa *et al.* 2009). In parts of Africa, the gum and resin may be used as adhesives, dyes, and lithographic ink (Abiyu *et al.* 2010).

12. There are few recent estimates of domestic consumption; most information is either subregional or must be gleaned from other data. In **Oman** (*Boswellia sacra*), annual domestic consumption for local celebrations is estimated to be 40-50 tons (Hassan Alaamri 2012). In 1997, the Roman Catholic and Orthodox Churches in **Ethiopia** used an estimated about 2 million kg (2,000 tonnes) of frankincense (Gebrehiwot *et al.* 2003). Eshete (2002) reported that more than 8,100 tonnes of natural gums were sold domestically from 1992-2001 – about 80% of which was *Boswellia papyrifera*. Thus, it an estimated 6,500 tonnes were consumed domestically over a ten-year period.

13. Trade in the Mediterranean region has occurred since at least 1700 BC (Hassan Alaamri 2012). Frankincense trade was recorded as early as the 4th century BC in **Oman** (Al-Gasani 2000). In **Ethiopia**, large-scale frankincense export did not begin until the 1930s (Ogbazghi 2001). The resin has long been used as incense for religious ceremonies around the world (Hassan Alaamri 2012; Mugah *et al.* 1997). There is also a long history of using *Boswellia* species in Ayurvedic, Unani, and Chinese medicine (Al-Harrasi *et al.* 2018; Brendler *et al.* 2018; Iram & Husein 2017; Jayatissa 2012; McCutcheon 2018; Zhu 1998). *Boswellia serrata* is included in the Ayurvedic Pharmacopoeia of **India**, the **European** Pharmacopoeia, and the **United States** Pharmacopeia (ABC-AHP-NCNPR 2016; Brendler *et al.* 2018). The resin and derivatives are incorporated into various dietary supplements (Meins *et al.* 2016) and often processed into essential oils to be used variously in fragrances, cosmetics, and aromatherapy (ITC 2014; Sommerlatte no date (n.d.). With some exceptions, most frankincense is exported from range countries as gum or resin (Bhattacharya & Hayat 2004; Brendler *et al.* 2018; Eshete 2002; McCutcheon 2018; Nour 2008). Some countries export value-added botanicals (such as essential oils or alcohol extracts derived from resin or bark) and products. Products from **Oman** include hair care products, aromatherapy aids, and skin cosmetics; fragrance, embalming, insect repellant, and food industry products (Hassan Alaamri 2012). ***Kenya*** produces commercial incense, essential oils, and shower gel (Mugah *et al.* 1997; Sommerlatte n.d.). As with many other commodities based on natural resources, the market value increases as it moves up the value chain, and the essential oil is valued at ten times that of the resin. There are some exceptions to that trend.

14. Contemporary international trade patterns are incomplete but are clearly multi-lateral, with range countries exporting and importing resin, gum, derivatives, and finished products derived from a variety of *Boswellia* species. *Boswellia frereana* produces a high quality resin known as “maidi” that is exported by **Somalia** where it is endemic (Eshete 2002); *B. neglecta* from **Kenya** (Mugah *et al.* 1997; Sommerlatte n.d.); *B. sacra*

from **Oman** and **Somalia** (the latter especially in a form locally called "beyo") (Eshete 2002); *B. papyrifera* from **Ethiopia** and **Sudan** (Eshete 2002); and *B. rivae* from **Nigeria** (McCutcheon 2018). According to Brendler *et al.* (2018), **India** is the only producer of *B. serrata* oleo-resin for the international market. However, **India** also imports *B. sacra* and *B. frereana* from the **Gulf** and **North Africa** (McCutcheon 2018). **Oman** is likely the source of *B. sacra*, but there are no *Boswellia* species native to Northern Africa. So, while *B. frereana* originates from **Somalia** (where it is endemic), it is unclear what path the raw material takes through the international market. High market demand was reported for *B. ovalifoliolata* (endemic to India) (Saha *et al.* 2015). The major *B. serrata* importers are **Trinidad and Tobago**, **Germany**, **Guatemala**, **Mexico**, and the **United States of America**. Europe is considered the top market for essential oils, especially in France for perfumery (ITC 2014, 2016).

15. It is difficult to assess trade levels in parts and derivatives of *Boswellia* species, as the data can be vague or incomplete. Applicable Customs Codes can be broad and may include other species. However, there are a few codes specific to *Boswellia*: HS Code 1302 1919 pertaining to *Boswellia serrata* extract; HS Code 1301 2990 Olibanum oil from **India**, and HS Code 1301 9020 Olibanum, myrrh and dragon's blood (**China** only). Brendler *et al.* (2018; Table 6) point to sources of trade information from the **Indian** subcontinent, which is mentioned below. Otherwise, information must be gleaned from industry market reports, i.e., dietary supplements and essential oil channels (McCutcheon 2018; MarketWatch 2018).

16. There are few estimates of overall trade volume. Coppen (1995) compiled some trade statistics for the FAO. International exports of incense gum averaged 252.5 tonnes/year from **Somalia** (1975-1980) and 757 tonnes/year from **Ethiopia** (1981-1983). World olibanum trade in 1987 was reportedly 3,200 tonnes (see table below) (Coulter 1987, as cited in Coppen 1995). From 1987-1993, **India** exported an average of 87.5 tonnes/year of frankincense resin (*B. serrata*). In 1997, the **Eritrea** Ministry of Agriculture statistics reported an export volume of 543 tonnes of olibanum resin (FAO 2001). Annual resin production from *Boswellia sacra* in **Oman** is ~70-100 tons/year (Hassan Alaamri 2012) and 702 tonnes/year from **Ethiopia's** North Gandar Zone (in the Amhara Region; Eshete 2002).)

Main sources and volumes of olibanum in world trade in 1987 (from Coppen 1995)

Species	Commercial name	Producing country	Quantity (tonnes)
B. papyrifera	Etritrean type	Sudan, Ethiopia	2,000
B. frereana	Maidi	Somalia	800
B. sacra	Beyo	Somalia	200
B. serrata	Indian type	India	200

17. Coppen (1995) also characterized the international market in terms of main consumers (the **Middle East** and **China**; **Germany** to some extent as well as other parts of **Europe** and **Latin America**) and suppliers (mostly **Ethiopia**, **India**, **Somalia**, and **Sudan**, as well as **Kenya**). In 1995, olibanum was sourced mainly from **Somalia** (from the species *B. carteri (*syn*. B. sacra)* and *B. frereana*); from "southern Arabia" (**Yemen** or **Oman**) (*B. sacra*); with minor amounts from **Somalia** (*B. bhau-dajiana* (syn. *B. sacra*) and *B. neglecta*) and **Ethiopia** (*B. papyrifera*). In 1997, it was reported that "true frankincense is obtained from *B. carteri* [syn. *B. sacra*], and some other species growing in northern **Somalia**, Dhofar [**Oman**] and Hadhramaut [**Yemen**];" and the main species from tropical east Africa were *B. papyrifera* and *B. neglecta* (Mugah *et al.* 1997, p. 21). In 1998, the most important *Boswellia* species for gum production in **Ethiopia** were *B. papyrifera*, *B. ogadensis*, and *B. rivae* (Deffar 1998). The FAO (2001) reported that **Sudan** and **Ethiopia** were the main olibanum exporters from sub-Saharan Africa. Mathe *et al.* (2004) reported the most important species to be *B. serrata*, *B. sacra, B. frereana* and *B. carteri* (syn. *B. sacra*); with inferior forms of frankincense from *B. papyrifera*. More recently, Brendler *et al.* (2018) characterized harvest and trade in *B. serrata* from **India**. Brendler *et al.* (2018) estimate that more than 177 metric tons of *B. serrata* was exported from **India** 2015-2017. Information on global market value is also scant. The *Boswellia* market in the **United States** is mainly for dietary supplements (ABC-AHP-NCNPR 2016).

Increasing international demand

18. Demand for *Boswellia* raw materials is expected to increase as established uses gain new appreciation in the personal care products industry and as new pharmaceutical applications are identified. Gesmalla *et al.* (2015) notes that the cosmetic and pharmaceutical industries hold great potential for development of *Boswellia* commodities. *Boswellia* resin is also used as a substitute for closely-related *Commiphora* species (commonly known as myrrh) (Saha *et al.* 2015) and for balsam (Orwa *et al.* 2009). According to one market

report, the global essential oil trade is expected to have a market value of US$11.19 billion by 2022, driven by increasing disposable incomes and research and development for food, beverages, cosmetics and personal care products (MarketWatch 2018). The **U.S.** sales of dietary supplements containing *Boswellia* increased from U.S.$1.5 million in 2013 to U.S.$2.1 million in 2016 (McCutcheon 2016).

19. With burgeoning studies on the medical applications of boswellic acids, pharmaceutical demand for *Boswellia* raw materials is likely to increase. Recent decades have seen a plethora of research on the therapeutic applications of boswellic acids, including in the treatment of cancer, arthritis, liver and kidney ailments, diarrhea, cholesterol, asthma, microbial, fungal, analgesic uses (Abdoul-Latif *et al.* 2012; Iram & Husein 2017; Moreillon *et al.* 2013; Oliff 2018; Zhang *et al.* 2016). *Boswellia ovalifoliolata* has also been investigated for veterinary applications (Al-Yasiry *et al.* 2016) and as an eco-friendly larvicide (Benelli *et al.* 2017).

20. In addition, it appears that nurseries the **United States** are taking an interest in growing *Boswellia* commercially for home gardeners. *Boswellia sacra* plants are grown as bonsai (Todd's Tropicals 2017; https://www.youtube.com/watch?v=li5i7hvJnE4) and for xeric landscaping (Tortorello 2011; Enlightenment Garden 2016; https://www.youtube.com/watch?v=_p0lqauHrZQ), though frankincense seed is reportedly hard to find and, by some accounts, hard to grow (Tortorello 2011).

Decline / Compounding impacts of intrinsic factors

21. At least seven species are found in international trade: *Boswellia frereana, B. neglecta, B. ovalifoliolata, B. papyrifera, B. rivae, B. sacra, B. serrata* (Abdoul-Latif *et al.* 2012; Al-Gasani 2000; Brendler *et al.* 2018; Eshete 2002; Ogbazghi 2001; Thulin & Warfa 1987). Of these seven, two are endemic and the remainder occur in 3-10 countries (See Annex 1). As noted above, the global status of some species has been assessed (see Annex 1); however the most traded species *B. papyrifera, B. sacra, B. serrata,* and *B. frereana* have yet to be assessed.

22. There is quantitative evidence that *Boswellia papyrifera* has been declining in recent decades in populations located in **Eritrea** (Ogbazghi *et al.* 2006), **Ethiopia** (Abiyu *et al*. 2010; Bantihum & Tesema 2018; Eshete 2002; Groenendijk *et al.* 2012)**,** and **Sudan** (Abiyu *et al*. 2010; Adam & El Tayeb 2008; Gessmalla *et al.* 2015; Nour 2008; Ogbazghi 2001; Ogbazghi *et al.* 2006; Paramanik *et al.* 2012). In the Nuba Mountains of **Sudan,** resin production from *B. papyrifera* declined 20-40% per hectare in the 8-year period from 2004 to 2011, which may be due to declining density of the trees (Ali 2004, *as cited in* Alemu *et al.* 2011). Groenendijk *et al.* (2012) estimate that at the current rate of harvest, *B. papyrifera* in **Ethiopia** yield will decline by 50% in the next 15 years and that the overall population will decline by 90% in the next 50 years.

23. In **Oman**, the primary range state of *B. sacra*, several years of monitoring indicate that trees are being overtapped, leading to declines (Ebuen 2016), and that the method of tree tapping and olibanum collection needs to be revised for long-term tree protection (Hassan Alaamri 2012).

24. There have been no quantitative studies documenting decline in *B. serrata* but there are indicators of decline. The species has been assessed as rare in **India**, with a high extinction risk (Modi & Mathad 2016), and is considered critically endangered or possibly extinct in **Sri Lanka** (MOE 2012). In **India**, and *B. serrata* shows low fruit set and is considered overexploited (Sunnichan *et al.* 2005); scarcity of the resource is leading to adulteration with other parts of the plant and even dirt from the ground near the trees (McCutcheon 2018).

25. Trade in some species has shifted over time, which may reflect a decline in older harvesting areas. Whereas *B. papyrifera* was considered only a minor source of frankincense from **Ethiopia** thirty years ago (Coppen 1995) and may be considered inferior in quality (Mathe *et al.* 2004), today it is widely collected in Ethiopia and declining (Abiyu *et al.* 2010; Bantihum & Tesema 2018; Eshete 2002; Groenendijk *et al.* 2012). Some species have been in trade for many years and although trade volumes appear to have remained constant at the country level, harvested populations may be experiencing serial depletion. This may be the case for *B. serrata* from **India**, where annual exports of frankincense resin has been fairly level over the past 30 years, with average annual exports of 87.5 tonnes/year in 1987-1993 (Coppen 1995) as compared to contemporary average exports of 89 tonnes/year in 2015-2017 (Brendler *et al.* 2018). Unsustainable collection led previously to decline in this species in the Indian state of Gujarat – from an average of 400 tonnes/year in the 1970s to 150 tonnes in the 1990s (Tewari 2014), and not exceeding an average of 20 tonnes/year in 2008-2013 (Brendler *et al.* 2018; Yogi *et al.* 2014). Since 1996, around 530 tonnes of resin has been harvested annually from the forests of Madhya Pradesh, mainly from the Sheopur forest (Bhattacharya & Hayat 2004; Brendler *et al.* 2018). Shahabuddin & Prasad (2004) report that at this level of exploitation, *Boswellia serrata* to become extinct in the Sheopur forest division. Other species appear to be under more recent collection pressure. For instance, the **Indian**-endemic *B. ovalifoliolata*, considered

vulnerable by the IUCN, is reportedly now in high demand for use as a substitute for myrrh gum resin (Saha *et al.* 2015).

26. Lack of or low regeneration is contributing to decline across the range of *B. papyrifera*, the most widely distributed and among the most traded species internationally, in **Eritrea**, **Ethiopia** and **Sudan** (Abiyu *et al*. 2010; Adam & El Tayeb 2008; Abtew *et al.* 2011; Eshete 2002; Gessmalla *et al.* 2015; Groenendijk *et al*. 2012; Nour 2008; Ogbazghi 2001; Ogbazghi *et al.* 2006). Populations of *B. ogadensis*, *B. ovalifoliolata*, *B. pirottae* are declining according to IUCN Red List assessments (see Annex 1) and several of the more localized or endemic species are also exhibiting no and little regeneration, including *B. popoviana* (Miller 2004f), *B. rivae* (Alemu *et al.* 2012), and *B. socotrana* (Miller 2004g). Poor regeneration is also reported for *B. serrata* in **India** (Sagar & Singh 2005).

Threats

27. Habitat destruction, insect infestation, and overtapping for domestic and international trade are threats across these species' ranges.

28. *Habitat destruction:* Throughout **Cameroon, Central African Republic, Chad, Eritrea, Ethiopia, Nigeria, Sudan,** and **Uganda** (Volleson 1989 *as summarized in* Abdoul-Latif *et al.* 2012), threats include farming, overgrazing, fire, and land clearing for shifting cultivation (Oqbazghi 2001 as cited in Abdoul-Latif *et al.* 2012). Overgrazing and use of wood for fuel are also threats (Eshete (2002). In **Oman**, gravel mining erodes soil, increases evaporation of water, decreases nutrient availability – all of which directly affect plant mortality. Adam and El-Tayeb (2008) noted that in **Sudan**, more than half of the seeds produced in three populations were infested and therefore not viable. Increased plant stress reduces seed production, which in turn reduces or eliminates the seed bank, greatly diminishing regeneration potential (Eshete 2002; Eshete *et al.* 2005; Hassan Alaamri 2012).

29. *Insect infestation: Boswellia* species are subject to attack from several species of beetles that bore into live trees. Termites and other insects infest the trees (Oqbazghi 2001; Abdoul-Latif *et al.* 2012). In **Oman**, at least three species of beetles, including *Sphenoptera chalcichroa*, lay eggs in the wounds of the bark and the larvae tunnel under the bark and bore into the trunks of the living trees (Strumia *et al.* 2001 *as cited in* Hassan Alaamri 2012). Wood-boring insects reduce the health of the tree, increasing their susceptibility to disease and contributing to high adult mortality observed in *Boswellia* populations (Groenendijk *et al.* 2012). *Sphenoptera chalcichroa* beetles are also found in **Sudan** and since the 1950s have decimated concomitant *Acacia nilotica* forests (FAO 2007). Infestations have also been reported on *B. papyrifera* in **Ethiopia** (Eshete 2002). In **India**, poor fruit set in *B. ovalifoliolata* has been linked to three predators: a weevil that feeds on buds and flowers; the palm squirrel, which eats the flowers and fruit; and the garden lizard that feeds on the pollinators of the tree, especially bees and wasps (Raju *et al.* 2012).

30. *Overtapping:* Research indicates that trees are being overtapped to meet international demand (for example, *B. serrata* in **India** (Bhattacharya & Hayat 2004); *B. sacra and B. papyrifera* in Djibouoti (Abdoul-Latif *et al.* 2012); *B. papyrifera* in Ethiopia and Eritrea (Abiyu *et al.* 2010; Eshete 2002; Mengistu 2011). In **Oman**, where the majority of *B. sacra* is found, declines reported following several years of monitoring (Ebuen 2016) are attributed to inappropriate tapping methods, little oversight during tapping, and more accessible trees contribute to trees often being overtapped and harvested continuously throughout the year (Hassan Alaamri 2012). Inappropriate tapping methods might include making cuts that are too deep or too long, in effect, girdling the tree. Ogbazghi (2001) noted that germination is higher and regeneration is better in areas that are closed to tapping or that have not been tapped. Since tapping occurs during the dry season when the trees are leafless, Mengistu (2011) reports that tapping the tree depletes carbon stores and forces the tree to make trade-offs in defences, vegetative growth, flowering and fruit production. Overharvested populations are characterized by a lack of young and sapling size classes. The lack of young trees and saplings and high mortality of adult trees in populations across these species range is indicative of poor regeneration (Abtew *et al.* 2011; Gessmalla *et al.* 2012; Nour 2008; Ogbazghi 2001; Ogbazghi *et al.* 2006). Overtapped trees have a lower pollination rate (16%) as compared to healthy trees (80%) (Rijkers *et al.* 2006). Sunnichan *et al.* (2005) found lower fruit set in tapped trees. Poor harvesting practices are contributing to decline in these species (Oqbazghi 2001; Abdoul-Latif *et al.* 2012) and the method of tree tapping and collection needs to be revised for long-term tree protection (Hassan Alaamri 2012).

Summary and Recommendations / Recommendations

31. International demand for frankincense appears to be increasing and there are growing concerns of overharvest for the medicinal and aromatic plant trade. Given the threats facing this species, coupled with its vulnerability to intrinsic (e.g., lack of young trees; declining population trends; decreased seed set) and

extrinsic factors (e.g., habitat loss; disease; overharvest), there is growing concern that unregulated international trade of frankincense might threaten the survival of these species. Information is incomplete and more data on the status, management, and trade in these species would be beneficial in order to more fully understand the impact of international trade in the species. In support of initiating a process to obtain more information and elucidate the impacts of international trade, Sri Lanka and the United States of America submit the following draft decisions for consideration and adoption by the Conference of the Parties.

Directed to the Secretariat

18.AA The CITES Secretariat shall issue a Notification to the Parties within 60 days of the conclusion of CoP18 requesting the following information:

a) biological data on *Boswellia* species, including population size, distribution, status and population trends;

b) available information about harvest and exploitation levels, trade names, and supply chain characteristics for domestic consumption and international trade;

c) information on threats to these species, especially as it pertains to the impact of harvest on these species;

d) information on any initiatives to artificially propagate these species or produce plantations of them;

e) existing regulations pertaining to the species and their habitat and management measures in place or under development, including sustainable harvest studies; and

f) suggestions for meetings or other venues that might provide opportunities to collaborate or share information regarding harvest and management of these species.

18.BB The CITES Secretariat shall compile responses from the Parties regarding the status, management, and trade in *Boswellia* species and provide these responses at the 25th meeting of the Plants Committee to inform their work.

Directed to the Plants Committee

18.CC The Plants Committee shall discuss and evaluate the information received and other relevant information available to it regarding the status, management, and trade in *Boswellia* species, highlighting key gaps in knowledge and making recommendations to inform 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.

Directed to the Parties

18.DD Range countries, consumer countries, and other countries involved in management, propagation, or trade of *Boswellia* species are encouraged to provide information regarding the status, management, and trade in *Boswellia* species.

COMMENTS OF THE SECRETARIAT

A. The Secretariat notes that none of the species in the genus *Boswellia* spp. are presently included in the CITES Appendices and that, therefore, only limited resources can be directed to work involving these taxa. The Secretariat acknowledges however that the analysis provided by Sri Lanka is based on thorough research.

B. The main purpose of the document seems to initiate “a process to obtain more information and elucidate the impacts of international trade” in *Boswellia* spp., presumably in anticipation of possible CITES-listing proposals. In this regard, and taken account of section C of Annex 6 of Resolution Conf. 9.24 (Rev. CoP17) on *Criteria for amendment of Appendices I and II*, draft decision 18.AA (presented in paragraph 31) could focus on those areas that seem most in need of information, i.e.:

i) species characteristics – role of the species in its ecosystem: The document does not provide information on this aspect.

ii) habitat trends: *Boswellia* habitats are described in paragraphs 3 and 8 of the document as desert-woodland in areas unsuitable for traditional agriculture. This seems contradicting to paragraph 28, which states that threats include farming and land clearing for shifting cultivation. Some drivers of trends in habitat availability (e.g. desertification, and climate change) seem not to be considered.

iii) threats: The document emphasises poor regeneration capability of the genus, partly linked to poor harvest and management practices, yet to what extent management and international trade are relevant drivers of the changes in the genus' regeneration capability would warrant more analysis.

iv) species management: information on this seems to be lacking in order to better understand the role of stakeholders close to the harvest (whether they are individual or informal collectors, local collector associations, or formal businesses; or whether harvest is centralized or decentralized), ownership rights (legal or customary structures governing the resource) and sustainable harvesting practices.

C. Draft decision 18.AA proposes to collect information on *Boswellia* species through a Notification to the Parties. However, this may not be the most effective way of collecting data, bearing in mind that calls for species-specific data do not always generate many replies, and that this is even less likely for non-CITES listed taxa. Thus, the Secretariat suggests that direct consultations with relevant range States and Parties, institutions, and industry associations, if they exist, or industry stakeholders, which might be more effective in addressing the noted knowledge gaps.

D. As an alternative, and while the information needed to support an Appendix listing in compliance with Resolution Conf. 9.24 (Rev. CoP17) is gathered, the Secretariat suggest Sri Lanka (and other range States) to consider listing *Boswellia* spp. in Appendix III as a means to obtain updated trade data.

E. The Secretariat would like to point that the document on *CITES implementation for trade in medicinal plant species* (document CoP18 Doc. 55) concurs with the analysis in this document regarding the need for better understanding of pertinent supply chain characteristics, and the need to liaise with relevant stakeholders.

F. If the Conference of the Parties decides to adopt draft decisions on *Boswellia* spp. along the lines of what is being proposed in paragraph 31, the Secretariat would suggest amendments to take account of its comments in the paragraphs above, as shown in Annex 2.

G. If the draft decisions are agreed as amended by the Secretariat, the Secretariat is of the view that most of the work proposed in the draft decisions in Annex 2 could be accommodated within the regular staff time of the Secretariat, as specified by Sri Lanka in Annex 3.

References

ABC-AHP-NCNPR Botanical Adulterants Program. 2016. Evaluation of the Authenticity and Quality of Top-Selling Boswellia Products by HPLC-Triple Quadrupole Mass Spectrometry. Botanical Adulterants Monitor Issue 8.

Abdoul-Latif, FM, LC Obame, IHN Bassole & MH Dicko. 2012. Antimicrobial activities of essential oil and methanol extract of Boswellia sacra Flueck. and Boswellia papyrifera (Del.) Hochst from Djibouti. International Journal of Management Modern Sciences and Technologies 1(1):1-10.

Abiyu, A, F Bongers, A Eshete, K Gebrehiwot, M Kindu, M Lemenih, Y Moges, W Ogbazghi & FJ Sterck. 2010. Chapter 7-Incense woodlands in Ethiopia and Eritrea: regeneration problems and restoration possibilities. In: Bongers F, Tennigkeit T, editors. Degraded forests in Eastern Africa: management and restoration. Oxford: Earthscan. pp. 133–152.

Abtew, A, J Pretzsch, T Mohamoud & Y Adam. 2011. Population structure, density and natural regeneration of Boswellia papyrifera (Del.) Hochst in Dry woodlands of Nuba Mountains, South Kordofan State, Sudan. DITSL GmbH, p. 245. Bonn, Germany.

Ackroyd, H & D Harvey. 2016. Conflicted Seeds + Spirit. Exhibition of new works by Ackroyd & Harvey at the University of Cambridge. Online at: https://www.conflictedseeds.com

Adam, AA & AM El Tayeb. 2008. A Comparative Study of Natural Regeneration of B. papyrifera and Other Tree Species in Jebel Marra Darfur Sudan. Research Journal of Agriculture and Biological Sciences 4(1): 94-102.

Al-Gasani, A. 2000. Land of Frankincense. UNESCO World Heritage List website: https://whc.unesco.org/en/list/1010

Al-Yasiry, RMA1, SAH Jawad, KJ Menati, SA Naji & IH Lokman. 2016. Effects of Boswellia Carterii And Boswellia Serrata in Drinking Water on the Growth Performance, Hematology Traits and Immune Response of Broiler Chicken. *Research & Reviews: Journal of Food and Dairy Technology* 4(4):27-37.

Alemu, AA, J Pretzsch, TES Mahmoud & YO Adam. 2012. Commodity chain of Frankincense from the dry woodlands of Nuba Mountains, South Kordofan State, Sudan. Small-scale Forestry 11(3): 10.1007/s11842-011-9189-4.

Alemu, S, S Alemu, H Atnafu, T Awas, B Belay, S Demissew, WRQ Luke, E Mekbib, S Nemomissa & J Bahdon. 2018a. Boswellia ogadensis. The IUCN Red List of Threatened Species 2018: e.T34385A128140745. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T44814A10950258.en.

Alemu, S, S Alemu, H Atnafu, T Awas, J Bahdon, B Belay, S Demissew, WRQ Luke, E Mekbib, Musili, P. & S Nemomissa. 2018b. Boswellia rivae. The IUCN Red List of Threatened Species 2018: e.T128044164A128044176. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T37866A10082448.en.

Awas, T, B Belay, S Demissew, S Nemomissa, E Mekbib, H Atnafu, S Alemu & Alemu. 2018. Boswellia pirottae. The IUCN Red List of Threatened Species 2018: e.T34394A128137387. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126567A50131280.en.

Bantihum, A & T Tesema. 2018. Regeneration Status of Acacia polyacantha and Boswellia papyrifera Species in Shimelegir Forest, Jawi District, Ethiopia. Journal of Natural Sciences Research 8(14):27-36.

Bhattacharya, P & SF Hayat. 2004. Sustainable NTFP management for fural development: a case from Madhya Pradesh, India. Interntional Forestry Review 6(2):161-168.

Brendler, T., JA Brinckmann, & U Schippmann. Sustainable supply, a foundation for natural product development: The case of Indian frankincense (*Boswellia serrata* Roxb. ex Colebr.). Journal of Ethnopharmacology 225:279-286. doi: 10.1016/j.jep.2018.07.017.

Coppen, JJW. 1995. Flavours and fragrances of plant origin. Rome : Food and Agriculture Organization of the United Nations. . 108 pp. Available http://www.fao.org/docrep/V5350e/V5350e00.htm#Contents

DeCarlo, A & SH Ali. 2014. Sustainable sourcing of phytochemicals as a development tool. The case of Somaliland's frankincense trade. The Institute for Environmental Diplomacy and Security. University of Vermont. Available: http://www.uvm.edu/ieds/sites/default/files/Somaliland_3_27_14.PDF

Deffar, G. 1998. Non-Wood Forest Products in Ethiopia. Rome, Italy: EC-FAO Partnership Program. http://www.fao.org/docrep/003/x6690e/X6690E01.htm#P226_14410

Ebuen, Y. 2016. Protecting the frankincense. Sultanate of Oman, Ministry of Information. https://omaninfo.om/english/module.php?module=topics-showtopic&CatID=35&ID=2744

Eshete, A. 2002. Regeneration Status, Soil Seed Bank and Socio-economic Importance of Boswellia papyrifera (Del.) Hoschst. in two Woredas of North Gondar Zone, Northern Ethiopia. Master's Thesis, Swedish University of Agricultural Sciences and Wondo Genet College of Forestry.

Eshete, A, D Teketay & H Hulten. 2005. The Socio-Economic Importance and Status of Populations of Boswellia papyrifera (DEL.) Hochst. in Northern Ethiopia: The Case of North Gondar Zone. Forests Trees and Livelihoods 15:55-74.

FAO (Food and Agriculture Organization). 2001. Global Forest Resources Assessment 2000. FAO Forestry Paper No. 140. UN Food and Agriculture Organization, Rome. Online: http://www.fao.org/docrep/004/y1997e/y1997e0f.htm

FAO. 2007. Overview of forest pests: Sudan. Forest Health & Biosecurity Working Papers FBS/31E. FAO: Rome, Italy. 18 pp. http://www.fao.org/forestry/12279-0139fe4fdeb6e212bc4c1d24d189d3663.pdf

Gessmalla, AF, EYA Raddad & GEA Ibrahim. 2015. Effects of tapping date, tapping direction and elevation on resin yield from Boswellia papyrifera in the Blue Nile State, Sudan. Natural Resources, Agricultural Development and Food Security-International Working Paper Series 15(12):14 pp. Online: http://economia.unipv.it/naf/

Groenendijk, P, A Eshete, FJ Sterck, PA Zuidema & F Bongers. 2012. Limitations to sustainable frankincense production: blocked regeneration, high adult mortality and declining populations. Journal of Applied Ecology. 49:164–173.

Hassan Alaamri, MM. 2012. Distribution Boswellia sacra in Dhofar Mountains, Sultanate of Oman: Economic Value and Environmental Role. Journal of Life Sciences 6:632-636.

Iram F, SA Khan & A Husain. (2017). Phytochemistry and potential therapeutic actions of Boswellic acids: A mini-review. Asian Pacific Journal of Tropical Biomedicine. Vol 7(6), 513-523. https://doi.org/10.1016/j.apjtb.2017.05.001

ITC (International Trade Centre). 2014. Market Insider: Essential Oils & Oleoresins. Geneva: International Trade Centre. https://studylib.net/doc/18120304/essential-oils-and-oleoresins-market-insider

ITC. 2016. Market Insider: Essential Oils & Oleoresins. Geneva: International Trade Centre. Geneva: International Trade Centre. Available: https://bit.ly/2BCXdGW.

Jayatissa, LP. 2012. Ayurvedic Medicinal Plants of Sri Lanka: Boswellia serrata. IAAM (Institute of Ayurveda and Alternative Medicine) & IAAM (Institute of Ayurveda and Alternative Medicine). Online database: http://www.instituteofayurveda.org/plants/index.php

Judd, WS, CS Campbell, EA Kellogg, PF Stevens & MJ Donoghue. 2008. Plant Systematics: A Phylogenetic Approach 3rd ed. Sinauer Associates, Inc., Sunderland, Massachusetts, USA.

Kandari LS, Negi T, Thakur AK, et al. (2015) Ethnobotanical and indigenous knowledge of important plants in East Hararghe, Eastern Ethiopia. Journal of Mountain Science 12(6): 1521-1533. DOI: 10.1007/s11629-014-3137-7.

MarketWatch. 2018. Essential Oil Market to Attain a Value of US$27.49 Bn by 2022; Booming Beauty and Personal Care Industry to Augment Sales of Essential Oils, Says TMR (Transparency Market Research). Press Release, Nov. 27, 2018. Online at: https://on.mktw.net/2Ri20Da

Mathe C, G Culioli, P Archier & C Vieillescazes. 2004. High-performance liquid chromatographic analysis of triterpenoids in commercial frankincense. Chromatographia 60(9/10):493-499.

McCutcheon A. 2018. Adulteration of Boswellia serrata. Austin, TX: Botanical Adulterants Prevention Program; Botanical Adulterants Bulletin. 2018.

Meins J, C Artaria, A Riva, P Morazzoni, M Schubert-Zsilavecz & M Abdel-Tawab. 2016. Survey on the quality of the top-selling European and American botanical dietary supplements containing boswellic acids. Planta Med. 2016;82(6):573-579. doi: 10.1055/s-0042-103497.

Mengistu, TM. 2011. Physiological ecology of the frankincense tree. PhD Thesis, Wageningen University and Research Centre, The Netherlands.

Miller, A. 2004a. Boswellia ameero. The IUCN Red List of Threatened Species 2004: e.T30414A9546504. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T30414A9546504.en.

Miller, A. 2004b. Boswellia bullata. The IUCN Red List of Threatened Species 2004: e.T44812A10950015. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T44812A10950015.en.

Miller, A. 2004c. Boswellia dioscoridis. The IUCN Red List of Threatened Species 2004: e.T44813A10950138. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T44813A10950138.en.

Miller, A. 2004d. Boswellia elongata. The IUCN Red List of Threatened Species 2004: e.T30415A9546667. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T30415A9546667.en.

Miller, A. 2004e. Boswellia nana. The IUCN Red List of Threatened Species 2004: e.T44814A10950258. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T44814A10950258.en.

Miller, A. 2004f. Boswellia popoviana. The IUCN Red List of Threatened Species 2004: e.T37866A10082448. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T37866A10082448.en.

Miller, A. 2004g. Boswellia socotrana. The IUCN Red List of Threatened Species 2004: e.T30416A9546843. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T30416A9546843.en.

Modi, RK & P Mathad. 2016. Floristic diversity with reference to rare and threatened plants from the forest of Yadgir District, Karnataka, India. International Journal of Scientific Research in Science, Engineering and Technology 2(4): 2394–4099.

MOE (Ministry of the Environment). 2012. The National Red List 2012 of Sri Lanka; Conservation Status of the Fauna and Flora. Ministry of Environment, Colombo, Sri Lanka. viii + 476pp.

Moreillon JJ, RG Bowden, E Deike, J Griggs, R Wilson, B Shelmadine, M Cooke & A Beaujean. 2013. The use of an anti-inflammatory supplement in patients with chronic kidney disease. *J Complement Integr Med.* 10(1):1-10. doi: 10.1515/jcim-2012-0011.

Mugah, JO, BN Chikamai, SS Mbiru & E Casadei. 1997: Conservation, Management and utilization of plant gums, resins, & essential oils. Proceedings of a regional conference for Africa held in Nairobi, Kenya-6-10 October 1997. Available: www.fao.org/3/a-x0098e.pdf

Negussie A, R Aerts, K Gebrehiwot, E Prinsen & B Muys. 2009. Euphorbia abyssinica latex promotes rooting of Boswellia cuttings. New Forests 37, 35-42.

Nour, LAM. 2008. Production and Productivity of Boswellia papyrifera in Jebel Elgarrie area (Blue Nile State). Master's Thesis, University of Khartoum, Sudan.

Ogbazghi, W. 2001 The distribution and regeneration of Boswellia papyrifera (Del.). Hochst. in Eritrea. PhD Thesis, Wageningen University and Research Centre, The Netherlands.

Ogbazghi, W, T Rijkers, M Wessel & F Bongers. 2006.The distribution of the frankincense tree Boswellia papyrifera in Eritrea: the role of environment and land use. Journal of Biogeography. 33:524–535.

Oldfield, S, C Lusty & A MacKinven. (compilers). 1998. The World List of Threatened Trees. World Conservation Press, Cambridge, UK.

Oliff, HC. 2018. Boswellia, Ginger, & Yarrow Combination Reduces Symptoms of Irritable Bowel Syndrome. HerbClip 021854-599.

Omani Sites on the World Heritage List. 2008. The Land of Frankencense Sites. Omani Sites on the World Heritage List. Web site of the Office of the Advisor to H.M. The Sultan of Cultural Affairs. Archived at: https://web.archive.org/web/20081012183204/http://omanwhs.gov.om/English/Frank/FrankincenseTree.asp

Orwa, C, RH Jamnadass, R Kindt, A Mutua & A Simons. 2009. Boswellia serrata. Agroforestree Database: A tree reference and selection guide, version 4.0. World Agroforestry Centre, Nairobi, Kenya.

Paramanik, T, SP Mishra & N Behera. 2012. Developing a sustainable method for harvest of gum from Boswellia serrata and Sterculia urens Roxb. Journal of Experimental Sciences 3(6):2.

Raju, AJS, PV Lakshmi, KV Ramana & PH Chandra. 2012. Entomophily, ornithophily and anemochory in the self-incompatible Boswellia ovalifoliolata Bal. & Henry (Burseraceae), an endemic and endangered medicinally important tree species. Journal of Threatened Taxa 4(7):2673–2684.

Rijkers, T, W Ogbaschi, M Wessel & F Bongers. 2006. The effect of tapping for frankincense on sexual reproduction in *Boswellia papyrifera*. *Journal of Applied Ecology* 43:1188-1195. https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2006.01215.x

Sagar, R & J Singh. 2005. Structure, diversity, & regeneration of tropical dry deciduous forest of northern India. Biodiversity Conservation 14:935–959.

Saha, D, D Ved, K Ravikumar & K Haridasan. 2015. Boswellia ovalifoliolata. The IUCN Red List of Threatened Species 2015: e.T50126567A50131280. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126567A50131280.en.

Shahabuddin, G & S Prasad. 2004. Assessing ecological sustainability of non-timber forest produce extraction: the Indian scenario. Conserv. Soc. 2 (2), 235–250.

Shahabuddin, G, R Kumar & A Verma. 2006. Annotated checklist of the birds of Sariska Tiger Reserve, Rajasthan, India. Indian Birds 2 (3): 71-76. Online: http://indianbirds.in/pdfs/IB2.3_ShahabuddinETAL_Sariska.pdf

Sommerlatte, H. n.d. (no date) Arbor Oils of Africa. Naro Maru, Kenya. Website: http://www.oilsafrica.com/arbor-collectors-arid-land-resources.php

Sultana, A. 2013. An updated checklist of birds of SariskaTiger Reserve, Rajasthan, India. Journal of Threatened Taxa. 5(13):4791-4804. Open Access: https://en.calameo.com/read/001552297295ef904539f

Sunnichan, VG, HYM Ram & KR Shivanna. 2005. Reproductive biology of Boswellia serrata, the source of salai guggul, an important gum-resin. Botanical Journal of the Linnean Society 147:73-82.

Tewari, DD. 2014. Is big business approach to managing non-timber forest products (NTFPs) benign? Rising unsustainable extraction and looming policy changes. Journal of Human Ecology 47(1):87-102.

Thulin, M. 1998. Boswellia sacra. The IUCN Red List of Threatened Species 1998: e.T34533A9874201. http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T34533A9874201.en.

Thulin M & AM Warfa. 1987. The frankincense trees (Boswellia spp., Burseraceae) of northern Somalia and southern Arabia. Kew Bulletin 42:487–500.

Tortorello, M. 2011. Turns out you can grow frankincense in the U.S. *The Bulletin*-Home/News Published December 13, 2011. https://www.bendbulletin.com/news/1425262-151/turns-out-you-can-grow-frankincense-in-the [Note: This url appears truncated but it is not.]

Tropicos. 2018. Flora of Pakistan: Burseraceae. Missouri Botanical Garden: Tropicos.org. Online: http://www.tropicos.org/Name/42000259.

Vaishnav V & U Janghel. 2018. A note on the clonal propagation of depleted threatened species Boswellia serrata Roxb. through branch cuttings. Tropical Plant Research 5(1): 27–28.

Vivero, JL, E Kelbessa & S Demissew. 2005. The Red List of Endemic Trees & Shrubs of Ethiopia and Eritrea. Fauna and Flora International, Global Trees Campaign, IUCN

Walter, KS & HJ Gillett. [eds] 1998. 1997 IUCN Red List of Threatened Plants. Compiled by the World Conservation Monitoring Centre. IUCN - The World Conservation Union, Gland, Switzerland and Cambridge, UK. lxiv + 862pp.

World Checklist of Selected Plant Families. 2018. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet: http://apps.kew.org/wcsp/home.do/.

Yogi RK, A Bhattacharya, & A.K. Jaiswal. 2014. Lac, Plant Resins and Gums Statistics at a Glance 2013. ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), India. Bulletin (Technical) No. 06/2014. 1-38 pp.

Zhang, J, I Biggs, J Sirdaarta, A White & IE Cock. 2016. Antibacterial and Anticancer Properties of *Boswellia carteri* Birdw. and *Commiphora molmol* Engl. Oleo-Resin Solvent Extractions. *Pharmacogn. Commn.* 6(3):120-136.

Zhu, Y.P. 1998. Chinese Materia Medica: Chemistry Pharmacology and Applications. Amsterdam: Harwood Academic Publishers. 714 pp.

Species Details

The species in **bold** are most traded, with small trade in underlined species. Unless otherwise noted, population information is from the IUCN Red List accounts.

Species	Scientific Synonyms	Distribution	Population Information	Status (IUCN Red List)
Boswellia ameero Balf. F.	none	Yemen	Locally common where found	Vulnerable 1998 & 2004 (Miller 2004a; Oldfield *et al.* 1998)
Boswellia bullata Thulin	none	Yemen	3 disjunct areas; rare	Vulnerable 2004 (Miller 2004b)
Boswellia dalzielii Hutch.	Likely a synonym of *B. papyrifera*	Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Niger, Nigeria, Senegal		Unknown
Boswellia dioscoridis Thulin	none	Yemen	4 disjunct areas; widespread and sometimes abundant, though limited area of occupancy	Vulnerable 2004 (Miller 2004c)
Boswellia elongata Balf.f.	none	Yemen	6 disjunct areas; widely scattered	Vulnerable 1998 & 2004 (Miller 2004d; Oldfield *et al.* 1998)
Boswellia frereana Birdw.	none	Somalia		Unknown
Boswellia globosa Thulin	none	Somalia		Unknown
Boswellia nana Hepper	none	Yemen	2 locations, area of occupancy <20km2	Endangered 1998 (Walter & Gillett 1998); Vulnerable 2004 (Miller 2004e)
Boswellia neglecta S. Moore	*B. elegans* Engl.; *B. holstii* Engl.; *B. hildebrandtii* Engl.; *B. microphylla*	Ethiopia, Kenya, Somalia, Tanzania, Uganda		Unknown
Boswellia ogadensis Vollesen	none	Ethiopia	Restricted range, rare, only known from type locality	Endangered 1998 (Walter & Gillett 1998); Vulnerable 1998 (Oldfield *et al.* 1998); Critically Endangered 2005 & 2018 (Alemu *et al.* 2018a; Vivero *et al.* 2005)
Boswellia ovalifoliolata N.P.Balakr. & A.N.Henry	none	India	Subpopulations in 4 areas; severely fragmented; 30% population decline in last 30	Indeterminate 1998-Andhra Pradesh (Walter & Gillett 1998); Vulnerable 2015 (Saha et al. 2015)

Species	Scientific Synonyms	Distribution	Population Information	Status (IUCN Red List)
			years; generation time = 20-30yr (25yr)	
Boswellia papyrifera (Caill. ex Delile) Hochst.	*B. chariensis* Guillaumin *B. odorata* Hutch *B. occidentalis* Engl.	Benin, Cameroon, Central African Republic, Chad, Djibouti,[e] Eritrea, Ethiopia, Nigeria, Sudan, Uganda	Ethiopia: in two areas where tapping occurs, 175 & 87 individuals/ha in 2 locations in; estimated 749 & 911 trees respectively; regeneration severely limited (Eshete 2002)	Apparently declining according to several studies. However, not assessed by the IUCN.
Boswellia pirottae Chiov.	none	Ethiopia	7 known occurrences in 2 river systems; rare; 100 individuals in 1 subpopulation; est. <10,000 total; generation time = 10-15yr	Lower risk/near threatened (Oldfield et al. 1998); Rare (Walter & Gillett 1998); Vulnerable (Awas et al. 2018; Vivero et al. 2005)
Boswellia popoviana Hepper	none	Yemen	Fragmented, rare distribution; little recruitment	Vulnerable 1998 & 2004 (Oldfield et al. 1998; Miller 200f4)
Boswellia rivae Engl.	*B. ruspoliana* Engl.; *B. boranensis* Engl.	Ethiopia, Somalia, Kenya	Little recruitment; dominant in some areas;	Least concern (Alemu et al. 2018b)
Boswellia sacra Flueck.	*B. bhaw-dajiana* Birdw. *B. b-d* var. *serrulata* Engl. *B. carteri* Birdw. *B. c.* var. *subintegra* Engl. *B. c.* var. *undulatocrenata* Engl.	Majority of the range is in Oman; also Somalia and Yemen; Djibouti[1]	Largest, most widespread population in Somalia. Oman: 400,000-500,000 trees (Hassan Alaamri 2012)	Near threatened (Oldfield et al. 1998; Thulin 1998)
Boswellia serrata Roxb. Ex Colebr.	*B. balsamifera* Spreng.; *B. glabra* Roxb. *B. thurifera* Roxb. ex Fleming	India, Sri Lanka[2], and possibly Pakistan,[3] and Nepal	Population apparently large (Brendler *et al.* 2018); Low regeneration (Sagar & Singh 2005)	Sri Lanka: Critically Endangered – Possibly extinct (MOE 2012); India: Rare (Modi & Mathad 2016)
Boswellia socotrana Balf.f.	none	Yemen	3 disjunct locations; rare with limited area of occupancy; no sign of regeneration in several populations	VU 1998 & 2004 (Miller 2004g; Oldfield et al. 1998)

[1] *Abdoul-Latif et al. 2012*

[2] *Jayatissa 2012; MOE 2012*

[3] *Orwa et al. (2009) indicate Pakistan is a range state though this is not borne out in Flora of Pakistan (Tropicos 2018).*

Draft decisions on *Boswellia* spp.: Revisions proposed by the Secretariat
(new text is underlined; deleted text appears in ~~strikeout~~)

Directed to the Secretariat

18.AA The CITES Secretariat shall issue a Notification to the Parties ~~within 60 days of the conclusion of CoP18,~~ and, as appropriate, liaise with relevant stakeholders of *Boswellia* trade, requesting the following information:

a) biological data on *Boswellia* species, including population size, distribution, status and population trends, and its role in the ecosystem in which it occurs;

b) available information about harvest and exploitation levels, trade names, stakeholders close to the harvest of the species and supply chain characteristics for domestic consumption and international trade;

c) information on threats to these species, especially as it pertains to the underlying causes of poor regeneration capability and the impact of harvest on these species;

d) information on any initiatives to artificially propagate these species or produce plantations of them;

e) existing regulations and ownership structures pertaining to the species, ~~and~~ their habitat, drivers of habitat trends and management measures in place or under development, including sustainable harvest practices~~studies~~; and

f) suggestions for meetings or other venues that might provide opportunities to collaborate or share information regarding harvest and management of these species.

18.BB The Secretariat shall compile and submit for consideration of the Plants Committee information received as per Decision 18.AA. ~~responses from the Parties regarding the status, management, and trade in *Boswellia* species and provide these responses at the 25th meeting of the Plants Committee for its consideration to inform their work~~.

Directed to the Plants Committee

18.CC The Plants Committee shall review ~~discuss and evaluate~~ the information received and other relevant information available to it regarding the status, management, and trade in *Boswellia* species, highlighting key gaps in knowledge and making recommendations to inform 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.

Directed to the Parties

18.DD Range States~~countries, consumer countries,~~ and ~~other~~ Parties~~countries~~ involved in management, propagation, or trade of *Boswellia* species are encouraged to provide information regarding the status, management, and trade in *Boswellia* species to the Secretariat.

TENTATIVE BUDGET AND SOURCE OF FUNDING
FOR THE IMPLEMENTATION OF DRAFT RESOLUTIONS OR DECISIONS

According to Resolution Conf. 4.6 (Rev. CoP16) on *Submission of draft resolutions, draft decisions and other documents for meetings of the Conference of the Parties*, the Conference of the Parties decided that any draft resolutions or decisions submitted for consideration at a meeting of the Conference of the Parties that have budgetary and workload implications for the Secretariat or permanent committees must contain or be accompanied by a budget for the work involved and an indication of the source of funding. The authors of this document propose the following tentative budget and source of funding.

The tasks allocated to the Secretariat in the draft decisions will involve normal staff time and those allocated to the Plants Committee might require intersessional work by the Committee and discussion or deliberation time during its meetings. However, Sri Lanka believes that the work can be accommodated within the regular work program of the Committee and without additional funding.