

NON-DETRIMENT FINDINGS (NDFs) STUDY FOR *PTEROCARPUS SANTALINUS* L. f. (RED SANDERS) IN INDIA



जहां है हरियाली ।
वहां है रवुशहाली ।।



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I. BACKGROUND INFORMATION OF THE TAXA

1. BIOLOGICAL DATA

1.1. Scientific and common names:

Pterocarpus santalinus L. f. (Family: Fabaceae) is commonly known as Red Sanders, Red Sandalwood, Ruby wood or Saunders wood in English. Other Indian vernacular names are Rakta Chandana, Harichandana (Sanskrit) Lalchandana (Hindi), Sivappu Chandanam, Sensandanam (Tamil), Yerra Chandanam, Agaru Gandhamu, Rakta Gandhamu (Telugu), Agaru, Rakta Chandana, Kempu Gandha (Kannada), Patrangam, Rakta Chandanam, Tillaparni (Malayalam), Lal Chandan, Rokto Chandan (Bengali), Lohoti Chondono, Rokto Chandano (Oriya) Tambada Chandana (Marathi), Chandan lal (Punjabi) Ratanjali (Gujarati).

1.2. Distribution

P. santalinus L. f. is endemic to India (Jackson, 1895; Rojo, 1972; Jain and Rao, 1983; Ahmed and Nayar, 1984; Oldfield *et al.*, 1998). There is one report of the species being native to Africa (Roubik, 1995; Rao and Raju, 2002), but this seems likely to be an error (Mulliken and Crofton, 2008). It is most probably mistaken with *Pterocarpus santalinoides* L' Herit. ex DC. which is also known as *Pterocarpus esculentus* Schum. & Thonn. and this species is native to tropical Africa (Jackson, 1895) and also south America. Its status is reported as uncertain in China (International Legume Database and Information Service, 2003) and occurrence is reported in Pakistan (Richter and Dallwitz, 2002) but likely to be introduced both in China and Pakistan (Kumar and Sane, 2003). Introductions are also reported in Sri Lanka and Taiwan (Mulliken and Crofton, 2008). About 28 introduced trees of *P. santalinus* exist in Matara District in Sri Lanka (Arunakumara, *et al.*, 2005). The species is erroneously reported to be cultivated in Philippines (List and Hörhammer, 1977). However, it is *Pterocarpus indicus* Willd. which was named earlier as *Pterocarpus santalinus* Blanco. (Jackson, 1895) being cultivated in the Philippines.



Fig . 1. Location map of occurrence of Red Sanders in five districts of Andhra Pradesh State in India.

The Red Sanders (*P. santalinus*) is naturally distributed in approximately 3.98 lakh hectares in Sesachalam, Veligonda, Lankamala and Palakonda hill ranges running through five districts namely, Chittoor, Kadapa, Kurnool, Nellore and Prakasam districts in Andhra Pradesh State of India (IFGTB, 2011).

1.3 Biological characteristics

1.3.1 General biological and life history characteristics of Red Sanders

P. santalinus is a small to moderate sized deciduous tree with erect bole and a rather dense, rounded crown, conspicuous by its blackish brown bark resembling the skin of crocodile, divided into rectangular plates by deep vertical and horizontal cracks. In its natural range it attains up to 10-12 meter height with a clean bole of 1.5-6.0 meter and a girth of 1.5 - 1.9 meter. However, in plantations it can attain up to 15-18 meter height with a clean bole of about 9.0 meter and girth of 2.5 meter (ICFRE, 1992). A blaze on the bark exposes the white colored sapwood which gradually turns red due to exudation of a red gummy juice. Heartwood is deep red color which on exposure turns to scarlet red. Leaves are imparipinnate, 10-18 cm long, leaflets 3, rarely 4 or 5, 4-8 cm long; broadly ovate or orbicular, coriaceous apex obtuse, slightly emarginate, under surface pale and clothed with fine grey hairs. The tree sheds leaves during January to the middle of March. Flowers are yellow in colour and are borne together in simple or sparingly branched racemes; pedicels are 5 mm long, calyx 5-6 mm long. Flowering takes place soon after the new leaves start emerging during April and continue till the middle of May. The species is mainly insect pollinated and the flowers are exclusively foraged by honey bees comprising of *Apis dorsata*, *A. cerana indica* and *A. florea*. The species shows facultative xenogamy, but mostly eliminates growing fruits from self-pollinated flowers. The natural fruit set rate is low compared to high flower production and reported to be 6% (Rao and Raju, 2002).

The fruits (Samara) of *P. santalinus* are obliquely orbicular, 4-5 cm in diameter including the wing, base narrowed into a short concavely curved stripe, 8 mm long. Seeds are 1-2, reddish brown, smooth leathery and 1.0-1.5 cm long. Fruit maturity takes about 11 months after flowering (Dayanand, 1988) and fruits ripen during February - March when the trees start shedding leaves. The winged fruits are blown off by wind during summer. The fallen fruits germinate easily during rains. The species is strong light demander and germination also requires light. Generally seedling regeneration is profuse after rains in open areas (Ramakrishna, 1962). However, fallen dried fruits, saplings and seedlings are prone to repeated fires during summer. In all the Red Sanders bearing forest areas the ground is covered by thick botha grass (*Cymbopogon coloratus*) which gets dried up during summer season and leads to repeated fires during summer. The fruits which escape fire germinate during rainy season. The seedlings and saplings get burnt by repeated fires or browsed by goats or cattle, but the root system remains alive. After such repeated die back a few seedlings get established. The *P. santalinus* is an excellent coppicer and owing to this ability the species is surviving in its natural ranges (Ramakrishna, 1962). Pure patches of red sanders can also be seen in some of its natural ranges which indicate the dominance of the species in those forests.

Growth rate of this species is very slow under its natural conditions. Reports on growth rate in natural Red Sanders forests are fragmentary. Measurements taken in 32 sample plots between 1920

and 1926 in 3 ranges (Balapalli, Rajampet and Kodur) indicated mean annual increment in girth at breast height, over bark per stem to be 0.29" (0.74 cm) for stems of seedling origin, and 0.54" (1.38cm) for coppice shoots. Data from sample plots laid at Kodovengammabhavi between 1914 and 1924 indicated that standards were putting on girth at 0.35" (0.89 cm) per year and coppice shoots at 0.44" (1.12 cm) per year. Sample plots laid in Thummalabailu area in Rajampet showed girth increment as low as 0.125" (0.32 cm). At an annual increment of 0.74 cm girth a tree would take 80-100 years to reach a girth of 60- 75 cm while a tree of 3.0 feet (91.4 cm) girth would be 150 to 250 years old (ICFRE, 1992).

It has been estimated that a seedling origin tree commences heartwood formation when it has attained at least 18 years and 15-23 cm girth. A coppice shoot origin tree starts showing sign of heart wood formation at the age of 15 years; when it has attained a girth of 23-38 cm (ICFRE, 1992). The studies conducted by Andhra Pradesh Forest Department in Rajampet indicated that only 30% heartwood content can be expected from total harvestable stem volume.

It takes 50-60 years for a tree of pole size (30 cm) to reach 70 cm girth which is harvestable girth in the natural forests. It is estimated that at least 10-12 years are required for trees to move from one girth class (10 cm class intervals) to next girth class. The wood of most of Red Sanders trees has a normal grain, however, there is also a rare variant with a 'wavy' grain which fetches higher prices in international markets.

The seed handling, nursery, propagation and plantation techniques for this species have been standardized (Dayanand and Lohidas, 1988). The plantations of *P. santalinus* have been raised successfully outside its natural ranges by the State Forest Departments. About 3000 hectares of plantations exist mainly in Andhra Pradesh and Tamil Nadu states and also to a lesser extent in several other states (IFGTB, 2011). The growth rate of the species has been reported to be faster under plantations raised in rich soils (ICFRE, 1992). The cultivation of this species in farm land is also getting popularized especially in Andhra Pradesh and Tamil Nadu in India. According to Andhra Pradesh Forest Department farmers are generally planting a few trees along the bunds or boundaries of farm land and occasionally as small block plantations. Therefore, the population of Red Sanders under cultivation in farm land is small compared to its natural population size and probably it may be of few hundred hectares in each state.

1.3.2. Habitat types

P. santalinus occurs in the forest formation which is called as "5A/C3 Southern Tropical Dry Deciduous Forests" as per Champion and Seth Classification and falls in the eco-terrestrial region IM1301 Deccan Thorn Scrub Forests and as well as IM0201 Central Deccan Plateau Dry Deciduous Forests. It grows on dry, hilly, often rocky ground, and generally found at altitudinal range of 150-900m. It prefers lateritic and gravelly soil and cannot tolerate water logging (Raju and Raju, 2000).

The principle tree species associated with *P. santalinus* are *Chloroxylon swietenia*, *Terminalia pallida*, *T. chebula*, *T. tomentosa*, *Albizia lebbeck*, *Hardwickia binata*, *Anogeissus latifolia* and *Dalbergia* ssp. In Rajampet and a few areas in Kadapa Division *P. santalinus* occurs in pure patches (IFGTB, 2011).

The total area of Red Sanders is estimated to be 3.98 lakh hectares in 8 Forest Divisions in Andhra Pradesh. It is found that the natural Red Sanders requires specific ecological niche. It occurs mainly in patches on rocky outcrops and generally not in scrub jungles found in plain areas. It does not occur in mountain folds, scrub jungles on foot hills and in valleys (IFGTB, 2011). Earlier reports also indicate special ecological niche requirement for natural Red Sanders. Raju and Raju (2000) have studied the relation between geological formations and Red Sanders distribution and found that quartzite and shale formations are important for occurrence of Red Sanders. They reported that about 82% of Red Sanders area is covered mainly by Gulcheru, Nagari, Pullampeta, Bairenkonda, Cumbum and Irlakonda quartzite and subordinately by Pullempet and Cumbum shale (Raju, 1999). It is also theorized that certain quartzites and shales formed during a short period in the Proterozoic era contained certain trace elements in significant quantities to favour the growth of Red Sanders.

Red Sanders prefers mainly very shallow to shallow brown coloured, sandy loam or stony soils of friable nature (Raju and Srinivasulu, 2008). In compact soils Red Sanders is not found. Hot and dry climate, higher average temperatures and low rain fall (500- 800 mm) are general features of Red Sanders areas. These climatic factors coupled with geological formations and soil factors and may be some more ecological factors form special “ecological niche” for limited Red Sanders distribution (IFGTB, 2011).

Table 1. Red Sanders bearing forest areas in eight Forest Divisions in Andhra Pradesh and sample plots laid to study population structure.

SI No.	Name of the Forest Division	No. of Ranges having natural Red Sanders	No. of Beats having natural Red Sanders	Red Sanders Bearing forest Area (Ha.)	No of Sample plots laid
1	Tirupati WLM	3	26	63424.58	84
2	Chittoor East	7	25	6260.00	5
3	Rajampet	4	32	84794.37	62
4	Kadapa	5	33	104550.80	107
5	Nellore	4	17	21900.00	27
6	Giddalur	2	6	21215.64	19
7	Proddatur	4	26	77522.09	79
8	Nandyal	1	6	18535.35	22
	Total	30	171	398202.83	405

Source : IFGTB (2011)

1.3.3 Role of the species in its ecosystem

The exact role of the species in its ecosystem is largely unknown. However, this fire hardy species is mainly responsible for forest tree cover in otherwise rocky dry hills in its natural habitat.

1.4 Population

1.4.1 Global Population size

The species is endemic to southern Eastern Ghats of Andhra Pradesh state in India. In its natural range the population size is estimated to be approximately 3.98 lakh hectares (IFGTB, 2011). The natural Red Sanders bearing forest area runs across eight Forest Divisions in Andhra Pradesh in India (Table.1). Out of this 3.98 lakh hectares about 1.68 lakh hectares of Red Sanders bearing forests occur in Protected Areas which include wildlife sanctuaries and National Parks (Table.2).

Table 2. Red Sanders bearing forest areas in Protected Areas (National Parks and Wildlife Sanctuaries)

Sl. No.	Name of the Division	Name of the Range	Total area of the Range (ha)	Red Sanders bearing forest area(ha)
1	Tirupati Wildlife	Chamala	22938.31	11100.00
2		Tirupathi	25486.12	23696.97
3		Balapalli	28627.61	28627.61
4	Rajampet	Chitvel	40116.46	25780.94
5	Kadapa	Siddhout	34691.83	26808.40
6		Vontimitta	16170.50	12884.63
7	Proddatur	Proddatur	10630.47	8739.66
8		Badvel	39719.48	24679.95
9	Nellore	Rapur	19176.00	3000.00
10		Atmakur	16766.71	2800.00
	Total		254323.50	168118.20

Source : IFGTB (2011)

Outside India the species has been introduced to a few countries like Sri Lanka and Pakistan (Mulliken and Crofton, 2008) on a very small scale. This species is also being planted by State Forest Departments and farmers in several states in India.

1.4.2 Current global population trends

The area of natural Red Sanders bearing forests is restricted to Eastern Ghats region of five districts in Andhra Pradesh and is more or less remaining constant over the years. However, the quality of the population in these forests is being affected due to various threat factors like selective illegal felling of higher girth class trees, repeated annual summer fires and cattle grazing (IFGTB, 2011).

The population structure and regeneration status of *P. santalinus* in its natural range was studied recently in detail by laying random sample plots (IFGTB, 2011). The average number of plants (including saplings, poles and trees of all girth classes) of *P. santalinus* were found to be 16.75 per sample plot (0.1 ha area). The average number of trees (above 30 cm girth at breast height) was found to be 9.19 per sample plot (Table. 3). However, the average number of trees above

70 cm girth class was found to be 13.2 per ha. The fig. 2 shows that the number of trees of below 70 cm girth class was higher. The reason for skewed distribution of trees towards lower girth class was due to large scale illegal felling of higher girth class trees for heartwood extraction. The higher girth class trees were highly scattered in occurrence among most of the areas sampled and were absent in many sample plots. Average number of seedlings (below 137 cm height) per sub-sample plot area (1 m² area) was estimated to be 0.74 (Table, 4). Although regeneration level was relatively high as many seedlings were of coppice origin indicating die back due to fires during previous summers.

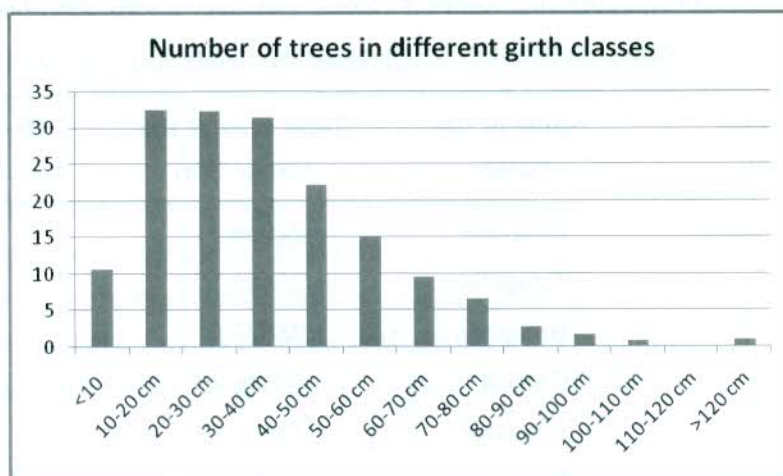


Fig.2. Average Girth class distribution (per 1.0 ha area) of *P. santalinus* in natural forests of Andhra Pradesh State (IFGTB, 2011).

1.5 Conservation status

1.5.1 Global conservation status (according to IUCN Red List)

Red List Category and Criteria: Endangered B1+2de ver 2.3 (1994)

1.5.2 National conservation status for India

Conservation and Assessment and Management Plan (CAMP) workshops for plants of southern India conducted during 1995 and 1997 assessed the species and considered the species as endangered (Oldfield, *et al.* 1998). *P. santalinus* is included in the negative list of exports notified by the GOI Notification 2 (RE-98) dt. 13-04-1998, 1997-2002.

1.5.3 Main threats within India

The following were the major threat factors occurring throughout the natural ranges of *P. santalinus* (IFGTB, 2011).

- a) **Occurrence of Repeated Fires:** The natural Red Sanders areas are highly prone to summer fires because of thick cover of dried botha grasses. Summer high temperatures, thick dry grasses and difficult terrains make the task of controlling annual fires very difficult. During the fires most of the small seedlings, saplings and sometimes poles (10-20 cm girth class) get dried up. Although these saplings regenerate from stumps that are subjected to repeated fires. The seed stock on the ground also gets burnt. A few seeds which escape intense fire will germinate during

Table 3. Average Girth class distribution (per 0.1 ha) of *P. santalinus* in eight Forest Division in Andhra Pradesh

Sl. No	Range	No. of Sample plots	Girth class (in cm) distribution of sapling, poles and trees in 0.1 ha main sample plots										Total No. of trees above 30 cm gbh	Total No. of plants Below 30 cm gbh				
			<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100			100-110	110-120	>120	Total
1	Tirupathi	84	0.34	2.04	3.28	3.25	2.56	1.63	0.97	0.35	0.07	0.06	0.06	0.01	0.03	14.65 (5.16)*	8.99 (3.20)	5.66 (2.47)
2	Chittoor	5	0.00	0.00	0.25	3.92	1.92	0.25	0.50	0.00	0.17	0.00	0.17	0.00	0.00	7.17 (1.34)	6.92 (1.24)	0.25 (0.71)
3	Rajampet	62	0.04	1.76	4.02	3.60	3.27	2.10	1.18	0.64	0.33	0.09	0.11	0.02	0.06	17.21 (2.451)	11.40 (2.083)	5.82 (1.912)
4	Kadapa	107	2.39	8.98	8.75	4.97	3.21	1.16	0.63	0.18	0.13	0.03	0.02	0.01	0.02	30.47 (7.43)	10.35 (2.46)	20.13 (7.06)
5	Proddatur	79	6.14	11.66	7.425	3.46	1.91	1.40	0.53	0.37	0.10	0.02	0.00	0.01	0.00	20.43 (4.80)	8.47 (3.71)	12.36 (11.62)
6	Nandiyal	22	0.00	0.00	0.00	1.68	2.64	2.09	0.95	0.68	0.18	0.18	0.05	0.05	0.45	8.95 (8.26)	8.95 (8.26)	0.00 (0.00)
7	Nellore	27	0.59	2.60	2.12	3.20	2.79	1.36	0.90	0.67	0.25	0.13	0.00	0.04	0.00	14.66 (0.99)	9.35 (1.91)	5.31 (0.99)
8	Giddalur	19	2.26	6.32	5.73	3.89	1.12	0.80	0.21	0.20	0.08	0.04	0.00	0.00	0.00	20.65 (8.13)	6.34 (3.04)	14.31 (6.86)
	Total/Av.	405	1.06	3.26	3.23	3.15	2.23	1.53	0.97	0.66	0.28	0.17	0.08	0.02	0.11	16.75 (0.73)	9.19 (0.79)	7.60 (0.53)

* Values in paranthesis indicate standard derivations

Source : IFGTB (2011)

Table 4. Regeneration level of Red Sanders in Andhra Pradesh in eight Forest Divisions.

Forest Division	No. of Sample plots (0.1ha)	Total No. of Sub Plots(1 m ²)	Total No. of sub plots with seedlings	Av. No. of Seedlings/m ² in 3 seedling height classes			Total no. of seedlings/m ²
				< 45 cm	45-90 cm	90-137 cm	
Tirupathi WLM	84	840	294	0.39	0.20	0.07	0.66
Chittoor East	5	50	5	0.08	0.02	0.02	0.12
Rajampet	62	620	322	0.51	0.29	0.15	0.95
Kadapa	107	1070	459	0.48	0.29	0.07	0.92
Nellore	27	270	82	0.40	0.11	0.03	0.54
Giddalur	19	190	125	0.61	0.35	0.17	1.13
Proddatur	79	790	449	0.65	0.21	0.06	0.91
Nandyal	22	220	94	0.50	0.19	0.01	0.70
Total	405	4050	1830	0.45	0.21	0.07	0.74

Source: IFGTB(2011)

rainy season. The saplings and poles which escape fire get established into trees. Effect of fire was also seen on flowers and fruit setting. The fire season generally coincides with flowering and fruit setting during the month of February to May. Since the trees generally have shorter bole height, the high ground fires affect the flowers, pollinators and young fruits, wherever tall grasses are found.

- b) **Grazing by domestic cattle:** The Red Sanders areas are surrounded by villages which have large number of cattle. Cattle grazing is observed in most of the areas. Because of the remoteness of the area and paucity of sufficient field staff it is very difficult to control the grazing. The Red Sanders leaves being good quality fodder the cattle graze on them.
- c) **Illegal Felling:** The illegal felling for high priced heartwood is one of the main threats for natural population of Red Sanders. Generally, the trees of above 60- 70 cm girth class are selectively harvested for heartwood. The poachers also injure other standing trees for detection of heartwood. Very high demand and price for heartwood in the international market is the main cause for illegal felling and smuggling. Generally, the landless and very poor communities residing in forest fringe areas are mainly employed by smugglers in felling of Red Sanders trees. The logs are cut and dressed up in the forest by removing sap wood using axes and transported by head load or by using bullocks from forests to outside villages during night hours and from there the wood is smuggled out clandestinely to various points using vehicles. The wood in various forms is smuggled out to other countries through air, sea or land routes with fake documents or under concealment with other goods.

The large number of people involved in illegal felling of trees for making livelihood, remoteness of the forest areas, rocky and undulated terrains and poorly equipped limited number of Forest Department Staff involved in patrolling the forests - are the factors that make it very difficult to contain the illegal felling completely. Continuous and rampant illegal felling is the main reason for

lack of trees of higher girth classes in the natural populations. The poachers and cattle grazers are also the cause of annual summer fires in Red Sanders areas.

2. SPECIES MANAGEMENT IN INDIA

2.1 Management measures

2.1.1 Management history

When the forest management was first introduced in these forests, during the middle of the 19th century, the Red Sanders was being removed in great quantities under the license system (Ramakrishna, 1962). Since the valuable forest was disappearing fast, cutting of Red Sanders was totally prohibited by grouping it with teak during 1865. During 1870s then British Government decided that the forests should supply fuel wood for Railways. Between 1870 and 1882, around 1,50, 472 tons of firewood was supplied from Red Sander bearing forests. The areas marked for felling contained high percentage of Red Sanders. Invasion of grasses in felled forest areas and repeated fires damaged the forests to a great extent (Ramakrishna, 1962). After 1883 the forests were put under a regular management plan. Well established silvicultural techniques were introduced to conserve the Red Sanders and the techniques also underwent periodic changes (Ramakrishna, 1962).

The selection system was first prescribed, but since this provided for the removal of the best of the Red Sanders trees, which had already been subjected to severe exploitation, the system was replaced with improvement felling. The system consisted in retaining well –formed trees of the better timber species and also saplings below 6" in girth and coppicing the rest. Later, 'coppice with standards' was followed with a rotation of 25 to 30 years for the coppice and 60 to 75 years for the standards. In this system 20-30 standards were retained per acre. In 1928, the simple coppice system with a rotation of 40 years replaced the coppice with standards system (Ramakrishna, 1962).

After the formation of Andhra Pradesh State in 1956, special attention was paid to the protection of Red Sanders. Felling of Red Sanders of all sizes by contractors has been prohibited since then. Exploitable girth of trees was prescribed by the Andhra Pradesh Forest Department in Working Plans. After 1958, either exploited trees by State Forest Department or seized logs from smugglers were auctioned periodically by the Government (Reddy, 1972).

At present no managed harvest is taking place in the Red Sander bearing forests in Andhra Pradesh. Each of the eight Forest Divisions in Andhra Pradesh having Red Sanders bearing forest have separate Working Plans which contain Red Sanders specific management plans. Only kind of harvesting that is taking place is illegal felling which is naturally un-managed, opportunistic and selective, since only higher girth class trees (generally above 60- 70 cm girth) and also trees with more desirable wavy grains are harvested for heartwood extraction. The high demand and price in international market is the root cause for illegal felling and smuggling (IFGTB, 2011).

At present the management plan mainly focuses on containing the illegal felling in natural forest areas, controlling the annual fires, grazing and augmenting the natural regeneration of Red Sanders by removing the botha grass (*Cymbopogon coloratus*) in selected areas.

2.1.2 Purpose of the management plans in place

The ultimate purpose of the current management plans are to improve the whole ecosystem of Red Sanders bearing forests by controlling the fires, illegal smuggling, soil erosion and grazing and improving the regeneration of Red Sanders in the natural forests.

2.1.3 General elements of the management plans

The current management plans of Andhra Pradesh Forest Department for Red Sanders bearing forests essentially consist of following elements.

1. Increasing the resource base: – Raising Plantations of Red Sanders outside its natural range
2. Encouraging the private plantations – Raising planting stocks of Red Sanders and supplying to farmers and tree growers to encourage the growing of the species out side the forests.
3. Conservation and Improvement of the resources – *in situ* Conservation through improvement of Red Sanders regeneration in natural forests by removing the botha grass and planting of seedlings in selected areas through various schemes.
4. Protection Measures: The protection measures mainly include containing the illegal harvest and transport of Red Sanders wood and protecting the forests from fire and cattle grazing. For controlling the illegal smuggling and transportation of Red Sanders wood the Andhra Pradesh state government is taking measures like formation of Base Camps, Striking Force, Mobile Parties, Forest marches and strengthening and expanding the Forest Check Posts, establishing Forest Stations and Armed Police Force. To ensure maximum convictions in forest offence cases legal advisors are being hired and also wide publicity is given for forest related crimes.

For protection from fires, formation of fire lines (8 m width) around periphery and formation of internal fire lines (5 m width) at 100m interval to control the spread of fire are being done in fire prone areas. The botha grass (*Cymbopogon coloratus*) is being uprooted along peripheral and internal fire lines. Uprooting of botha grass 1 m radius around young plants and singling is being done in problem areas.

2.1.4 Restoration or alleviation measures

The restoration and alleviation measures taken mainly include protection from fire, protection from biotic disturbances, construction of check dams across streams in forest areas to control the rain water run off and soil erosion and planting of seedlings of Red Sanders in patches where scarcity of regeneration is observed (Jain, 1996).

2.2 Monitoring system

2.2.1 Methods used to monitor harvest

Any harvest in the natural forests is closely monitored and controlled by the State Forest Departments. For harvesting the cultivated Red Sanders permission for harvest has to be obtained by the private owner from the State Forest Departments as per relevant Forest Act and State Timber Transit Rules. The transit and export of Red Sanders is monitored by State Forest Departments, Ministry of Environment and Forests - Government of India, Director General of Foreign Trade

(DGFT)- Ministry of Commerce and Industry - Government of India, CITES Management Authority of India and Customs Department - Government of India.

2.2.2 Confidence in the use of monitoring

There is a considerable level of confidence in the monitoring systems used which is indicated by the seizures of illegals harvested Red Sander logs taking place at various levels and all over the country. However, it is estimated that the seized wood constitute only about 30% of the wood smuggled out of India (IFGTB, 2011).

2.3 Legal framework and law enforcement

There are many laws enacted and modified time to time by federal and state governments in India. Currently, several Acts and Rules regulate the harvest and possession of Red Sanders wood.

- a. According to **Andhra Pradesh Forest Act, 1967, other State Forest Acts and Indian Forest Act, 1927** which has been adopted by most of the States and is directly applicable to the Union Territories of India, unauthorized possession or transportation of forest produce is a cognizable offence.
- b. **Wild Life (Protection) Act 1972** prohibits any removal of trees including *Pterocarpus santalinus* from Protected Areas.
- c. **The Foreign Trade Policy** which is an instrument under the Customs Act, 1962 totally prohibits export of Red Sanders in any raw form such as logs, sawn timber, chips, powder etc. both from wild or cultivated sources (except value added products extracts, dyes and musical instruments). Violations of export policy invite the punishment under the Customs Act such as imprisonment extending up to 7 years and fine or both.
- d. *P. santalinus* is classified as a “reserved tree” under the **Andhra Pradesh Preservation of Private Forest Rules, 1978**. Cutting, transport and sale require permission from the Divisional Forest Officer in accordance with rules set by the State Government.
- e. **The Andhra Pradesh Sandal Wood and Red Sanders Wood Transit Rules, 1969** also specify that any import, export or transport of *P. santalinus* wood, chips or powder must be accompanied by a permit detailing the items and quantities involved, their source and destination. Further, the rules require that all items in trade (including individual wood pieces, bags of powder, etc.) be marked and if relevant, sealed. There are also provisions for the marking of individual trees at the time of felling and onward chain of custody requirements.
- f. **Tamil Nadu Timber Transit Rule, 1968** specifies that possession and transport of *P. santalinus* timber, chips and powder similarly require permits from the District Forest Officer in the state of Tamil Nadu, but only if the quantity involved exceeds five kilogrammes. Felling of this species is currently banned in Tamil Nadu.
- g. According to **Tamil Nadu Forest Act 1882**, the *P. santalinus* is a scheduled timber. No person shall possess a quantity of any scheduled timber, more than 0.50 cubic meters unless the scheduled timber bears distinguishable Government mark or property mark affixed under the Tamil Nadu

Timber Transit Rules 1968 as the case may be. However, there is no bar to grow any species including scheduled timber species in private lands.

3 UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. Type of use (origin) and destinations (purposes)

Heartwood and its derived extracts and powders are the main plant parts used for various purposes within and outside India. In India, the heartwood of *P. santalinus* is used in the treatment of diabetes; the water held in cups made from heartwood is used in the treatment of this disorder. Preparations made from the wood are used to reduce swelling, alleviate pain, and stop bleeding and treat infections. Wood is used as astringent, tonic, as external application for wounds, cuts and inflammations, in treating headache, skin diseases, fever, boils, scorpion sting and to improve sight. The red heart wood yields a natural dye santalin which is used as a coloring agent in pharmaceutical preparations and food stuffs. The wood extract is also used as astringent, diaphoretic, in inflammations, headache, skin diseases, bilious infections and chronic dysentery (Chopra *et al.*, 1956; Anon, 1969). The heartwood of this species is also used in making furniture, carvings, musical instruments and occasionally agricultural implements. However, the quantum of wood being traded in India for domestic consumption is very less compared to that being traded internationally.

The wood is in high demand in China and Japan for making traditional furniture, carvings and traditional musical instruments. Timber with a 'wavy' grain is in particularly high demand in Japan for the manufacture of the musical instrument the 'shamisen', a three-stringed flute used in classical music. The *P. santalinus* dye is being used in Europe and USA for coloring alcoholic beverages and food stuffs (Green, 1995).

All kinds of Red Sanders wood of all sizes including chips and powder are in demand and being traded in international market at a phenomenal price indicate that the wood may have some uses in other countries which are undisclosed.

3.2 Harvest

3.2.1 Harvesting regime

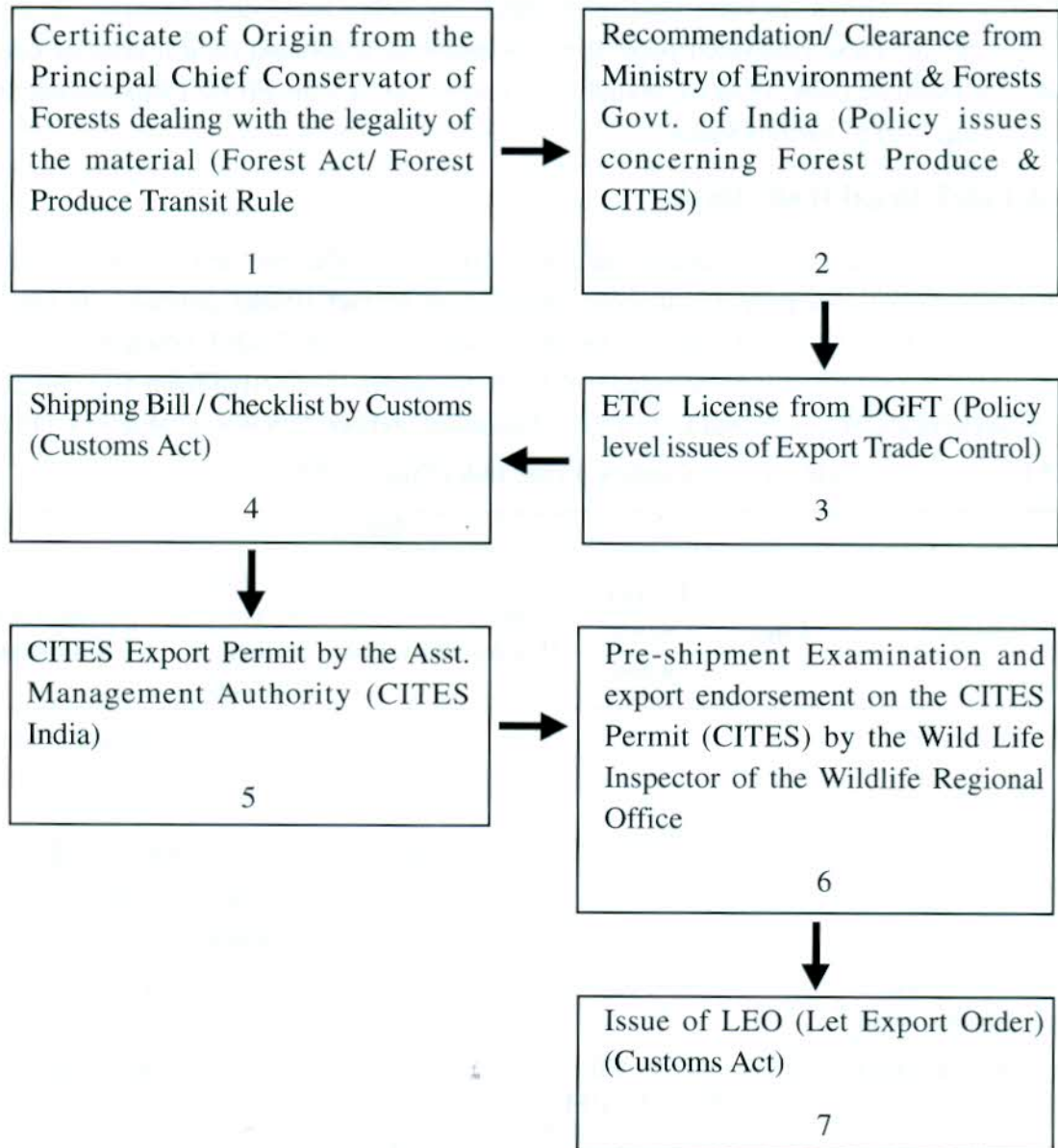
At present no managed harvest is taking place in the Red Sander bearing forests in Andhra Pradesh. As mentioned in previous sections, only kind of harvesting that is taking place at present is illegal felling which is naturally un-managed, opportunistic and selective in such a way that only higher girth class trees (generally above 60- 70 cm girth) and also trees with desirable wood grains are harvested for heartwood extraction.

3.2.2. Harvest management/ control (quotas, seasons, permits, etc.)

Extraction of living trees from the natural forest is prohibited and silvicultural removals, if any, are as per the prescriptions of the approved Working Plans of Forest Divisions. In the protected areas, removals of any kind of plant parts is prohibited legally. The legal trade is limited to occasional sale of confiscated timber by the Government of Andhra Pradesh. For harvesting in private land

prior permission has to be obtained by Forest Department and certificate of origin has to be issued by the Forest Department.

The process of legal export of Red Sanders from India is clearly laid out and it involves several government agencies. The legal export of Red Sanders in all forms including extracts and derivatives involves following seven processes (Wildlife Crime Control Bureau, India).



The Institute of Forest Genetics and Tree Breeding (IFGTB) Coimbatore, India has conducted a detailed study on population structure, growing stock, regeneration level, etc., in natural Red Sanders bearing forests in Andhra Pradesh state (IFGTB, 2011). Considering the very slow growth rate of the species in wild, high level of threat from the illegal felling, smuggling and annual fire, skewed distribution towards small girth class trees in the current populations, absence or highly scattered distribution of harvestable higher girth class trees (above 60-70 cm girth) in many populations, it was concluded that harvest for heartwood from natural populations may not be sustainable currently. Therefore, it has been arrived to a conclusion that any harvest of Red Sanders wood from wild and

export of the same should be discouraged. Since, there is no legal harvest and export currently taking place from the wild population, establishing "Export Quota for wild populations" is not required.

It is suggested that future sustainable harvest should be made from plantations and trees grown on farm land. At present there are about 3000 hectares of Red Sanders plantations of various ages available with several State Forest Departments. So far, felling is not being done in these plantations. Occasionally, trees grown in farm land (patta land) are being harvested. However, if at all any "Export Quota" for these cultivated populations is required, a detailed field inventory need to be undertaken to estimate growing stock available in plantations of State Forest Departments and trees growing in farm land in various states.

3.3 Legal and illegal trade levels

Legal trade is limited to occasional sale of confiscated timber by the Government of Andhra Pradesh. International trade primarily involves wood chips, extract, timber and carvings. From 1991-2003, India exported 717.7 M T chips, 10.8 MT extract and 186.3 M T powder (Mulliken and Crofton, 2008). *P. santalinus* was included in CITES Appendix II effective from 16 February, 1995 following acceptance of a proposal from India. Therefore, export data is available in CITES Trade

Table.5 Gross export trade of Red Sanders From India Since 1995-2010

Year	Source	Logs	Timber/ Sawn wood	Items			Importing Countries
				Chips/ Powder	Extracts/ Derivatives	Carvings/ Roots/ Other Products	
1995	Cultivated	-	-	-	6720 KIL	-	Denmark, France, UK, Israel, Italy, Netherlands
1996	Cultivated	-	-	-	4100 KIL	-	France, UK, Italy
1998	Cultivated	-	-	-	8824 KIL	1147 SET (Carvings)	Germany, UK, Italy
1999	Confiscated/ Seizures, Wild	-	5100 KIL	-	2497 KIL	-	US, Italy
2006	Pre-Convention, Wild	5003 Nos	458509 KIL, 2933.16 CUM	-	-	-	Honk Kong, China, Singapore
2007	Confiscated/ seizures	-	-	-	0.5 KIL	-	UK
2008	Pre-Convention, Wild	449076 KIL		5000 KIL	14178 KIL	-	Honk Kong, Japan, Singapore; Saudi Arabia; Germany, UK, Netherlands
2009	Pre-Convention	-	-	-	1413 KIL	-	Netherlands
2010	Confiscated/ (Roots)	-	-	25000	-	120 LTR (Roots)	UAE, Germany

Source : CITES Data Base

database since 1995. From 1995-1998 India exported, 1147 sets of carvings, 19,644 kg of extracts of cultivated origin to different countries. However, since 1999 no wood from cultivated source was exported. Mainly logs, timber, sawn wood, wood chips, extracts and other products like carving and roots in small quantity were exported from confiscated, wild and preconvention material sources from India (Table.5).

The illegal trade level for *P. santalinus* is reported to be very high. Recently, Data on seizures were collected from all the State Forest Departments and other agencies involved in seizures and enforcement throughout India (IFGTB, 2011). The maximum amount of Red Sanders were seized within Andhra Pradesh, the state which has the natural populations of the species (Table, 6). The present stock of seized Red Sanders all over India estimated around 10,437 MT. Andhra Pradesh alone has around 7311 MT stored in the Depots. Around 3126 MT of seized Red Sanders logs is available outside Andhra Pradesh with various agencies. The data indicate that large number of seizures are taking place within the natural ranges and also outside the natural range which indicates movement of large amount of illegal wood of Red Sanders within India. Almost all these stocks seized are of illegal origin from wild sources as there is no harvest being made by the Forest Department either from the plantations or from the natural forest. The contribution from cultivated source towards the seized stock is negligible (IFGTB, 2011).

Table 6. Quantity of Red Sanders seized and stored in various states, Union Territories and other agencies across India.

S. No.	STATE / Union Territories	Quantity in Kg
1	Andhra Pradesh	7311095.00
2	Assam	101000.00
3	Bihar	102313.70
4	Chattishgarh (9.951 Cmt) [1 Cmt Of Red Sanders =1400 Kg]	14000.00
5	Gujarat	59810.00
6	Himachal Pradesh	11927.00
7	Jammu & Kashmir	93912.00
8	Karnataka	12140.00
9	Kerala	61320.20
10	Maharashtra (Customs + Police + Forest Departments)	496385.00
11	Manipur	3630.00
12	Mizoram	50192.00
13	Nagaland	8000.00
14	Orissa	19500.00
15	Tamil Nadu	299732.00
16	Uttar Pradesh	17502.25
17	DRI Guwahati Region	67938.40
18	Office of Commissioner of Customs and Excise, Hyderabad Region	38083.00

S. No.	STATE / Union Territories	Quantity in Kg
19	Office of Commissioner of Customs (Preventive), Kolkata	10460.00
20	Office of Chief Commissioners of Customs, Chennai	455222.00
21	DRI West Bengal and North Eastern States	504390.00
22	Office of Commissioner of Customs (Preventive), Mumbai II	293130.00
23	Office of Commissioner of Customs (Preventive), Chennai	274095.00
24	Office of Customs Gujarat Zone	131608.00
TOTAL (In MT)		10437.39

Source: IFGTB, 2011

Table 7. Year wise seizure of Red Sanders wood by Andhra Pradesh Forest Department and stock available in various Red Sanders depots.

Year	No. of Cases	Red Sanders Wood Seized (In MT)	No. of Vehicles Seized	No. of Persons Arrested
2002-03	185	186.760	42	59
2003-04	481	719.086	122	320
2004-05	269	323.930	118	310
2005-06	458	623.999	199	319
2006-07	728	1029.888	373	578
2007-08	890	1458.538	504	819
2008-09	668	796.658	223	455
2009-10	880	922.070	384	650
2010-11	-	1250.210	-	-
TOTAL	4559	7311.095	1965	3510

Source: Andhra Pradesh Forest Department, 2011.

It is approximately estimated that the tune of annual removal from the natural forests stands at 3000 MT of heartwood of Red Sanders through illegal felling. According to Andhra Pradesh Forest Department estimate on an average 1000 MT of heartwood only could be seized by Forest Department and other wood is smuggled out. There is very little demand for Red Sanders wood locally for toy making and chemical extracts for use in Ayurveda and pharmaceutical industry. The high demand and high price for heartwood in international market is the main reason for current high level of illegal trade.

II. NON-DETRIMENT FINDING PROCEDURE (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFs?

Yes. The methodology used is based on IUCN checklist for NDFs which is enclosed in the annexure.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

For making NDF following criteria were mainly used.

- a. Current population structure of *P. santalinus* revealed through detailed field survey throughout its natural ranges in Andhra Pradesh State in India. The field survey revealed that the current population of *P. santalinus* is highly skewed towards the lower girth classes (< 60- 70 cm girth class). The higher girth class trees (i. e. above 70 cm) were either absent or highly scattered throughout its natural range. It is because of past working of the forest and continuous selective illegal felling of higher girth trees for heartwood extraction.
- b. Very slow growth rate of the species in its natural conditions. It is estimated that it takes at least 80-100 years for *P. santalinus* saplings to reach 70 cm girth which is approximately harvestable size for heartwood extraction.
- c. High level of threat factors for the populations. The threat factors identified are illegal felling, repeated annual fires and cattle grazing which are affecting the population structure of natural Red Sanders.
- d. Level of legal and illegal trade.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

The population structure was studied through field survey by laying out stratified random sample plots of size 0.1 ha. in the identified natural populations of *P. santalinus* in Andhra Pradesh with a sampling intensity of 0.01% of total area. The trees in each sample plot were counted and distributed to different girth classes with a class interval of 10 cm girth at breast height (gbh) and total number of mature trees of different girth classes was calculated based on sample plot analysis. Phenological observations like vegetative stages, flowering and fruiting of *P. santalinus* was recorded within each 0.1 ha main sample plots across its natural ranges. Natural Regeneration was studied by laying ten random 1m × 1m sized sub-plots within each 0.1 ha main plot. The total number of seedlings of less than 137 cm height within the 1m x 1 m size random sub plots were counted and recorded.

During field survey the biological and ecological threat factors were studied and information also collected through interaction with local Forest Department staffs / Personnels. Data on removals were collected from Andhra Pradesh Forest Department. Data on seizures were also collected from all the State Forest Departments and other agencies involved in seizures throughout India. Data was

also collected from actual observations in the field by counting the cut stumps in the sample plots and observations on nature of stem origin (coppice or seed). Other data regarding area of species distribution, management practices, and seizures were collected from Andhra Pradesh Forest Department. Other information and data were collected from published literature. No study has been made regarding estimation of growing stock according to age class in the plantations available with Forest Department and farmers.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Most of the data used were primary data collected from actual field survey and therefore are highly reliable.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

There was no reliable data on population status, structure and regeneration level of *P. santalinus* in its natural ranges. The Institute of Forest Genetics and Tree Breeding conducted a detailed field study in remote hilly areas in Red Sander bearing forests in Andhra Pradesh for making NDF for *P. santalinus*. This kind of field survey requires man power and funding support and needs to be carried out periodically to monitor the populations. For accurate and quick monitoring of the natural populations of *P. santalinus* in future techniques like Remote sensing and GIS need to be employed.

6. RECOMMENDATIONS

1. Considering the very slow growth rate of the species in wild, high level of threat from the illegal felling, smuggling and annual fire, skewed distribution towards small girth class trees in the current populations, absence or highly scattered distribution of harvestable higher girth class trees (above 70 cm) in many populations, it is concluded that harvest for heartwood from natural population may not be sustainable currently. Therefore, any harvest of Red Sanders wood from wild and export of the same should be discouraged.
2. Since, there is no legal harvest currently taking place from the wild population, it is recommended that, the "Export Quota" as per CITES guidelines may not be required currently for wild populations.
3. The illegal felling and smuggling of Red Sanders wood is found to be at high level, need to be stopped completely.
4. Any future plan of harvest of Red Sanders wood and export should be from cultivated sources like Forest Department Plantations and trees growing in farm land. Therefore, systematic tree improvement programme need to be initiated to make the cultivation of this slow growing trees highly profitable under cultivation.
5. The natural Red Sanders bearing forest areas in Andhra Pradesh require augmented in-situ and ex-situ conservation measures to enhance the natural regeneration and also to protect the existing stocks of Red Sanders.

6. The species specific Remote sensing GIS techniques need to be used for more accurate estimation of natural Red Sanders areas and monitoring the populations periodically in future.
7. Currently, Non-detriment Finding (NDF) study has been carried out for wild population of *P. santalinus*. However, a detailed study may also be carried out in future for cultivated populations of *P. santalinus* by estimating the area under cultivation in farm land as well as plantations with State Forest Departments, harvestable growing stock available and also quantity and quality of heartwood in plantations.
8. To contain the illegal trade of Red Sanders wood, other countries which are regular importers of Red Sanders wood and products may also be encouraged to be more vigilant on source of Red Sanders wood shipped in and CITES permits issued with such shipments.

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Annexure
CHECKLIST TO ASSIST IN MAKING NON-DETRIMENT FINDINGS FOR APPENDIX II EXPORTS

Table 1. Plants. Summary of Harvest Regime for Plant Species

Species : *Pterocarpus santalinus* L. f Country (if applicable State or Province) : India (Andhra Pradesh state)

Date (of making Non-detriment Finding) : November 2011 Period to be covered by finding : 2012-2022 (10 years)

Name: Director, IFGTB Coimbatore Position in Scientific Authority : Director

Is the species endemic, found in a few countries only, or widespread? Endemic to Andhra Pradesh State in India

Conservation status of the species (if known): IUCN Global status : Endangered B1+2de ver 2.3 (1994)

National status : Endangered Other: .

Type of harvest	Main product	Degree of control	Demographic segment of population harvested			Relative level of off-take (include number or quantity if known)			Reason for off-take and percentage (if known)			Commercial destination and percentage (if known)					
			Immature	Mature	Sex	Low	Medium	High	Unknown	Subsistence	Commercial	Others	Local	National	Inter-national		
1.1 Artificial propagation		a) Regulated b) Illegal or unmanaged															√
1.2 Non-lethal harvesting of fruits/flowers/seeds/leaves		a) Regulated b) Illegal or unmanaged															
1.3 Non-lethal harvesting of bark/roots/wood		a) Regulated b) Illegal or unmanaged															

Type of harvest	Main product	Degree of control	Demographic segment of population harvested			Relative level of off-take (include number or quantity if known)			Reason for off-take and percentage (if known)			Commercial destination and percentage (if known)		
			Immature	Mature	Sex	Low	Medium	High	Unknown	Subsistence	Commercial	Others	Local	National
1.4 Removal of whole plant	Heart wood	a) Regulated												
		b) Illegal or unmanaged		√				√						
1.5 Removal of whole bulb		a) Regulated												
		b) Illegal or unmanaged												
1.6 Killing of individual by removal of seeds, leaves, bark, roots, wood		a) Regulated												
		b) Illegal or unmanaged												

Table 2: Factors Affecting Management of the Harvesting Regime

Biological characteristics : Animals only		
2.1. Life history: What is the species' life history?	High reproductive rate, long-lived	
	High reproductive rate, short-lived	
	Low reproductive rate, long-lived	
	Low reproductive rate, short-lived	
	Uncertain	
2.2. Ecological adaptability: To what extent Is the species adaptable (habitat, diet, environmental tolerance etc)?	Extreme generalist	
	Generalist	
	Specialist	
	Extreme specialist	
	Uncertain	
2.3 Dispersal efficiency: How efficient is the species' dispersal mechanism at key life stages?	Very Good	
	Good	
	Medium	
	Poor	
	Uncertain	
2.4. Interaction with humans: Is the species tolerant to human activity other than harvest?	No interaction	
	Pest /Commensal	
	Tolerant	
	Sensitive	
	Uncertain	
Biological characteristics : Plants only		
2.1. Life form: What is the life form of the species?	Annual	
	Biennial	
	Perennials (herbs)	
	Shrub and small trees (max. 12 m.)	
	Trees	√
2.2. Regeneration potential: What is the regenerative potential of the species concerned?	Fast vegetatively	
	Slow vegetatively	
	Fast from seeds	
	Slow or irregular from seeds or spores	√
	Uncertain	
2.3. Dispersal efficiency: How efficient is the species' dispersal mechanism?	Very Good	
	Good	
	Medium	√
	Poor	
	Uncertain	
2.4. Habitat: What is the habitat preference of the species?	Disturbed open	
	Undisturbed open	
	Pioneer	
	Disturbed forest	
	Climax	√

National status: Animals and plants

2.5. National distribution: How is the species distributed nationally?	Widespread, contiguous in country	
	Widespread, fragmented in country	
	Restricted and fragmented	√
	Localised	
	Uncertain	
2.6. National abundance: What is the abundance nationally?	Very abundant	
	Common	
	Uncommon	√
	Rare	
	Uncertain	
2.7. National population trend: What is the recent national population trend?	Increasing	
	Stable	
	Reduced, but stable	√
	Reduced and still decreasing	
	Uncertain	
2.8. Quality of information: What type of information is available to describe abundance and trend in the national population?	Quantitative data, recent	√
	Good local knowledge	
	Quantitative data, outdated	
	Anecdotal information	
	None	
2.9 Major threats: What major threat is the species facing (underline following: overuse/ habitat loss and alteration/ invasive species/ other: and how severe is it?	None	
	Limited/Reversible	√
	Substantial	
	Severe/Irreversible	
	Uncertain	

Harvest management: Animals and plants

2.10. Illegal off-take or trade: How significant is the national problem of illegal or unmanaged off-take or trade?	None	
	Small	
	Medium	
	Large	√
	Uncertain	
2.11. Management history: What is the history of harvest?	Managed harvest: ongoing with adaptive framework	
	Managed harvest: ongoing but informal	
	Managed harvest: new	
	Unmanaged harvest: ongoing or new	√
	Uncertain	
2.12. Management plan or equivalent: Is there a management plan related to the harvest of the species?	Approved and co-ordinated local and national management plans	
	Approved national/state/provincial management plan(s)	
	Approved local management plan	√
	No approved plan: informal unplanned management	
	Uncertain	

2.13. Aim of harvest regime in management planning: What is harvest aiming to achieve?	Generate conservation benefit	
	Population management/control	
	Maximise economic yield	
	Opportunistic, unselective harvest, or none	√
	Uncertain	
2.14 Quotas: Is the harvest based on a system of quotas?	Ongoing national quota: based on biologically derived local quotas	
	Ongoing quotas: "cautious" national or local	
	Untried quota: recent and based on biologically derived local quotas	
	Market-driven quota(s), arbitrary quota(s), or no quotas	√
	Uncertain	
Control of harvest: Animals and plants		
2.15. Harvesting in Protected Areas: What percentage of the legal national harvest, occurs in State-controlled Protected Areas?	High	
	Medium	
	Low	
	None	√
	Uncertain	
2.16. Harvesting in areas with strong resource tenure or ownership: What percentage of the legal national harvest occurs outside Protected Areas, in areas with strong local control over resource use?	High	
	Medium	
	Low	
	None	√
	Uncertain	
2.17. Harvesting in areas with open access: What percentage of the legal national harvest occurs in areas where there is no strong local control, giving de facto or actual open access?	None	√
	Low	
	Medium	
	High	
	Uncertain	
2.18. Confidence in harvest management: Do budgetary and other factors allow effective implementation of management plan(s) and harvest controls?	High confidence	√
	Medium confidence	
	Low confidence	
	No confidence	
	Uncertain	
Monitoring of harvest: Animals and plants		
2.19. Methods used to monitor the harvest: What is the principal method used to monitor the effects of the harvest?	Direct population estimates	√
	Quantitative indices	
	Qualitative indices	
	National monitoring of exports	
	No monitoring or uncertain	

2.20. Confidence in harvest monitoring: Do budgetary and other factors allow effective harvest monitoring?	High confidence	
	Medium confidence	√
	Low confidence	
	No confidence	
	Uncertain	
Incentives and benefits from harvesting: Animals and plants		
2.21. Utilisation compared to other threats: What is the effect of the harvest when taken together with the major threat that has been identified for this species?	Beneficial	
	Neutral	
	Harmful	
	Highly negative	√
	Uncertain	
2.22. Incentives for species conservation: At the national level, how much conservation benefit to this species accrues from harvesting?	High	
	Medium	
	Low	
	None	√
	Uncertain	
2.23. Incentives for habitat conservation: At the national level, how much habitat conservation benefit is derived from harvesting?	High	
	Medium	
	Low	
	None	√
	Uncertain	
Protection from harvest: Animals and plants		
2.24. Proportion strictly protected: What percentage of the species' natural range or population is legally excluded from harvest?	>15%	√
	5-15%	
	<5%	
	None	
	Uncertain	
2.25. Effectiveness of strict protection measures: Do budgetary and other factors give confidence in the effectiveness of measures taken to afford strict protection?	High confidence	
	Medium confidence	√
	Low confidence	
	No confidence	
	Uncertain	
2.26. Regulation of harvest effort: How effective are any restrictions on harvesting (such as age or size, season or equipment) for preventing overuse)?	Very effective	
	Effective	
	Ineffective	
	None	√
	Uncertain	

Scoring System to Assist Scientific Authorities in Making Non Detriment Findings - Plot of Responses to Questions in Table 2

Question Number	Question Category	Question	Response -1 to 5
2.1	Biology	BIOLOGY - Life form	5
2.2		BIOLOGY - Regeneration potential	4
2.3		BIOLOGY - Dispersal	3
2.4		BIOLOGY - Habitat	5
2.5	Status	STATUS - National distribution	4
2.6		STATUS - National abundance	3
2.7		STATUS - National population trend	2
2.8		STATUS - Information quality	1
2.9		STATUS - Major threat	2
2.1	Management	MANAGEMENT - Illegal off-take	4
2.11		MANAGEMENT - Management history	4
2.12		MANAGEMENT - Management plan	3
2.13		MANAGEMENT - Aim of harvest	4
2.14		MANAGEMENT - Quotas	4
2.15	Control	CONTROL - Harvest in PA	4
2.16		CONTROL - Harvest in strong tenure	4
2.17		CONTROL - Open access harvest	1
2.18		CONTROL - Confidence in harvest management	1
2.19	Monitoring	MONITORING - Monitoring method	1
2.2		MONITORING - Confidence in monitoring	2
2.21	Incentives	INCENTIVES - Effect of harvest	4
2.22		INCENTIVES - Species conservation incentive	4
2.23		INCENTIVES - habitat conservation incentive	4
2.24	Protection	PROTECTION - Proportion protected from harvest	1
2.25		PROTECTION - Effectiveness of protection	2
2.26		PROTECTION - Regulation of harvest	4

Figure 2 - Scoring System to Assist Scientific Authorities in making Non-Detriment Findings - Plot of responses to questions in Table 2

