

**NON-DETRIMENT FINDING (NDF)**  
Report for *Nardostachys grandiflora* in  
Bhutan Himalaya





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**Bhutan Himalaya**

*Proposal to fix national quota for sustainable trade*

**(October 2022)**

**Nature Conservation Division & Social Forestry & Extension  
Division, Department of Forests and Park Services,  
Ministry of Agriculture and Forests**

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**With best wishes and Tashi Delek!**

**Nature Conservation Division &  
Social Forestry and Extension Division**



## EXECUTIVE SUMMARY

Non-Wood Forest Product (NWFP) including *N. grandiflora* is one of the most important sources of livelihood for the highlanders. In Bhutan, primarily used for manufacturing incense, which is burned during religious rituals and ceremonies to appease the humans, local deities and gods. In recent times the demand for *N. grandiflora* by many small-scale incense making industries and traders that are dependent on NWFP are on the rise. Which means there is a high pressure on the habitats at certain periods of the year and some of the key issues identified by the collectors were the non-sustainability of current collecting methods and the difficulties in managing the common resource pool in a controlled and sustainable manner. The species has been evaluated as Critically Endangered under criteria A2cd of the IUCN Red List. Therefore, there is a need to fix national quota for sustainable international trade through this Non-Detriment Finding (NDF) report.

This NDF report is divided into two chapters, the first chapter describes the biological characteristics, habitat and ecology, species usage, management, trade and legal aspects etc. Chapter 2 describes the actual survey report and the 9-step process of NDF and prescribes NDF advice and recommendations. The survey design and methodologies were partly adopted from the biodiversity survey protocol developed by Nature Conservation Division functioning under the Department of Forests & Park Services (DoFPS 2020) and the IUCN (2018). A total of 1377 random plots were surveyed out of which 242 plots did not encounter *N. grandiflora*.

The survey data was analyzed using Microsoft Excel, Pivot Table and PCORD statistical software designed for ecological analysis. There was presence of 5 major lifeform group and the cover % of *N. grandiflora* was at 17% when compared with herbaceous life-form groups which indicated the cover % of *N. grandiflora* is remarkably high. Further, the indicator species analysis showed the presence of *N. grandiflora* was very significant in cluster 1 out of 7 clusters with  $P^* < 0.05$ . Canonical Correspondence Analysis showed that *N. grandiflora* occurrence was highly correlated with slope (0.966) in Axis 1 and aspect (0.939) in Axis 2. It prefers the slope of 25-45 degrees in alpine and subalpine vegetation zones. The occurrence of the plant was mostly on moist, open meadows and moist shrubby Juniper-Rhododendron scrub habitat facing north aspect. A total of 29 sub-population sites were recorded across 9 field divisions covering an area of 27.97square kilometer extending from East to West Bhutan indicating wide spread within a geographical space. The total growing stock of *N. grandiflora* was estimated at 497 Metric Tons (MT) at the national level including both immature and mature population and individual count ranged from 56 to 138 per plot. Based on the assessment and analysis, the DoFPS recommends an Allowable Harvest Limit (AHL) of 25% in a 7-year generation length which would mean an AHL of 18MT per year. Therefore, a national quota is fixed at 18MT until next NDF report.

For the sustainability of *N. grandiflora*, The DoFPS will enhance compliance monitoring and patrolling at sites during harvest and trade of specimen. Conduct research on regeneration, reproduction and develop biomass equation in future and ensure strict compliance for issuance of CITES permit. Further develop and implement *N. grandiflora* conservation action plan and facilitate fair trade deal for rural livelihoods.

### **Lists of Acronyms**

AITR	Annual Illegal Trade Report
AOO	Area of occupancy
BWS	Bumdeling Wildlife Sanctuary
CCA	Canonical Correspondence Analysis
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CITES	Convention on International Trade of Endangered Species of Fauna & Flora
CoP	Conference of Parties
DoFPS	Department of Forests & Park Services
EOO	Extent of occurrence
FIRMS	Forestry Information Reporting & Monitoring System
FNCA	Forest & Nature Conservation Act 1995
FNCRR	Forest & Nature Conservation Rules and Regulations 2017
ITMS	Institute of Traditional Medicine Services
IUCN	International Union for Conservation of Nature
JDNP	Jigme Dorji National Park
JKSNR	Jigme Khesar Strict Nature Reserve
MSPCL	Menjong Sorig Pharmaceutical Corporation Limited
NBC	National Biodiversity Centre
NCD	Nature Conservation Division
NDF	Non-Detriment Finding

NWFPs	Non-Wood Forest Products
PNP	Phrumsengla National Park
RD	Relative Density
SFED	Social Forestry & Extension Division
SoP	Standard Operating Procedures
SWS	Sakteng Wildlife Sanctuary
TAC	Technical Advisory Committee
UWICER	Ugyen Wangchuck Institute for Conservation & Environmental Research
WCNP	Wangchuck Centennial National Park

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# CHAPTER 1:

## INTRODUCTION

### BACKGROUND

*Nardostachys grandiflora* DC is a perennial herb and it belongs to the Valerianaceae family and the Latin synonyms are: *Nardostachys jatamansi* and *Nardostachys chinensis* (Gautam & Raina, 2016). It is locally known as Pang-poe in Bhutan and it is the only species within its genus, and it is found in Thimphu, Haa, Paro, Bumthang, Chukha, Gasa, Samtse, Trashigang, Tashi Yangtse, Wangdue Phodrang, Dagana and Tsirang districts of Bhutan. The species occurs within an altitude range of 3810m to 5155m (Grierson A.J.C. & Long D.G., 2001) with known slow regeneration after harvest of the rhizomes.

The *N. grandiflora* has a wide range of uses ranging from medicinal purposes to making perfumes globally and in Bhutan, it is generally used for production of traditional medicine and incense. Although the rhizomes are traditionally collected as an ingredient for the production of local incense and traditional medicine in the recent past, the species is now increasingly collected for the international market. Processed and semi-processed medicinal plant species including *N. grandiflora* are readily available in the local markets and they are usually collected in huge quantities with no consideration for sustainable harvest and trade management. Such practice would lead to the depletion of resources in the wild and further many small-scale incense making industries and private enterprises that are dependent on NWFP are on the rise. Access to natural resources is perceived as a bountiful and easy opportunity to make profit by the people and government, this motive and action undermine the sustainability of natural resources (Larsen & Olsen, 2008). Thus, there is an urgent need to set a quota for export of NWFP listed under CITES appendices that are collected and traded within and outside Bhutan. This NDF report targets to set a national quota and facilitate the trade of *N. grandiflora* for the benefit of the NWFP groups and the Bhutanese people in general, without undermining resource sustainability.

National export quota will ensure that export of specimens is maintained at a level that has no detrimental effect on the population. This management tool of the national quota system meets the requirement of CITES when export quotas are established for the first time and subjected to revision annually (Resolution Conf. 14.7 & CoP 15, 2010).

The facilitation of sustainable harvesting and trade will improve the socio-economic condition of the people and contribute towards economic recovery from the strong impact of Covid 19 pandemic. At this stage, the Royal Government of Bhutan is in economic recovery mode, whereby facilitation of such trade will help generate revenue to the

community and the Government. However, the trade of such specimens should not undermine the overall conservation policy, national legislation and the CITES convention at the broader spectrum. Currently no comprehensive management plan exists, however certain regulatory mechanisms are in place to address the concerns to some extent. No artificial propagation of *N. grandiflora* was initiated by community groups or any projects due to its abundance in the wild for now. The exports requested are all sourced from the wild by the NWFP Management and marketing groups and sold to traders to make their livelihood. In order to collect the resources from the wild, the permits are issued based on the annual harvesting limit fixed in the management and marketing plan for commercial use. Further, the national law allows to collect and trade the species for the NWFP groups as their important source of livelihood and the interim framework for management and marketing of NWFPs allows 60 species including *N. grandiflora* for commercial use. However, a very basic harvest management measure is in place to address the sustainable utilization and management of the species, the current nationwide survey provided the baseline data for Non-Detriment Finding (NDF) decision to mitigate depletion in the wild. This NDF was focused on conservation and sustainable utilization of *N. grandiflora* and no NDF for this species was reported from Bhutan so far. However, NDF on this species was reported by Larsen and Olsen (2008) for Nepal and thus this NDF is reporting for the first time from Bhutan. This report will further validate the previously made NDF on *N. grandiflora* with additional findings from the recent survey.

The survey was conducted by nine field offices namely: Bumdeling Wildlife Sanctuary (BWS), Bumthang Forest Division, Sakteng Wildlife Sanctuary (SWS), Jigme Khesar Strict Nature Reserve (JKSNR), Paro Forest Division, Phrumsengla National Park (PNP), Wangchuck Centennial National Park (WCNP), Thimphu Forest Division and Jigme Dorji National Park. *N. grandiflora* has been listed in CITES appendix II since 1997.

## BIOLOGICAL CHARACTERISTICS

The rhizomatous herb is between 10 and 60 cm in height. The inflorescence may have one or more terminal capitate clusters. The capitate inflorescence is erect and usually measures 9-30cm, sometimes branched above. The flower heads are approximately 2 cm in diameter and bloom between June and September. The calyx measures from 2-2.8mm and they are either entire or toothed. The corolla is tubular-campanulate and measures 5.5-13mm and the color ranges from pink to purple, hairy; lobes 2-4mm, obtuse. Obovoid fruit measures approximately 5 x 2.5mm, long and flattened. Basal leaves are in rosettes and the shape of the basal leaves are linear to narrowly spatulate and it measures 4-15cm long and the width measure 0.4-1.7cm, glabrous or pilose on main veins and margin is entire or serrulate. Aromatic woody rhizome is covered in a mantle of fibrous dead petioles and it measures up to 12 cm long (Grierson A.J.C. & Long D.G., 2001). Seed germination, which takes place in May-June, is very low 10-20% according to Nautiyal *et al.* (2003), Gautam and Raina (2016) with no persistent seed bank. The species grows vegetatively with

successive ramets (vegetative clones) produced very close together in a dense clump (Ghimire et al., 2008), (Gautam & Raina, 2016) However, such observation was deficient from Bhutan.

## HABITAT AND ECOLOGY

*N. grandiflora* occurs mostly in open moist steep slopes in rocky alpine meadows or in dry Juniper and Rhododendron scrubs, minimum elevation recorded was 3464 m and maximum was 4766 m during the time of survey. The population growth rate was higher in meadow habitats as compared with rocky habitats and the growing season of the species spans from May to October (Ghimire et al., 2008). The species reproduces through vegetative means and through seeds, and mature between 3 and 5 years. The generation length of the species is between 3 and 10 years (Larsen & Olsen, 2008).

## ROLE OF THE SPECIES IN ITS ECOSYSTEM

*N. grandiflora* is a small plant growing in clusters/patches that may appear dense where it occurs. It is generally not very frequent in any of the habitats where it is found, but no studies have been conducted in Bhutan (Larsen & Olsen, 2008).

## CURRENT GLOBAL POPULATION AND CONSERVATION STATUS

The global population size is declining due to anthropogenic pressures like deforestation, habitat fragmentation, illegal trade, overexploitation, overgrazing, and unsustainable development activities (Larsen & Olsen, 2008). These threats have impacted the long-term sustainability of the species in the wild through habitat loss, degradation and overharvesting. It appears that none of the species range countries have so far developed and implemented mitigation plans between the period 2001 and 2022. Undocumented population declines of *N. grandiflora* may also be occurring in its entire distribution range including Bhutan. The species has been listed as Critically Endangered under criteria A2cd of the IUCN Red List. The species are distributed in Bhutan, India, Nepal, Pakistan and China (Chauhan, 2021).

## USE OF THE SPECIES

The roots of *N. grandiflora*, leaves and stems of *Rhododendron ciliatum*, *Rhododendron setosum* and aerial parts of *Tanacetum nubigenum* are widely used for medicinal and aromatic purposes in Asia (Larsen & Olsen, 2008). *N. grandiflora* is also used as a detoxifier and treatment of chronic fever and heart disorders (Wangchuk & Olsen, 2008). In addition, it is used as an important ingredient in the production of incense, essential oils, and perfumes. More than half of the national collections are exported to India and the rest are supplied to the domestic market for traditional medicine, incense, perfumes, etc. The

essential oil content of rhizomes known as spikenard oil is reported to be effective in treating leprous wounds (Gautam & Raina, 2016), (Wangchuk et al., 2008). In Bhutan, pounded plants are mixed with other plant material (locally known as “sang”) and used primarily to manufacture incense, which is burned during religious rituals and ceremonies to appease the humans, local deities and gods (Mulliken & Crofton, 2008). All the specimens are sourced from the wild. Given its broad use and medicinal properties, the species continues to be exploited. This has resulted in overexploitation and relentless harvesting leading to habitat loss.

## HARVEST REGIME AND MANAGEMENT

Generally, *N. grandiflora* is harvested from the state reserved forest and to ensure sustainable collection or harvesting, the technical regulations are developed by the Department of Forests and Park Services (DoFPS, 2017). The Department of Forests and Park Services is responsible for regulating the collection of any resources from the state reserved forests (DoFPS, 1995). However, communities are also empowered for management of resources within the area where the community have traditional and customary rights through approval of resources management and marketing plans by the Head of the Ministry. The approved plan is valid for the period of five years. The implementation of activities by the group is monitored periodically by the concerned forestry officials. To ensure sustainable collection of resources, the group must obtain a collection permit from the forest office before commencement of resources collection annually. The permits are issued based on the annual harvesting limit fixed in the management and marketing plan. Also, the group must also adhere to the harvesting prescription outlined in the plan to ensure that their collection method is not detrimental to the survival of species. Currently there is no quota set for export of any NWFPs collected and traded within and outside Bhutan. However, communities are allowed to harvest NWFPs for their domestic use without obtaining a permit. Key issues identified by the collectors were the non-sustainability of current collecting methods and the difficulties in managing a common resource in a controlled and sustainable manner. Although most of the collectors were aware of the scientific method of harvesting, implementation of the sustainable harvesting approach has been a complex issue involving ecological, biological, social and economic factors (Lakey & Dorji, 2016). For the targeted species, almost every collector/harvester followed a seasonal harvesting pattern, which means there is a high pressure on the habitats at certain periods of the year. This again could be a bottleneck in sustaining the habitats (Malla Thakuri et al., 2020).

## LEGAL AND ILLEGAL TRADE LEVELS

The level of international trade detected by enforcement agencies was based on the CITES Annual Illegal Trade Report submitted to the Repository Government Geneva, Switzerland



for 2 consecutive years as shown below.

Date of seizure	Species	Description of specimen	Quantity	Unit
25/11/2019	<i>Nardostachys grandiflora</i>	ROO	70	KIL
27/11/2019	<i>Nardostachys grandiflora</i>	ROO	270	KIL
30/12/2019	<i>Nardostachys grandiflora</i>	ROO	331.15	KIL
09/07/2020	<i>Nardostachys grandiflora</i>	ROO	15.00	KIL

Table 1. CITES AITR 2019 and 2020

The economic value may pose a threat leading to overutilization of any forest resources (Thakuri B. M., 2018). However, much of the decline in other Trans-Himalayan regions is attributed to loss of natural habitat. Precise and recorded figures on informal and illegal collection and trade of medicinal plants are not available. The severity of the illegal trade could be serious and detection rate is very low over the past three years.

The following graph shows the quantity of *N. grandiflora* issued in between the year 2017 to 2021 in JDNP and Paro division respectively both for domestic use and probable export.

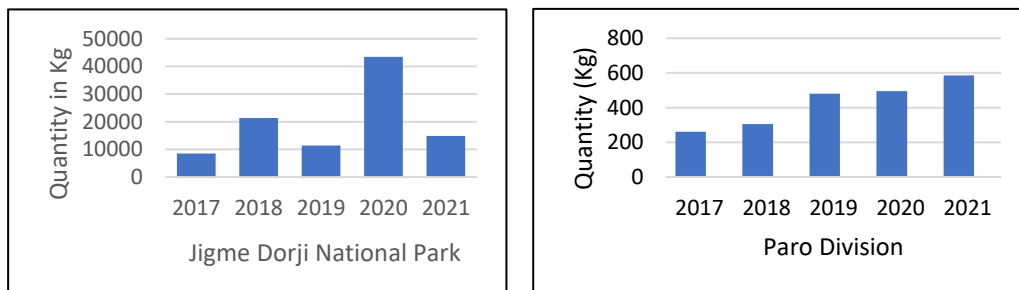


Figure 1. Quantity allowed to collect legally with permit inside two Park/Division

The volume of harvest was estimated based on the quantity issued by Jigme Dorji National Park and Divisional Forest Office, Paro for collection during the calendar year 2017 to 2021 as shown in the above figure for two divisions, which was considered as current level of quantity harvest in the country, based on the data generated through FIRMS database of the Department. Annually, the Menjong Sorig Pharmaceutical Corporation Limited (MSPCL) uses over 18 tons of medicinal plants in their formulary, 85 % of which comprise species collected directly from the wild. Olsen (2005a) estimated that exports of unprocessed air-

dried *N. grandiflora* rhizomes from Bhutan to India totaled somewhere between 3-35 tons during 1997/98.

#### LEGAL FRAMEWORK AND LAW ENFORCEMENT

The Ministry of Foreign Affairs of the Royal Government of Bhutan formally declared the acceptance of the amendment to Article XXI of the CITES Convention on 15 August 2002 by designating the DoFPS as the Management and Scientific Authority and currently, the CITES matters are dealt with by the Nature Conservation Division. One of the factors contributing to the sustainability of *N. grandiflora* resource *In-situ* will be determined by the national legislation. The collection of any medicinal plants for commercial purposes requires a permit from the DoFPS with specific requirement of NWFPs ownership certificate, Certificate of Origin, Internal Movement order, Export permit and the rule further grants the user rights to the local communities for domestic use and consumption. Further, the National Forest Policy of 2011 allows the community to collect NWFPs from the Community Forests and State Reserved Forests under the NWFP strategy, and the strategy highlights the need for formation of user groups to manage resources within the limit of community forest management regime. The access to collect the resources is granted after the formation of the NWFP management group and the group is responsible for preparing the management plan and its operational plan. These groups usually carry out collections based on the harvesting limit set in the plan. However, in areas where such groups are not formed, collection permits are also granted to individual collector(s).

NWFPs including *N. grandiflora* is one of the most important sources of livelihood for the highlanders in Bhutan. There are 146 NWFP groups in the country for sustainable management, out of which 7 are involved in *N. grandiflora* management. The interim framework for management and marketing of NWFPs allows 60 species including *N. grandiflora* for commercial use. However, in March 2021, the harvest and marketing of the *N. grandiflora* was temporarily suspended to plan and prepare the NDF study as desired by the CITES Management and Scientific Authority of the Royal Government of Bhutan in accordance with the Article IV of the CITES convention. The national law also states that “No person may export any animal or plant or any parts or product of such animal or plant, without a permit issued by the Ministry certifying lawful acquisition, and ministry’s opinion stating that the export will not be detrimental to the survival of the species” (DoFPS, 1995). The national law is aptly relevant and it syncs well with the CITES trade regulations.

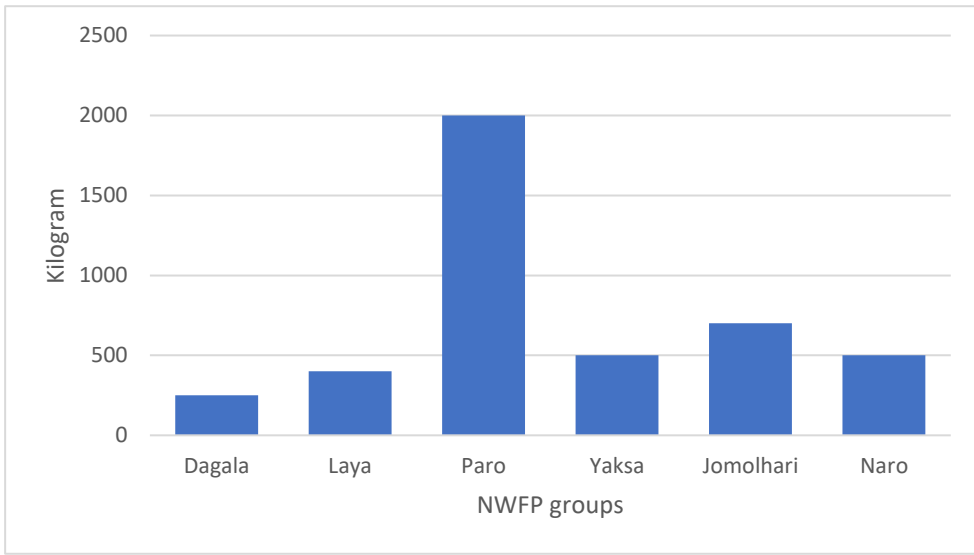


Figure 2. Current level of harvest by the existing NWFP user group in the country



**Photo 1: Non-wood Forest Product (NWFP) group of Paro district, West Bhutan**

## CHAPTER 2:

### NON-DETRIMENT FINDING (NDF) PROCESSES AND RESULTS.

#### OVERVIEW OF PROCESS FOR DEVELOPMENT OF THE NDF.

The CITES Secretariat recommends the 9 STEPs process to develop non-detriment findings (NDFs) reports which will help CITES Scientific Authorities in making science-based decisions. While the current NDF on *N. grandiflora* developed follows these steps recommended, the team also conducted a week-long training for team members as a part of their capacity development exercises which included development of methodologies and conducting pilot surveys to test the applicability.

Following the piloting, testing and planning in conjunction with the 9 steps of NDF recommended, the teams were engaged for field data collection, data sorting, analysis and report preparation along with the findings/results which are detailed below.

#### EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT.

An assessment was carried out based on 1377 sample plots laid in potential growing area stretching from east to west, Jigme Dorji National Park surveyed 504 plots and ranked top among others, Jigme Khesar Strict Nature Reserve surveyed 213 plots and the lowest was surveyed by Bumdeling Wildlife Sanctuary with 32 plots. Enough data was obtained for analyzing the habitat conditions and for estimating the growing stock of the species in the country, however the species were not fully matured during the time of survey, which must have affected the estimation of growing stock available in the country. The data collected in the field were verified and corrected, including the identification of the species, and defined the mathematical formula to estimate the growing stock during the data analysis and report writing. The outcome of the training workshop was presented to the Technical Advisor of the Department of Forest and Park Services, Chief Forestry Officer and the Principal Forestry Officer from the Social Forestry and Extension Division. Further, the current level of *N. grandiflora* harvested in the country was verified through the permit issued by the DoFPS, and data on Illegal trade of the specimen was verified from the past CITES annual illegal trade report submitted to the repository government. All the possible threats were listed and analyzed using Miradi software based on field observations made by the team during the survey. The population distribution and density of *N. grandiflora* was derived from the plot survey and observation in the field and the severity of the concerns, risks and impacts were derived out of the stakeholder consultation during the workshop. Therefore, the assessments were all done through the primary data of the survey, secondary sources available and stakeholder consultation including expert opinions for assessment.

## FIELD SURVEY METHODOLOGIES, RESULTS AND FINDINGS.

The survey design and methodologies were partly adopted from the biodiversity survey protocol (NCD & DoFPS, 2020) and the IUCN (Red List Technical Working Group, 2018). Before the commencement of the field survey, *N.grandiflora* collection sites were listed and mapped by collectors on chart paper. Based on a map drawn, the distribution sites were drawn on Google Earth using polygon.

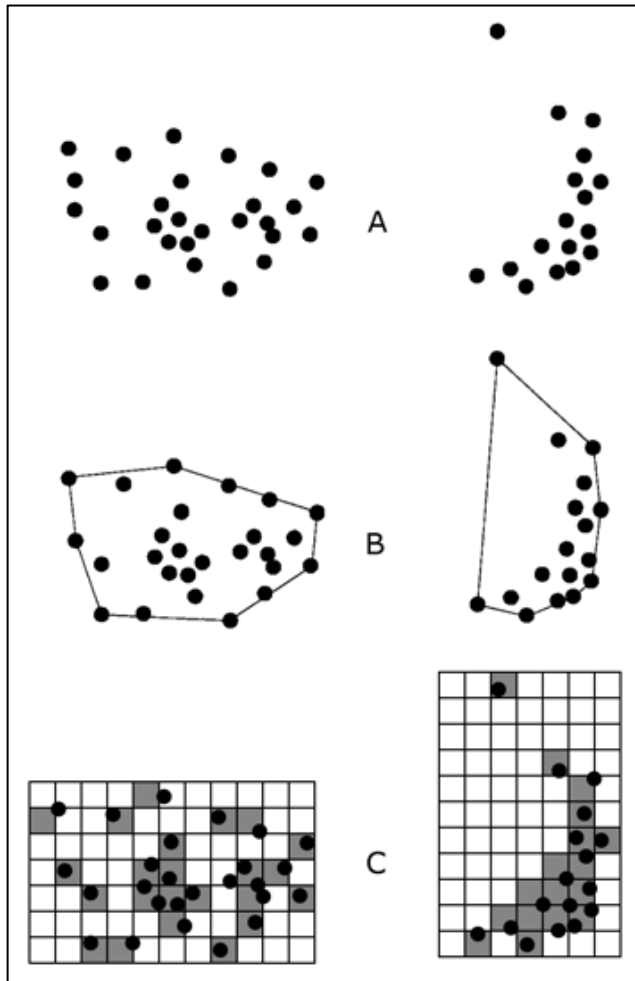


Figure 3. Two examples of the distinction between EOO and AOO. (A) is the spatial distribution of known, inferred or projected sites of present occurrence. (B) shows one possible boundary to the EOO, which is the measured area within this boundary. (C) shows one measure of AOO which can be achieved by the sum of the occupied grid squares.

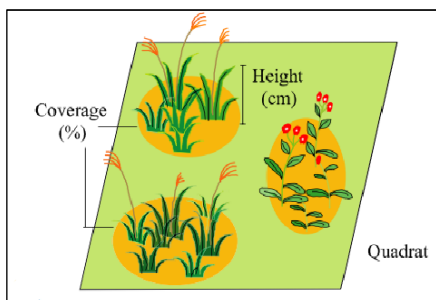
The transect routes were established along the altitudinal gradient covering all the major habitats. Data of the ground vegetation was collected by establishing the quadrat pot measuring  $2 \times 2\text{m}^2$  and the tallest height of each species was measured using 5m-fiberglass tape. The AOO of each species was estimated inside the quadrat as shown in Figure 4.





Photo 2: Survey team members carrying out assessment at Sakteng Wildlife Sanctuary





Ground vegetation survey method (wangda 2006)



Figure 4. Quadrate plot design and estimating the cover % of each species inside the plot.

The survey was carried out by respective field division staff following the species survey protocol. The survey sites were determined by the presence of the species and the sample size considered was 7 plots per hectare representing all the habitat types. Week-long training workshop on data analysis was provided to the field staff to process the data analysis. Preliminary data was cleaned in Microsoft Excel and processed using pivot-table analysis. Analysis was performed using the statistical software designed for ecological analysis, that is PC-ORD version 5.1. Cluster analysis was performed using Relative Sorensen (Bray-Curtis method) distance measure and Ward's method for grouping the similarity among the samples. Species relationship was tested with 5 habitat variables namely latitude, longitude, elevation, aspect, slope using Canonical Correspondence Analysis (McCune B. & Mefford M. J., 2016).

#### QUANTIFICATION OF *N. GRANDIFLORA*.

A total of 29 sub-population sites were recorded across 9 field divisions during the survey. From this survey, distribution and abundance of *N. grandiflora* is fairly known from different locations in Bhutan. However, accuracy of quantity available for harvest in each location may have to be compromised as the AOO in the field relied on the empathy of the surveyors. The total Extent of Occurrence (EOO) was 27.97square kilometers extending from East to West Bhutan. The geographic range of species was derived based on the IUCN red list assessment method. The EOO data was estimated through observation in the field by the surveyors and the species occurs sporadically with huge variance within the EOO. A total of 1377 quadrat plots were randomly distributed and surveyed across the species range districts of Bhutan. The following component of the equation was defined mathematically and thoughtfully applied for calculation. The application of this equation elsewhere requires further work in the field. Lakey and Dorji (2016) reported 8.9 individuals/m<sup>2</sup>, with an average of 7 stems per clump of *N. grandiflora* from Lingshi Dungkha, Jigme Dorji National Park and "28,186 *N. grandiflora* is needed to be uprooted

in order to collect 39.46 kg of its dried roots” (Wangchuk & Olsen, 2008). Based on this default value, it is estimated that 715 numbers of rhizome are required to weigh 1 kg of *N.grandiflora* in dried form. It has to be noted that the current stock at site was estimated for the months of June, July and August except for Paro which was estimated for November month, during the time of field assessment. The growing stock at site would be much higher when the plants fully mature in the months of August and September as anticipated by the survey team members. The growing stock estimation was directly proportional to level of disturbance and habitat suitability for growth of *N. grandiflora*

where Stock factor = Area in hectare x Percent of occurrence x Weight per Volume;

$$S_f = A \times \% \text{ of Occurrence} \times w/v$$

Weight per volume = Average Weight in 2x2 plots / Average Volume of *N. grandiflora*

$$w/v = \frac{\text{Avg. w inside 2x2 plots}}{\text{Avg. v of } N.\text{grandiflora}}$$

The weight per volume was taken on the basis of the average weight measured at JKSNR, that is 0.000536 kg as default value for estimating the growing stock for the rest of the country. The average volume of *N. grandiflora* was derived out of height multiplied by the sum of all cover percent occurring inside AOO.

Where Stock = Average Volume x Stock Factor

$$S = \text{Avg. v} \times S_f.$$

Using the above formula, it was calculated that 497 metric tons of *N.grandiflora* from the total area survey as the growing stock.

S. No.	Park/Division	EOO in Km <sup>2</sup>	Estimate in ton	Kg/Km <sup>2</sup>	Average count per plot in No.
1	Thimphu	0.47	4.86	10.35	101
2	JKSNR	7.27	31.63	4.35	115
3	PNP	0.15	1.95	13.00	56
4	WCNP	1.8	15.32	8.51	73
5	SWS	0.21	7.74	36.87	79
6	Paro FD	0.64	16.48	25.75	38
7	BWS	0.03	2.36	78.79	107
8	Bumthang	0.28	4.39	15.68	138
9	JDNP	17.12	410.07	23.95	79
		27.97	494.81		

Table 2. Growing stock under each Parks/Divisions

#### FLORISTIC COMPOSITION OF THE FIVE MAJOR LIFEFORM DISTRIBUTIONS.

The analysis of the data from the recent survey of the species showed the following floristic composition of the major life form distribution in Bhutan. A total of 537 species of plants within 40 families were recorded, of which 65 were trees and shrubs, 427 herbs, 31 graminoides (Grass, Hedge and Sedge) and 14 were spore bearing plants including fern, fungi, moss and lichen. The life-form composition of the ground vegetation has a considerable proportion of herb species with 41% followed by woody species at 36%, *N. grandiflora* at 17%, graminoides 6% and spore bearing plant around 1% respectively. The composition of *N. grandiflora* was highest in Bumdeling Wildlife Sanctuary at 28.69 %, Bumthang, JKSNR and JDNP had almost similar composition at 20% each. Likewise, SWS, Paro, PNP and WCNP composition ranged from 12.73% to 16.5% and Thimphu had the lowest at 2.76% respectively. Out of the 1377 survey plots, 242 plots did not record *N. grandiflora* presence inside the Area of Occupancy (AOO).



Photo 3: Participatory mapping exercise with the community of Paro

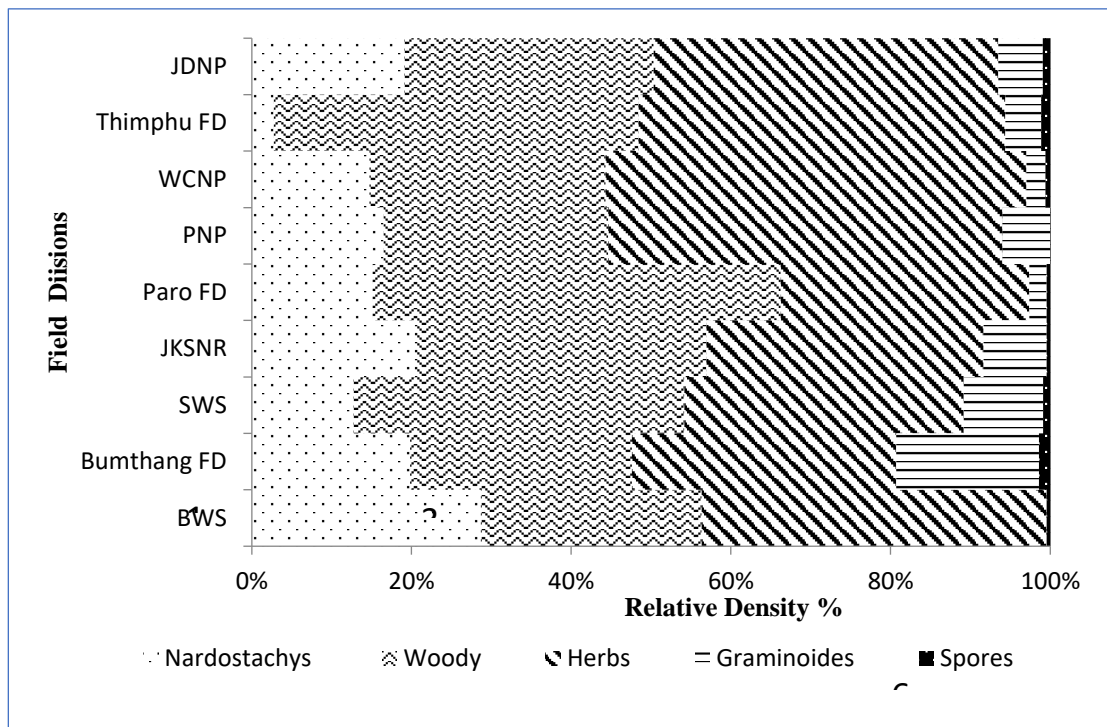


Figure 5. 100% stacked graph showing field division wise distribution pattern and proportion of five lifeform groups of herbaceous plants including *N. grandiflora* species, woody perennials, graminoides composed of grass, hedge and sedge and very less cover % of spore bearing plants.

#### CLUSTER & INDICATOR SPECIES ANALYSIS.

Hierarchical clustering method was used to identify the pattern of clusters by arbitrarily marking the similarity index scale at 25% threshold and each of the clusters were significantly separated by indicator and dominant species as indicated in the graph below. The most dominant families were Compositae (n=78 species) followed by Rosaceae (n=38), Ranunculaceae (n=29), Primulaceae (n=27), Scrophulariaceae (n=26), Gentianaceae (n=23) etc out of 68 families in total. The dominance index in terms of log of total abundance and the frequency for each species, including their ranks are presented in Annexure 2.

**Cluster 1:** There were as many as 25 indicator species with  $P^* < 0.05$ , the most significant species were *Anaphalis nepalensis*, *N. grandiflora* and *Geranium donianum* and 67 species were insignificant species with  $P^* > 0.05$ . The most dominant species in this cluster were *N. grandiflora* (42.28), *A. nepalensis* (12.4) *Acanthocalyx nepalensis* (12.1), *G. donianum* (8.8), *Anaphalis cooperi* (6.9) etc.

**Cluster 2:** In this cluster 11 were significant and the most significant species were *Juniperus recurve*, *Rhododendron aeruginosum* and *Carex* species and 128 were insignificant species. The most dominant species were *Carex* species (6.7), *Juniperus recurve* (5.8), *Potentilla microphylla* (4.9), *R. aeruginosum* (4.7), *Neopicrorhiza scrophulariflora* (4.7) etc.

**Cluster 3:** In this cluster 16 were significant and the most significant species were *Juniperus squamata*, *Meconopsis grandis* and grass species and 20 were insignificant species. The most dominant species were *J. squamata* (93.2), Grass species (6.3), *Primula* species (5.4), *Artemesia hedinii* (4.5) etc.

**Cluster 4:** In this cluster 19 were significant and the most significant species were *Potentilla arbusculata*, *Anaphalis xylorhiza* and *Tanacetum* species and 51 were insignificant species. The most dominant species were *P. arbuscula* (80.1), *P. peduncularis* (10.4), *Bistorta microphylla* (7.5), *A. xylorhiza* (6.5) etc.

**Cluster 5:** In this cluster 26 were significant and the most significant species were *Anemone demissa*, *Pedicularis gracilis* and *Pleurospermum hookeri* and 53 were insignificant species. The most dominant species were *Rhododendron lepidotum* (61.5), *P. hookeri* (23.9), *A. demissa* (12.4), *Bistorta vivipara* (12) *Saussurea hieraciodes* (9.6) etc.

**Cluster 6:** In this cluster 15 were significant and the most significant species were *Rhododendron setosum*, *Juncus concinns* and *Delphinium drepanocentum* and 66 were insignificant species. The most dominant species were *R. setosum* (58.8), *J. concinns* (6.5), *Potentilla anserina* (5.6), *Cyananthus macrocalyx* (4.9) etc.

**Cluster 7:** In this cluster only 2 were significant and the most significant species were *Rhododendron anthopogon* and *Rhododendron campanulatum* and 40 were insignificant species. The most dominant species were *R. anthopogon* (71.8) and *R. campanulatum* (5.9) species respectively.

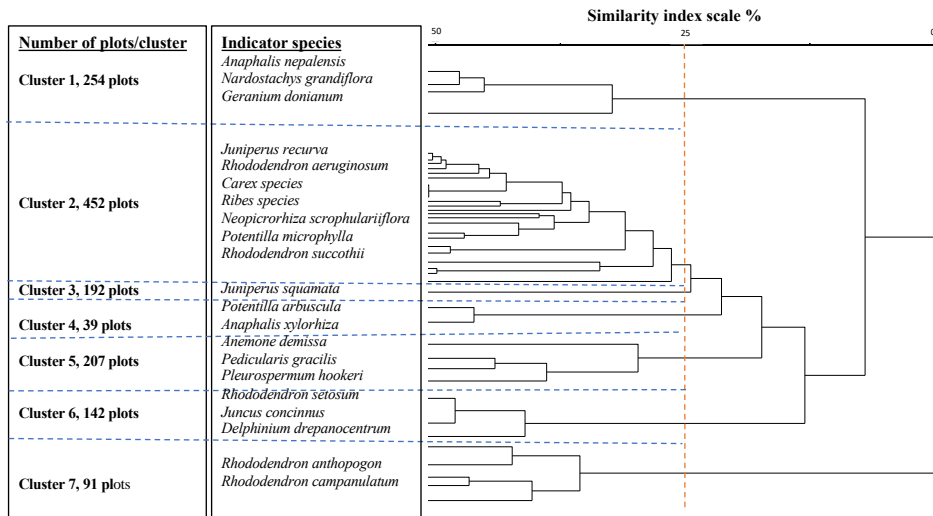


Figure 6. A graph showing the cluster dendrogram showing sequential clustering of species using Relative Density (RD) % data occurring inside 1377 plots and the similarity index scale (%) arbitrarily marked at 25 % portraying 7 cluster solution (clade/group) marked with red dotted lines. The cluster analysis was performed using distance measure of relative Sorensen (Bray-Curtis) and Wards as linkage method.

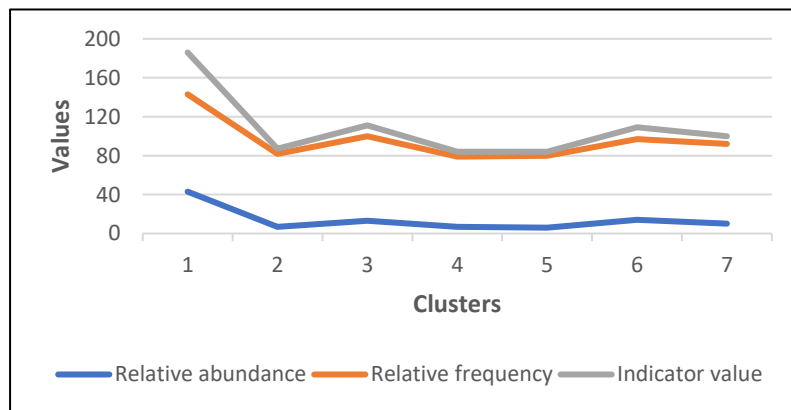


Figure 7. Graph showing the relative abundance, relative frequency and indicator value of *N. grandiflora* within different clusters performed through Indicator Species Analysis.

#### RELATIONSHIP OF THE SPECIES TO ENVIRONMENT.

Canonical Correspondence Analysis (CCA) was performed to investigate the relationship between *N. grandiflora* and the 5 environmental variables such as altitude, latitude, longitude, aspect and slope (Figure 3). The biplot showed a clear pattern of species distribution in blue dots within the environmental space and the length of the red arrow



(vector length) indicates the influence of the environment on species distribution and occurrences. *N. grandiflora* occurrence was highly correlated with slope (0.966) in Axis 1, aspect (0.939) in Axis 2 and latitude (0.947) was inversely correlated to Aspect in Axis 3. Other environmental variables like altitude and longitude did not show a significant relationship with the species. It prefers the slope of 25-45 degrees in alpine and subalpine vegetation zones. The occurrence of the plant was mostly on moist, open meadows and moist shrubby Juniper-Rhododendron scrub habitat facing the northern aspect. Weberling (1975), Amatya & Sthapit (1994) and Ghimire *et al.* (2015) reported a similar observation (Mulliken & Crofton, 2008).

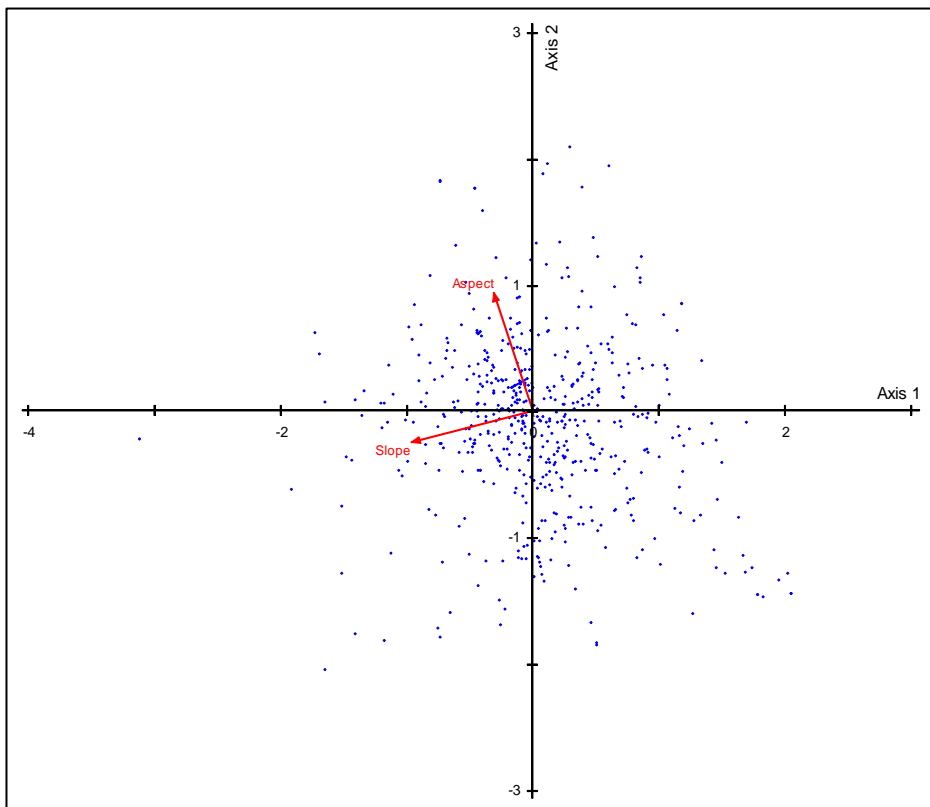


Figure 8. CCA biplot showing species significantly related to slope and aspect in an environmental space

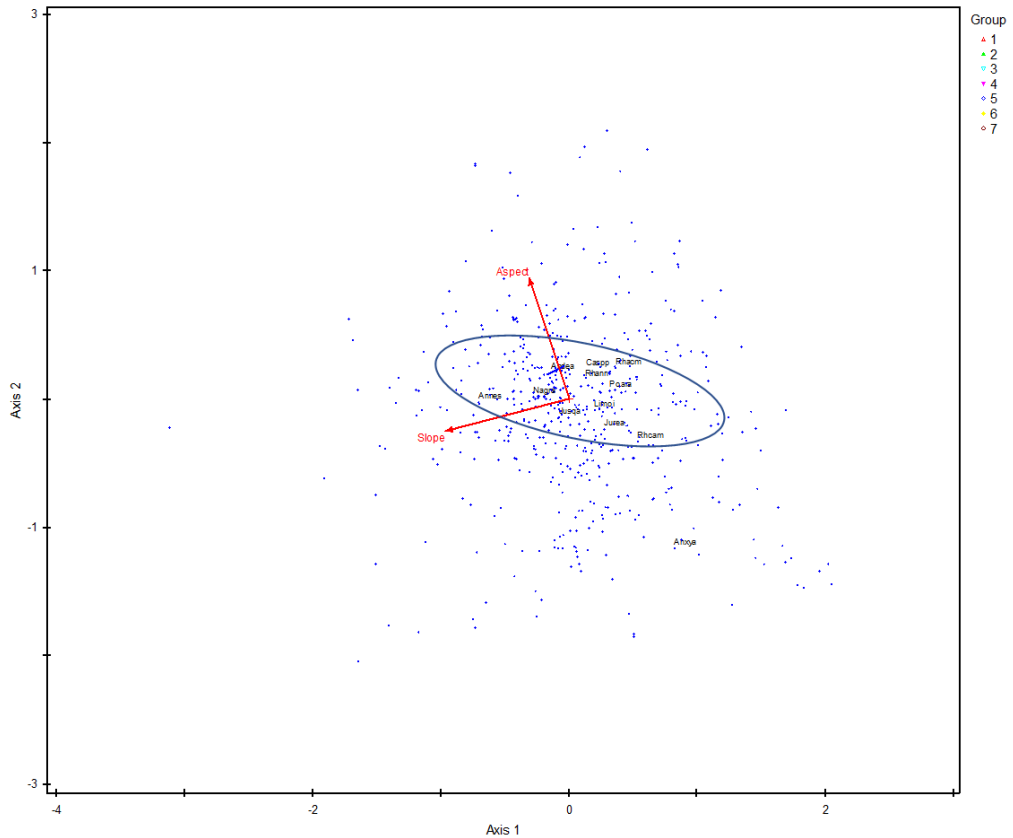


Figure 9. CCA biplot showing the significant indicator species (assigned with species code) inside the *N.grandiflora* habitat. The species are mentioned under cluster analysis.

No.	<u>Variables</u>	<u>Axis 1</u>	<u>Axis 2</u>	<u>Axis 3</u>
1	Altitude	0.005	-0.135	-0.317
2	Latitude	-0.053	0.027	-0.944
3	Longitude	-0.030	0.043	-0.017
4	Aspect	-0.253	0.965	0.006
5	Slope	-0.950	-0.307	0.078
	Eigenvalue	0.152	0.077	0.062
	Variance in species data % of variance explained	0.200	0.1	0.1
	Cumulative % explained	0.200	0.3	0.4
	Pearson Correlation, Spp-Envt*	0.565	0.456	0.467
	Kendall (Rank) Corr., Spp-Envt	0.402	0.322	0.271

Table 3. showing the \* Correlation between sample scores for an axis derived from the species data and the sample scores that are linear combinations of the environmental variables. Set to 0.000 if axis is not canonical.

## A 9-STEP PROCESS OF NDF.

A 9-step approach to NDF (Wolf et al., 2016) for *N. grandiflora* was adopted for the first time in Bhutan. A significant amount of time was spent in the field for data collection and analysis to understand its distribution and quantification to determine the national growing stock and possibly develop an action plan for species conservation in near future. The species distribution, density and growing stock were determined at the national level to develop management interventions including the policy intervention regarding the harvesting practice, use and trade of the specimen from Bhutan from now on. The data on species occurrence from the field was collected by adopting the biodiversity survey protocol (NCD & DoFPS, 2020) and EOO and AOO was adopted from IUCN field assessment methodology (Red List Technical Working Group, 2018).

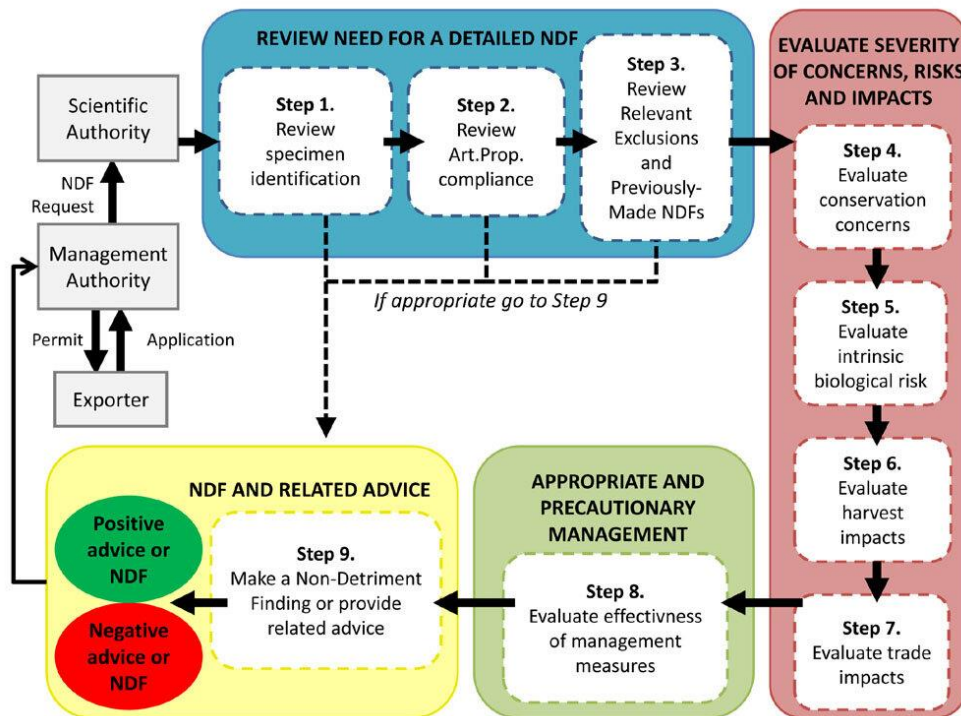


Figure 10. Nine step pathways for making NDF for perennial herbs listed in CITES Appendix II (Wolf et al., 2016).

### STEP 1: SPECIES REVIEW.

The *N. grandiflora* species was reviewed and authenticated to avoid the confusion of identification. It can be easily distinguished from other species because there is no morphologically similar look-alike species for identification. Taxonomic uncertainty does

not exist with this species and this was confirmed and validated through the voucher specimen with inflorescence. Voucher specimens at the National Herbarium and MSPCL were also referred and cross checked.

#### STEP 2: REVIEW ARTIFICIAL PROPAGATION COMPLIANCE.

No artificial propagation of *N. grandiflora* has been tried in Bhutan and the registration of nurseries is out of question. None of the beneficiaries have attempted to cultivate the species other than collecting from the wild. Domestication and cultivation of these many medicinal plant species are still a major challenge due to its availability in the wild. Also, harsh climatic conditions and requirement of specific sites for its growth discourages people to initiate such activities.

#### STEP 3: REVIEW RELEVANT EXCLUSIONS AND PREVIOUSLY MADE NDF.

The harvest or the commercial export of NWFP including *N. grandiflora* is permissible by the national law of the Ministry of Agriculture and Forests to any member of the management group (DoFPS, 2017), (DoFPS, 1995) Further, collection and trade has been enhanced with enabling policy developed for management and marketing policy developed since 2009. Such policies were developed mainly to increase rural income through sustainable management and marketing of NWFPs. This is primarily to improve the effectiveness in sustainable management of natural resources growing in the locality. The community/group are allowed to harvest NWFP resources for commercial purposes based on species list and management plan approved by the Ministry. Case study from Nepal towards valid NDF published by Larsen and Olsen (2008) on *N. grandiflora* provided basic information representing Nepal Himalaya and population size was estimated based on the Pokhara camp workshop (2001). For this NDF from Bhutan, the report includes information on floristic composition of the major life form distribution and its habitat description. Further, the current NDF report also has extensive information to aid in determining the national consensus. Therefore, the NDF proposed from Bhutan is adequate to reach a decision with all the required information and will help to curtail illegal harvest and formalize trade of specimens for export in a regulated manner as specified.

#### THREAT ANALYSIS

Threat analysis is a part of NDF steps 4 to 7 process to address the pertinent and perceived threats. The threat analysis was performed using Miradi software and the overall threat assessment for *N. grandiflora* was medium (Table 3) which can be mitigated through innovative remedial measures. There were 8 threats observed as collated from the stakeholders based on their observation on different spatial, temporal, and biological spaces. Basically, the threats were derived from the biological resource use considered as the single most important factor for assessment. Amongst the threats identified, the illegal and rampant collection was the main threat, followed by unsustainable and untimely collection including the use of lethal harvesting techniques. To reduce those threat levels,

enhanced monitoring at collection sites will be strengthened through smart patrolling, pre/post-harvest at sites and adoption of good practice harvesting guidelines. The imposing ruggedness of the Himalayas and the very limited resources may affect policing and enforcement challenges in conducting compliance monitoring. Waste disposal and climate change were ranked as medium threats and therefore waste disposal Standard Operating Procedures (SOP) will be adopted for collection of *N.grandiflora* as is being implemented while harvesting *Ophiocordyceps sinensis*. Biodiversity monitoring plots will be established inside the *N. grandiflora* habitat to study the impacts of climate change by collecting the climatic data at site. Grazing and trampling by livestock, man-made arson, landslide and erosion were rated very low threats, although the majority of the *N. grandiflora* habitat falls under the grazing area of the yaks owned by the highlanders. Generally, grazing occurs in the summer and autumn seasons and the livestock are then migrated to the lower altitude in the colder seasons. By then the perennial *N. grandiflora* will be under the cover of snow for almost 3 to 4 months giving a chance to the rhizomes to rejuvenate in the spring season. The collection of medicinal and aromatic plants from JDNP is very significant compared to the rest of the collection sites in the country and therefore compliance monitoring will be in place as and when required.

Direct Threats	Scope	Severity	Irreversibility	Total	Overall Threat Rating
Grazing and trampling by livestock	2	1	1	7	Low
Illegal and rampant collection	3	4	3	17	Very High
Unsustainable and untimely collection	3	3	3	15	High
Use of lethal harvesting techniques	3	3	3	15	High
Intentional fire	1	1	1	5	Low
Landslide and soil erosion	1	1	1	5	Low
Waste disposal	2	2	1	9	Medium
Climate change	2	1	2	8	Medium

Scoring criteria			
Rank	Scope	Severity	Irreversibility
Very high	4	4	4
High	3	3	3
Medium	2	2	2
Low	1	1	1

Overall Threat Ranking	
Rank	Score range
Very high	16-20
High	11-15
Medium	6-10
Low	1-5

Note: Total = 2 \* (Scope + severity)+Irreversibility

**Definition**

**Scope:** The proportion of the target that can reasonably be expected to be affected by the threat within ten years, given the continuation of current circumstances and trends

**Severity:** Within the scope, the level of damage to the target from the threat that can reasonably be expected given the continuation of current circumstances and trends.

**Irreversibility:** the degree to which the effects of a threat can be reversed and the target affected by the threat restored.

Table 4. Threat ranked according to field observation and the consultation





STEPS 4-7 EVALUATION OF SEVERITY OF CONCERNS, RISKS AND IMPACTS

**Photo 4: Illegal collectors apprehended by Forestry and Police personnel at Jigme Khesar Strict Nature Reserve, Haa**

The severity of concerns, risks and impacts are NDF steps 4 to 7 as shown below in table No 5. The assessments were based on the knowledge, experience and field observation of the stakeholders after thoroughly understanding the explanation of the factors as “High” “Medium” “Low” or “Unknown” respectively.

The table below shows the severity of the conservation concern and identified threat relevant to the harvest area, plant part harvested versus life form of species and harvest impact on individual plants factor was rated as “high”. *N. grandiflora* has been listed as Critically Endangered under criteria A2cd of the IUCN Red List. Habitat specificity and vulnerability, harvest impact on target population and on other species and also illegal trade was rated as “medium”. Therefore, it is fair enough to harvest one fourth out of the total population for the benefit of the rural communities under purview of plant genetic resources conservation and utilization. The removal of only one fourth out of the total population will ensure the population recovery and reduce intrinsic biological risks and also harvest impact on individual plants. Such issues will be addressed through planning and implementation of the *N. grandiflora* conservation action plan with a definite harvesting plan addressing sustainable use of the genetic resources. The current NDF study did not cover a social survey on domestic demand of *N. grandiflora* consumption due to the indefinite trading of the processed and semi-processed products within and outside Bhutan. Further, the study lacks knowledge on the generation length of the *N. grandiflora* and mature population size at different sites. Without such data, the rate of species recovery is difficult to predict and this would require data from several years to estimate colonization and extinction probabilities. Only then we can estimate the rate of recovery at growing sites. Therefore, UWICER, Bumthang will conduct research on regeneration, reproduction and biomass equations for some of the important NWFP species with dedicated time and funds in near future to address the severity of concerns and risk of *N. grandiflora* harvest and trade.



NDF steps	High	Med	Low	Unk	Information sources used
<b>4. Severity of conservation concern and identified threats relevant to the harvest area</b>	High				Stakeholder consultation workshop from 15-21 November 2021 at Lobesa, Punakha
<b>5. Intrinsic Biological Risks</b>					
Plant part harvested versus life form of species	High				
Habitat specificity and vulnerability		Med			
Regeneration		Med		Unk	
Reproduction				Unk	
<b>6. Harvest Impacts</b>					
On individual plants	High				
On target population		Med	Low		
On other species		Med	Low		
<b>7. Trade Impacts</b>					
Legal trade			Low		
Illegal trade		Med			

Table 5. NDF steps from 4 to 7 rated based on the explanation of the factors (Wolf et al., 2016) and expressions of the workshop participants.

**STEP 8: EFFECTIVENESS OF MANAGEMENT MEASURES.**

During the stakeholder consultation workshop with 9 Field Division, they have reported that species specific management measures do not exist for trade, however the current management and monitoring for any forestry related activities do help in sustainable management and threat mitigation. These efforts can/must however be scaled up. For harvest management a very basic to moderate form of management is practiced in the

form of NWFP management and marketing plan (refer the graph below for details). The rigor of management must be strengthened comprehensively for wild harvest by limiting the harvest level to 25% out of the total population and verifying with the NWFP groups while harvesting at site as a precautionary measure. The requirement of fulfilling these requirements for CITES permit by the exporter/applicant also helps mitigate unsustainable harvesting of the species.

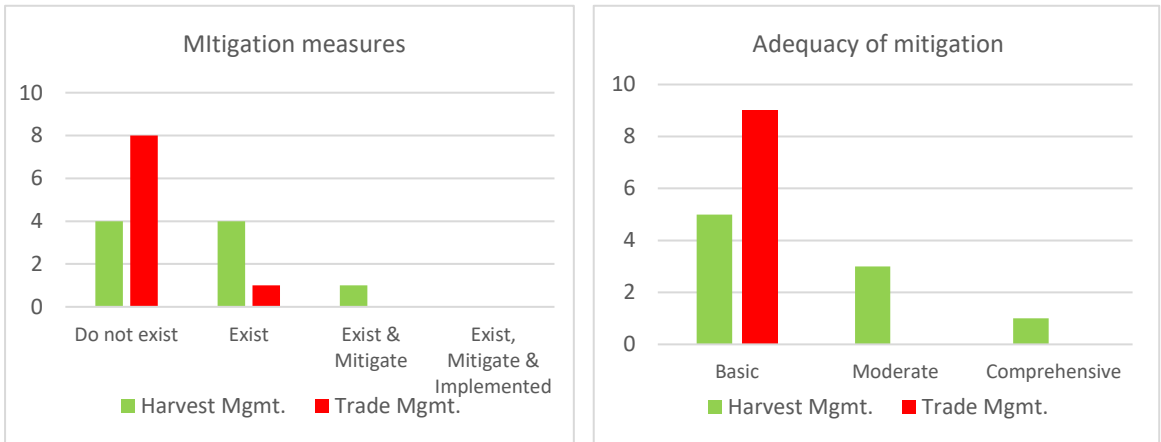


Figure 11. Graph showing the effectiveness of the harvest and trade management measures

#### STEP 9: NDF ADVICE.

The NDF went through various stages from planning to training of the survey team members and consultation at different levels. Based on the assessment and analysis, this NDF report recommends an Allowable Harvest Limit (AHL) of 25% in a 7-year generation length which would mean an AHL of 18MT per year, provided that the harvest and management is done in accordance with the existing rules and regulations of the country to ensure the population recovery and also to reduce intrinsic biological risks and harvest impact on individual plants for sustainability. The annual harvesting limit will be applied for both domestic consumption and international trade. The Technical Advisory Committee (TAC) of the DoFPS generously endorsed to harvest 18 metric tons of *N. grandiflora* annually without detrimental effect to the survival of the species in the wild.

This NDF also recommends, but not limiting to:

1. Enhanced compliance monitoring and patrolling at sites during harvest and trade of specimens. The severity of the illegal trade could be serious and detection rate of illegal collection and trade is very low over the past three years. This will be

further strengthened through networking and stakeholder engagement to trace the specimen in trade.

2. Conduct of research on regeneration, reproduction and development of biomass equations with dedicated time and funds to understand the generation length, reproductive biology and quantification explicitly.
3. Ensuring strict compliance for issuance of CITES permit by the CITES authorities and for issuance of collection permit by the field Rangers. The CITES Management Authority must withhold to issue a CITES permit if the conditions are not met as prescribed in this NDF for export of specimens. The Rangers must be better informed and guided by this NDF to issue the collection permit as per the set quota in their respective areas. So far, the permit issued for collection of the species was based on the demand of the collectors, thus this NDF seeks change management.
4. Development and implementation of *N. grandiflora* conservation action plan with strategic actions. Reinforce the principles of good management practices along with the policy framework and disseminated to the group for strict compliance. Greater attention must be paid to promote sustainable harvesting methods.
5. Facilitate fair trade deals for rural livelihoods. The collection and export of *N. grandiflora* species which was suspended since March 2021 must be immediately lifted and allowed for collection and export under lawful process.

A regional approach to manage this regional resource could be initiated by CITES platform, involving a range of stakeholders from both range States and consumer countries to achieve wider conservation objectives (Mulliken & Crofton, 2008). Facilitation of such initiative would further curtail illegal harvest and formalize trade of specimens in a regulated manner and achieve the collective goal of “Legal” “Traceable” and “Sustainable” for all time.

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