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

Eighteenth meeting of the Plants Committee
Buenos Aires (Argentina), 17 to 21 March 2009

Non-detriment findings

REPORT OF THE PLANTS WORKING GROUPS IN THE INTERNATIONAL EXPERT WORKSHOP ON NON-DETRIMENT FINDINGS

1. This document has been submitted by the Scientific Authority of Mexico, as chair of the international steering committee of the workshop[*].

2. Mexico organized an international expert workshop on non-detriment findings in Cancún from 17 to 22 November. The PC Chair was involved in the preparation of this workshop from July 2007 and attended it together with the following members of the Committee: Ms Beatrice Khayota, Mr Greg Leach, Ms Dora Rivera Luther, Mr Noel McGough, Ms Mariana Mites Cadena, Mr Tukirin Partomihardjo and Ms Adrianne Sinclair.

3. Four working groups on plants were established during the workshop:

   – Trees, co-chaired by Rafael María Navarro (Spain) and James Grogan (United States of America);
   – Perennials plants, co-chaired by Greg Leach (Australia) and Adrianne Sinclair (Canada);
   – Succulents and cycads, co-chaired by John Donaldson (South Africa) and Patricia Dávila (Mexico); and
   – Geophytes and epiphytes, co-chaired by Noel McGough (United Kingdom of Great Britain and Northern Ireland) and Beatrice Khayota (Kenya).

4. The full results of each working group are provided in Annexes 1, 2, 3 and 4 to the present document. The 30 case studies discussed in those groups are available on the workshop website at: http://www.conabio.gob.mx/institucion/cooperacion_internacional/TallerNDF/taller_ndf.html

5. We are grateful to the working group co-chairs, rapporteurs and participants for their collaboration, as well as to the authors who prepared and presented the 30 case studies reviewed during the workshop.

6. The Plants Committee is invited to analyse and discuss the results of these working groups with a view to prepare documents for the 15th meeting of the Conference of the Parties, in fulfilment of Decision 14.135 and 14.143 directed to the Committee.

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

TREES WORKING GROUP FINAL REPORT

Principles for Non-detriment Findings (NDF) for TREES

1. A species' listing on Appendix II indicates that, based on the available trade and scientific information and in the view of the Parties, international trade at current rates or patterns has placed it at risk of harm in its environment on a range-wide basis.

2. The non-detriment finding (NDF) required from CITES Scientific Authorities for Appendix II (and Appendix I) species verifies that traded volumes or products do not cause harm to the species or look-alike species within the range State.

3. Because species and products derived from them are the relevant units of trade, the NDF must consider biological and environmental parameters relevant to the population status of the Appendix II species. For trees, anticipated impact of current or proposed harvests on species' population status (structure & dynamics) is the central question that must be addressed during the NDF process.

4. The extent to which species population status has been described and is understood determines the scale, quality and certainty at which NDFs can be made. Comprehensive knowledge of nation-wide population structures (stocks) and dynamics (recovery capacity) would allow annual export quotas to be set at the national level in confidence that these would be non-detrimental to the species' survival. Lacking comprehensive knowledge at the national level, and considering the precautionary principle, NDF should be undertaken at the scale at which sufficient knowledge exists to verify non-detriment. In most cases at present, this scale will be the management unit within which complete or statistically inferred knowledge of population status is sufficient to assess harvest impacts on species survival.

5. Sufficient biological information for Appendix II tree species exists to propose harvest and management systems where population status is known. Management systems should represent best current practices for the type of species (product) involved, and should be adaptive over time, incorporating new understanding of harvest impacts on species' population dynamics as revealed through practice (production) and research.

6. Risk associated with a negative outcome from the NDF process – that is, NDF allowing exports produced unsustainably – declines as the level of understanding of population status and management systems designed to mitigate negative impacts increases.

Making NDF for tree species

As explained in the draft Working Groups´ guidelines, *The main objective of the workshop, as indicated in Decision 14.49, is to enhance CITES Scientific Authorities´ capacities, particularly those related to the methodologies, tools, information, expertise and other resources…*

The Trees Working Group has agreed that these four elements can be addressed as follows:

– First, the Scientific Authority should consider the harvest regime and determine whether specimens are taken from a plantation or from the wild. If taken from a plantation, the NDF can be made relatively quickly since it considers that the plantation has been verified by the Management Authority and that the removal of the specimens does not affect populations in the wild (therefore this should imply a low risk of the operation).

– If specimens come from the wild, the Scientific Authority should take a more cautious approach and consider whether the harvest implies removal of the whole tree or not.

– If removal of the specimen does not result in the death of the tree (as in the case of some medicinal trees and agarwood-producing species), the guideline of maintaining the resource in the population over time and through a recovery period between harvests should be followed, with the objective of minimizing the impact of harvesting on species populations in the wild.

– If removal of the specimen results in the death of the tree, then adherence to comprehensive guidelines (encompassing information available, possible methodologies, etc.) is required. The essential elements of such guidelines are here proposed by this Working Group.

– General guidelines to help making an NDF are presented in this document and its Annexes (A, B, C, D), which include examples of species-specific guidelines for mahogany and agarwood:

A. Case Studies Matrix
B. Developing a Non-detriment Finding methodology for Agarwood-producing taxa (PC17 Inf.4 – not included in this document, available on CITES webpage)
C. Guidelines for making NDF´s for Mahogany (PC17 Doc. 16.1.2 – not included in this document, available on CITES webpage)
D. NDF Workshop Format

Essential elements of NDF (guidelines) for tree species

ELEMENT 1: SPECIES DISTRIBUTION AREA (RANGE) AT RELEVANT SCALES

Objective: Characterize the species' distribution at different spatial and jurisdictional scales so that production and conservation areas can be identified.

ELEMENT 2: POPULATION PARAMETERS AS INDICATORS OF SUSTAINABLE MANAGEMENT

Objective: Characterize species population status (standing stocks & dynamics) to provide standards for evaluating harvest impacts.

ELEMENT 3: MANAGEMENT SYSTEMS & HARVEST RATES

OBJECTIVE: With sufficient knowledge of distribution and population parameters, determine whether management systems are appropriate to species populations subject to harvest AND whether harvest levels are sustainable.

ELEMENT 4: MONITORING & VERIFYING HARVESTS

Objective: Determine whether adequate monitoring & verification systems are in place to ensure the sustainability of harvest and to reduce illegal activities & illegal trade.

ELEMENT 5: CONSERVATION & THE PRECAUTIONARY PRINCIPLE

OBJECTIVE: Determine whether safeguards are in place to ensure that representative natural populations and phenotypic & genetic diversity represented in harvested populations are conserved.

NDF guidelines for tree species

Having established the purpose of the NDF, the Trees Working Group concluded that the basic elements to be considered for making NDF for timber and non-timber tree species have been elaborated by recent working groups focused on Appendix II species (bigleaf mahogany, agarwood). These elements have been generalized and adapted to be applied to the taxa as follows:

ELEMENT 1: SPECIES DISTRIBUTION AREA (RANGE) AT RELEVANT SCALES

Objective: Characterize the species' distribution at different spatial and jurisdictional scales so that production and conservation areas can be identified. Suggested scales & tools that may be available include:

NATIONAL (HISTORICAL, CURRENT) DISTRIBUTION

- Vegetation & forest cover maps

- Ecosystem or eco-zoning maps
- National forest inventories
- Herbarium collection data (georeferenced)
- Existing & potential conservation areas

SUB-NATIONAL (E.G. REGIONS, STATES, WATERSHEDS) DISTRIBUTION

- National databases, including management units
- Sub-national forest inventories
- Sub-national mapping from various sources

LOCAL (FOREST MANAGEMENT UNIT) DISTRIBUTION

- Statistical samples from inventories for forest management plans
- GIS representation of harvest areas
- Commercial censuses, ideally based on georeferenced data
- Local, specialist & industry knowledge

ELEMENT 2: POPULATION PARAMETERS AS INDICATORS OF SUSTAINABLE MANAGEMENT

Objective: Characterize species population status (standing stocks & dynamics) to provide standards for evaluating harvest impacts. Suggested parameters & tools that may be available include:

POPULATION STRUCTURE: NUMBER OF INDIVIDUALS, AGE AND/OR SIZE DISTRIBUTION, DENSITY, VOLUME/QUANTITY

- o Field inventories applying appropriate statistical methods
- o Published studies
- o Reliable proxy data (e.g. local knowledge, historical data)

POPULATION DYNAMICS: RATES OF MORTALITY, GROWTH, REPRODUCTION, REGENERATION & RECRUITMENT

- o Long-term studies using appropriate methods
- o Modeling approaches (e.g. matrix)
- o Published studies
- o Reliable proxy data (e.g. local knowledge, historical data)
- o Information on other factors affecting populations (e.g. microsite preferences, pests, disturbances)

ELEMENT 3: MANAGEMENT SYSTEMS & HARVEST RATES

OBJECTIVE: With sufficient knowledge of distribution and population parameters, determine whether management systems are appropriate to species populations subject to harvest AND whether harvest levels are sustainable. Suggested aspects to review & issues to consider include:

Inventory (or description) of commercial & non-commercial trees, ideally with mapping/spatial referencing

Harvest operations

- Identification of material to be harvested, understanding that differing harvest systems can be implemented
- Equipment / tools & methods to be used (appropriate or not)
- Measures for reducing damages during harvests (direct & environmental)
- Identification & protection of reserved areas / seed trees / future crop trees

Silvicultural practices

- Pre- & post-harvest
- Examples: liana cutting, liberation thinning, seed tree selection

Restoration / alleviation measures/ reduction of harvest impacts

- Seed tree retention
- Enrichment planting, with adequate seed selection (e.g. vigor, genetic diversity)
- Cutting cycle (rotation) or fallow period
- Post-harvest measures for reducing damages (direct & environmental)

Harvest rate evaluation

- Standards: intensity (retention %), minimum diameter cutting limit
- Quantitative knowledge of population status through appropriate statistical methods
- Expected (current) production & recovery rates (future production)
- Appropriate scaling methods

ELEMENT 4: MONITORING & VERIFYING HARVESTS

Objective: Determine whether adequate monitoring & verification systems are in place to ensure the sustainability of harvest and to reduce illegal activities & illegal trade. These may consist of or include:

Monitoring & verification systems

- Pre- & post-harvest review mechanisms to verify management practices
- Permanent plots to assess harvest impacts on populations
- Chain-of-custody from harvest to export
- Transparent practices that improve control of trade in harvested products
- Where export quotas have been set, assessment of the extent to which they indicate sustainable harvests

Optimization of timber / non timber use & processing

- Conversion / correction factors for translating raw material (e.g. standing volume, pre-processed weights) into processed product (e.g. sawnwood, extracts, etc.)

ELEMENT 5: CONSERVATION & THE PRECAUTIONARY PRINCIPLE

OBJECTIVE: Determine whether safeguards are in place to ensure that representative natural populations and phenotypic & genetic diversity represented in harvested populations and the role of the species in the ecosystem are conserved. Precautionary measures may consist of:

- Conserving different populations throughout the natural range to ensure phenotypic & genetic diversity
- Conserving the existing range of age/ size classes and distribution of the species while considering processes of natural succession and recruitment.
- Avoiding negative impacts of harvest on other species and the ecosystem
- Establishing reserve areas to protect unharvested populations
- Establishing seed banks & other mechanisms for conservation of germplasm
- Accounting for the effects of legal & illegal harvesting on species conservation status
- Giving due consideration to incentives & benefits from harvests (e.g. species/habitat conservation)

Annex A

Case Studies Matrix

Level of Knowledge: High, Middle, Low	**TIMBER SPECIES**					**NON-TIMBER SPECIES**		
	A.	***B.***	***C.***	***D.***	***E.***	***F.***	***G.***	***H.***
ESTIMATION OF SPECIES RANGE AREA								
National level	High	Middle	High	High	High	Middle	High	Low
Subnational level	High	Middle	High	Middle	High	Low	High	Low
Management units	High	High	High	Middle	No applicable	Low		Low
POPULATION PARAMETERS								
Periodic measurements	High	Low	High	Low	Low	Low	High	Low
Indicators of sustainable management	High	High	High	Middle	Low	Low	Low	Low
Local reference values	High	Low	High	Low	Low	Low	Low	Middle
MANAGEMENT PRINCIPLES, METHODS & INDICATORS								
Silvicultural system	High	Middle	High	Middle	Low	Low	Middle	Middle
Silvicultural treatments	Middle	Low	No applicable	Low	Low	Low	Low	Middle
Harvest systems	High	Low	High	Middle	Middle	Low	Middle	Middle
Regeneration	High	Low	High	Middle	Low	Low	Middle	Low
Conservation	Middle		High	High	High	Middle	High	Low
Commercial plantations ¿domestication?	Low	Low	No applicable	Middle	Middle	Middle	High	Middle
MONITORING & VERIFYING HARVESTS, PROCESSING & CONSERVATION								
Determination of annual production quotas	High	Middle	Low	Low	No applicable	Middle	High	Low
Optimization of product processing		Low	Middle	Low	Low	High	High	Middle
Monitoring & verification	High	Low	Middle	Low	Middle	Middle	High	Low

Note: this table was build considering tree case studies´ species or groups of species in order to contrast the applicability of the different elements to be considered when making Non-detriment Findings.

Annex D

NDF Workshop Output Format

1. Information about the target species or related species
1.1 Biological and species status:
ELEMENT 1: SPECIES DISTRIBUTION AREA (RANGE) AT RELEVANT SCALES
OBJECTIVE: Characterize the species' distribution at different spatial and jurisdictional scales so that production and conservation areas can be identified.
ELEMENT 2: POPULATION PARAMETERS AS INDICATORS OF SUSTAINABLE MANAGEMENT
OBJECTIVE: Characterize species population status (standing stocks & dynamics) to provide standards for evaluating harvest impacts.
1.2 Takes/uses (e.g. harvest regime):
ELEMENT 3: MANAGEMENT SYSTEMS & HARVEST RATES
OBJECTIVE: With sufficient knowledge of distribution and population parameters, determine whether management systems are appropriate to species populations subject to harvest AND whether harvest levels are sustainable.
1.3 Management, monitoring and conservation:
ELEMENT 4: MONITORING & VERIFYING HARVESTS
OBJECTIVE: Determine whether adequate monitoring & verification systems are in place to ensure the sustainability of harvest and to reduce illegal activities & illegal trade**.**
ELEMENT 5: CONSERVATION & THE PRECAUTIONARY PRINCIPLE
OBJECTIVE: Determine whether safeguards are in place to ensure that representative natural populations and phenotypic & genetic diversity represented in harvested populations are conserved.
2. Field methodologies and other sources of information.
Biological and species status data: See NDF Guidelines for Trees
Harvesting and trade data: See NDF Guidelines for Trees
3. Data integration for NDF elaboration Consider the elements in the NDF Guidelines for Trees with specific reference to the following: • Estimation of species range area • Population parameters • Management principles • Monitoring & verifying harvests, processing • Conservation
4. List and describe the ways <u>data quantity and quality</u> may be assessed See NDF Guidelines for Trees

5. Summarize the common <u>problems, errors, challenges or difficulties</u> found on the elaboration of NDF.

The analysis of case studies helped identify elements in which information or action were inadequate. In particular:

- Population parameters considered basic to evaluating harvest impacts were generally unavailable within range States
- Silvicultural practices for reducing impacts and fostering post-harvest population recovery were considered rudimentary or inadequate
- Monitoring systems for verifying management practices and chain-of-custody were lacking
- Conservation measures were also frequently lacking
- There is a high frequency of look-alike species within the relevant taxa
- Effective taxonomic identification of species in trade (and in finished products containing a mixture of species) is often lacking

More generally, the Trees WG considered that the existence (or not) of the following conditions would impact the making of NDF:

- Political will & long-term commitment
- Human & economic resources
- Availability of accurate data
- Time constraints
- Effective monitoring

6. Summarize the main <u>recommendations</u> which could be considered when making an NDF for this taxonomic group.

It is recommended that a Scientific Authority be in place with expertise in the taxa concerned.
Consult the range of expertise available, including other range States and their experience with NDF.

Use available tools (e.g. species, trade and other databases on the CITES website, among others).

Encourage capacity building (including e-learning tools) focused on training & long-term development of Scientific Authority expertise
Promote research on:

- Population parameters considered basic to evaluating harvest impacts
- Silvicultural practices for reducing impacts and fostering post-harvest population recovery
- Monitoring systems for verifying management practices and chain-of-custody and conservation measures

Training in species identification

7. Useful references for future NDF formulation.

See references included in the case studies

PERENNIALS WORKING GROUP FINAL REPORT

Perennials Working Group Output Format

1. Information about the target species or related species
Please refer to the Perennial Plants Working Group Annex A. Elements identified in the decision tree are source of specimen, i.e., artificially propagated vs. wild (while noting that specimens from plants grown from wild plants are to be treated as wild) as well as taxonomic status of species. All other elements are listed in the first columns of the first and second tables in the Annex.
2. Field methodologies and other sources of information.
Please refer to the Perennial Plants Working Group Annex A. Sources of information are listed in the second column of the second table in the Annex A (the table that enables assessment of factors affecting management of the collection).
3. Data integration for NDF elaboration
Data integration is built into the guidance (decision tree, evaluation of resilience table, evaluation of data quality and quantity for each factor). For example, an early decision can be made based on whether the specimen is wild or not. Next, there is a table to determine species' level of resilience. Finally, there is a table that provides information sources, with examples that range from quantitative to qualitative. It is suggested that a more rigorous approach, which may imply more data gathering, be applied for less resilient species.
4. List and describe the ways <u>data quantity and quality</u> may be assessed
Data quantity and quality may be assessed by providing a list of information sources, including qualitative and quantitative sources, used to evaluate each factor. Our working group found that data quality may vary depending on the collection situation. For example, harvester interviews, although qualitative, may be a very reliable data source in some cases.
5. Summarize the common <u>problems, error, challenges or difficulties</u> found on the elaboration of NDF.
• Field surveys are very limited. • It is difficult to establish and enforce quotas • The lack of knowledge on the size of the present population and trends in population changes • When management of plant species is multi-jurisdictional, coordinating numerous people involved in the NDF process can sometimes be difficult. • Budget and time constraints are also significant challenges facing Scientific Authorities and wildlife managers in regards to making NDFs. • The monitoring of illegal harvest (aside from annual population surveys) is a considerable challenge

6. **Summarize the main <u>recommendations</u> that could be considered when making an NDF for this taxonomic group.**
• Provided there is sufficient training/ capacity, the IUCN checklist is a useful process to make an NDF; however, the process is simplified as suggested in the Perennial Plants Working Group Annex A. We have identified criteria for assessing resilience and factors to evaluate collection and management. Information needed and relevant methodologies are dependent upon the resilience of the species to collection, and some examples are provided. • The NDF process should be based on a risk assessment, indicating when more data or a more rigorous approach is needed. • ISSC-MAP is a useful tool to develop an integrated management plan for the species which can either inform or be a management outcome based on the NDF • Parties can share information on NDFs by posting it on their websites e.g. USA and Canada. • Parties can share vegetation surveys by posting it on their websites (e.g. Canada) • Information exchange and cooperation among Parties, stakeholders, government entities, non-governmental organizations, and researchers is essential to share information on the biology, trade and conservation status of CITES-listed species in order to maintain self-sustaining populations and make scientifically based NDFs. • NDF decisions are based on evaluations that are reviewed and adapted to reflect changing conditions (e.g., invasive species, disease, predators). • It was recognized that the understanding and application of the Resolution Conf. on Artificial Propagation (Resol. Conf. 11.11) is not always straightforward or easily implemented. The Plants Committee should develop further guidance on the application of the resolution. • If there is a need for capacity building, experience has shown that expert workshops on NDF techniques can be highly beneficial.
7. **Useful references for future NDF formulation**
• Rosser & Haywood (2002): Guidance for CITES Scientific Authorities. Checklist to assist in making non-detriment findings for Appendix II exports. - xi+146 pp., IUCN, Gland and Cambridge • Duties of the CITES Scientific Authorities and Scientific Review Group under Regulations 338/97 and 865/2006. http://ec.europa.eu/environment/cites/pdf/srg/guidelines.pdf • http://www.floraweb.de/proxy/floraweb/map-pro/Standard_Version1_0.pdf • CUNNINGHAM (2001): Applied ethnobotany. Earthscan; PETERS (1994): Sustainable harvest of non-timber forest plant resources in tropical moist forest. An ecological primer. - WWF Biodiversity Support Program, Washington. • ANON. 2007. International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP), version 1.0. Medicinal Plant Specialist Group of the IUCN. Published by German Federal Agency for Nature Conservation. BfN-Skripten 195, 2007

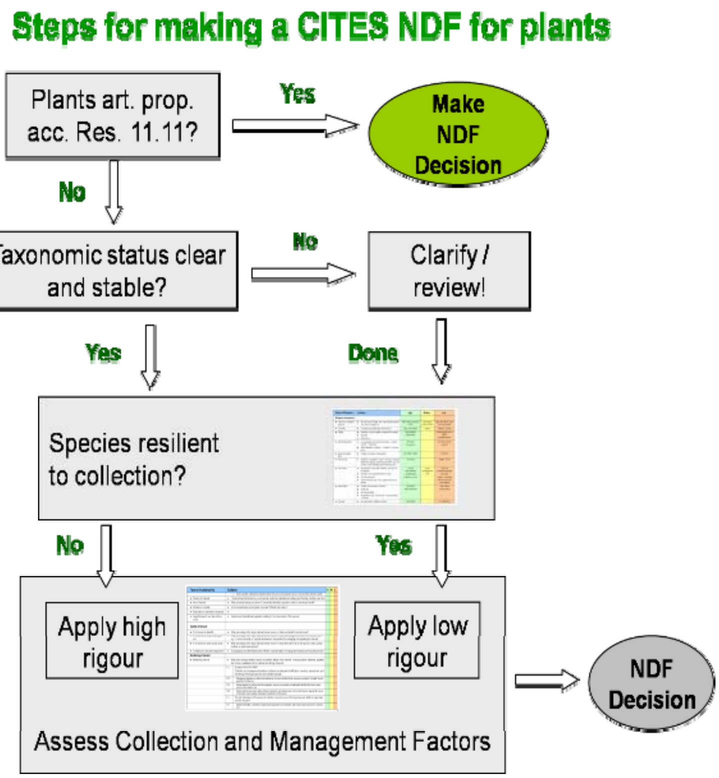
Annex A

Guidance for Scientific Authorities in making a CITES Non-detriment Finding

This Annex describes a process for making non detriment findings for perennial plant species (and perhaps all CITES Appendix II plants), summarized in a decision tree. It builds upon the IUCN Checklist and other references by incorporating the sources of information and methods that can be used to evaluate certain factors as well as identifying when a more rigorous approach is needed (i.e., when more information and data are needed).

All elements of the following references for making NDFs were reviewed and included as appropriate for perennial plants:

(1) Tables 1 and 2 of the Guidance for CITES Scientific Authorities, IUCN NDF Checklist[1]
(2) Cancun Workshop Case Study Format[2];
(3) EU-SRG Guidance Paper[3];
(4) International Standard for the Sustainable Wild Collection of Medicinal and Aromatic Plants, ISSC-MAP[4] (ISSC-MAP especially provided guidance for the factors "Management Plan" and "Monitoring Methods" through detailed criteria and indicators); and
(5) Susceptibility matrices published by Cunningham (2001) and Peters (1994)[5].



The first factor to consider is the source of the plant specimen or material – i.e. whether the source of the specimen proposed for trade is from the wild or artificially propagated. If the specimen was artificially

1 Rosser, A. & M. Haywood. 2002. Guidance for CITES Scientific Authorities. Checklist to assist in making non-detriment findings for Appendix II exports. - xi+146 pp., IUCN, Gland and Cambridge

2 NDF Workshop Doc.3, http://www.conabio.gob.mx/institucion/cooperacion_internacional/TallerNDF/Links-Documentos/WebPage%20-%20Format%20-%2023%20May%2008.doc

3 Duties of the CITES Scientific Authorities and Scientific Review Group under Regulations 338/97 and 865/2006. http://ec.europa.eu/environment/cites/pdf/srg/guidelines.pdf

4 http://www.floraweb.de/proxy/floraweb/map-pro/Standard_Version1_0.pdf

5 CUNNINGHAM (2001): Applied ethnobotany. Earthscan; PETERS (1994): Sustainable harvest of non-timber forest plant resources in tropical moist forest. An ecological primer. - WWF Biodiversity Support Program, Washington.

propagated according to Resol. Conf. 11.11[6], a simple NDF is made. If the specimen was grown from a plant collected from the wild (i.e. motherstock is wild), the specimen is treated as wild requiring an NDF to be made.

The next factor to consider is taxonomic status of the species. Assess whether the taxonomic circumscription, including authorities and synonyms, is stable or is dynamic. If the status of the taxon is dynamic, then the taxonomy is usually uncertain (e.g., the taxon may consist of several entities which have to be assessed separately). Sources of information include published floras, CITES checklist, identification guides, and taxonomic experts.

Once the taxonomy is checked, the next step involves evaluating the resilience of species to collection. The evaluation is done by considering factors most indicative of resilience or vulnerability of the particular species to collection. The table does not include an exhaustive list of indicators to consider for high, medium, and low resilience but rather includes examples taken from Cunningham (2001) and Peters (1994). Species are evaluated as having higher resilience i.e. less at risk from collection, if most of the resilience factors are in the higher category. It is expected that judgement will be cautionary, for example, if a species has only a few factors of lower resilience and several deemed higher resilience, the species may still be considered as having a lower resilience to collection.

Assessment of the resilience of the species to collection

Factors of Resilience	Guidance	Higher Resilience	Medium	Lower Resilience	Ref
Biological characteristics					
Life form vs. harvested plant part	Basic life forms for plants: tree, shrub, perennial, annual, bulb, climber, epiphyte, etc.	Latex, flowers, fruits and leaves Short-lived life forms	Some resins, fruits and seeds	Bark, stem tissue, roots, bulbs, whole plant Long-lived life forms	1, 5
Distribution	Currently known global range of the species	wide, cosmopolitan	narrow	restricted, endemic	2, 5
Habitat	• Preference: Types of habitats occupied by the species • Specificity • Habitat threat	highly adaptable habitat stable		narrowly specific to one habitat habitat threatened	1, 2, 5
National abundance	• Local population sizes: Everywhere small <> Large to medium <> Often large • Spatial distribution: Scattered <> Clumped <> Homogeneous	often large homogenous		Everywhere small scattered	1, 5
National population trend	Population increasing or decreasing?	increasing or stable		decreasing	1
Other threats	Habitat loss / degradation; invasive alien species (directly affecting the species); harvesting; persecution (e.g. pest control); pollution (affecting habitat and/or species)	none or low		multiple, severe	1, 2
Reproduction	• Regeneration or reproductive strategy: dioecious, sexual, asexual • Pollination: biotic (specialised vector?), wind • Pollinator abundance • Flower/Fruit phenology: annual, supra-annual, unpredictable	Asexual wind pollinated annually fruiting pollinators common	sexual generalist pollinator	Dioecious specialised pollinator monocarpic fruiting unpredictable pollinators rare; bats, hummingbirds	2, 5
Regeneration	• Capacity of the species to reproduce	fast growing easily		slow growing not resprouting	1, 5

[6] Resolution Conf. 11.11 (Rev. CoP14). Regulation of Trade in Plants. (http://www.cites.org/eng/res/11/11-11R14.shtml)

Factors of Resilience	Guidance	Higher Resilience	Medium	Lower Resilience	Ref
	• Growth rate • Sprouting capability • Regeneration Guild: Early Pioneer <> Late Secondary <> Primary	resprouting early pioneer		primary	
Dispersal	• Seed germination: viability, dormancy • Seed dispersal strategy • Disperser abundance • Dispersal efficiency	high viability wind and other abiotic vectors		long dormancy Biotic, with specialized vector	1, 5
Harvest characteristics					
Harvest specificity	Indiscriminate collection of other species vs. target species easy to identify	target species easy to identify		Indiscriminate collection of other species	5
Demographic segment of population	Are mature and immature plants harvested?	collection of all age-classes		highly selective collection of one age-class	1, 2
Multiple use	Multiple, conflicting uses vs. single use or non-competing	single use or non-competing		Multiple, conflicting uses	5
Yield per plant	With high yield less individuals are affected by collection	High	medium	Low	
Scale of trade	• Quantitative information on numbers or quantity, if available; otherwise, a qualitative assessment; • Trade level: High – medium – low • Local, national, international	Low		High	1, 5
Utilization trend	Increasing fast <> Slowly increasing <> Stable or decreasing	Stable or decreasing	Slowly increasing	Increasing fast	5

The final step involves assessing factors affecting management of the collection or harvest. Examples of data sources are included for each element. It is expected that where possible, greater rigour, for example, multiple data sources, intensive field study, etc, will be used for species that are considered less resilient to collection. In general, it is expected that Scientific Authorities will work with the information that is available and seek more extensive information for species with very low resilience. It is also recognized that sources of data considered most reliable will vary depending on the species and collection situation. For example, in some cases knowledge of population abundance gained from local harvesters may be the only information available, yet very reliable.

Assessment of factors affecting the management of the collection

Factors of sustainability	Guidance	Ref
Biological characteristics		
Role of the species in its ecosystem	Consider the role of the species in the ecosystem and whether ecosystem processes are interrupted or changed by the collection of the species. Is the species a keystone or guild species, do other species depend on it for survival (e.g., food source)? • Scientific literature • Expert (including collector) knowledge • Field observations	2
Population status		
National distribution	Range and distribution of the species in the country (whether or not the distribution of the species is continuous, or to what degree it is fragmented): • National distribution map, • Herbarium records, surveys or other vegetation inventories • Expert knowledge (all stakeholders) • Field studies • GIS vegetation coverages • Modelling	1, 5
National conservation status	Conservation status of the species in the country • Species at Risk Lists • Conservation Data Centres • Experts (all stakeholders) • Scientific literature • Herbarium records • Field surveys (locations, population size, etc.)	2
National population trend	Population increasing or decreasing? To be measured over a time period independent of the harvest • Refer to conservation status • Reported harvests • Experts (all stakeholders) • Field surveys over short term • Field surveys over long term • Demographic studies (population viability analyses)	1
Global conservation status	Refer to global assessment to compare national situation to global range • Published global assessments (e.g., IUCN Red List, Conservation Data Centres , e.g., Nature Serve) • Consult other range states • Undertake global assessment with other range states	2
Global Distribution	Refer to global distribution for national context • Published global distribution map • Consult other range states	2, 5
Global population size and trend	Refer to global population size and trend for national context • Published global assessment • Consult other range states	2
Harvest management		
Regulated / unregulated	"Regulated" refers to a sanctioned (government approved or otherwise official) harvest that is under the full control of the manager • Market reports • Experts (all stakeholders) • Trade volume records (e.g. WCMC CITES trade database; statistics from Customs; National or state permit databases) • Enforcement reports • Field and market surveys	1, 2
Management history	What is the history of harvest? Is the harvest ongoing or new? • Literature • Experts (all stakeholders, including trade networks)	1, 2
Illegal harvest or trade	How significant is the national problem of illegal or unmanaged harvest or trade? Assess the levels of both unmanaged and illegal harvest	1

Factors of sustainability	Guidance	Ref
	• Market information • Information from traders, collectors, wildlife managers • Compare exports and imports with other Parties • Compare CITES permit data to other export data sources (national trade statistics) • Enforcement reports • Field and market surveys	
Management plan	Is there an adaptive management plan related to the collection of the species with the aim of sustainable use? • National and international legislation relating to the conservation of the species • Management plan in place • Plan specifies plant and habitat conservation strategies (may include protected areas) • Collection practices in place • Collection practices specify restoration measures (e.g., planting seed when whole plant is removed) • Requirement to keep records of collection • Collection records are reviewed and collection monitored • Management plan is reviewed at regular intervals specified in the plan • Limitations on collection (examples include collection seasons, minimum and maximum age / size class allowed for collection based on proportion of mature, reproducing individuals to be retained, maximum collection quantities, maximum allowed collection frequency, maximum allowed number of collectors) • Periods allowed for collection are determined using reliable and practical indicators (e.g., seasonality, precipitation cycles, flowering and fruiting times) and are based on information about the reproductive cycles of target species. • The age / size-classes are defined using reliable and practical characters (e.g., plant diameter / DBH, height, fruiting and flowering, local collectors' knowledge).	1, 2, 4
Control of harvest		
Percent of harvest in state Protected Areas	What percentage of the legal national harvest occurs in state-controlled Protected Areas? • Harvester information or interviews • Enforcement information or interviews • Park manager information or interviews • Compare location information from permit with maps of protected areas • GIS layers of harvesting and land tenure	1
Percent of harvest in areas of strong tenure	What percentage of the legal national harvest occurs in areas with strong local control over resource use? e.g.: a local community or a private landowner is responsible for managing and regulating the harvest • Harvester information or interviews • Enforcement information or interviews • Landowner information or interviews • Compare location information from permit with maps of protected areas • GIS layers of harvesting and land tenure	1
Percent of harvest in open access areas	What percentage of the legal national harvest occurs in areas where there is no strong local control, giving de facto or actual open access? • Harvester information or interviews • Enforcement information or interviews • Compare location information from permit with maps of protected areas • GIS layers of harvesting and land tenure	1
Proportion of range or population protected from harvest	What percentage of the species' natural range or population is legally excluded from harvest? • Compare distribution map with maps of areas excluding harvest • Information or interviews with wildlife managers	1
Confidence in effectiveness of strict	Are there measures taken to enforce strict protection? • Information or interviews with protected areas managers	1

Factors of sustainability	Guidance	Ref
protection measures		
Effectiveness of regulation of harvest effort	How effective are any restrictions on harvesting (such as age or size, season or equipment) for preventing overuse? • Information or interviews with resource managers	1
Confidence in harvest management	Are there effective implementation of management plan(s) and harvest controls? • Information or interviews with resource managers	1
Monitoring of harvest		
Monitoring of collection impact and management practices	Is management of wild collection supported by adequate identification, inventory, assessment, and monitoring of the target species and collection impacts? Does the rate (intensity and frequency) of collection enable the target species to regenerate over the long term? • Baseline information on population size, distribution, and structure (age classes) • Records on collected quantities (species/area/year) • Qualitative indices, e.g., discussions with collectors • Quantitative indices, e.g., roots per pound collected as an indication of population size, the quantity of national exports • Identification of target species with voucher specimens from the collection site • Direct population estimates through field surveys, including surveys of populations before and after harvest (field surveys / data collection program is critical when collected quantities are above potential production)	4
• Confidence in monitoring	Are there effective implementation of monitoring and harvest impact controls? • Monitoring confirms that abundance, viability and quality of the target resource / part of plant is stable or increasing	1
• Other factors that may affect whether or not to allow trade	• What is the effect of the harvest when taken together with the major threat that has been identified for this species? • At the national level, how much conservation benefit to this species accrues from harvesting? • At the national level, how much habitat conservation benefit is derived from harvesting?	1, 3

SUCCULENTS AND CYCADS WORKING GROUP FINAL REPORT

Succulents and Cycads Working Group Output Format

1. Information about the target species or related species

1.1. Biological and species status:

General (all species):
- Population size (small populations pose a greater risk)
- Species id (need to be able to determine what species is being traded)
- Threat status
- Population structure (mainly need to determine relative numbers of adults, juveniles, seedlings)
- Recruitment
- Recovery after harvesting

Specific instances:
- Habitat condition (as an indicator of other impacts on the population)
- Pollinators (cycads and many succulents have specific pollinators)
- Population health (e.g dead-live ratios, infections, predation)
- Growth rates (individual growth rates)
- Mortality (where harvesting of dead material is important)

1.2. Takes/uses (e.g. harvest regime):

- Trade history (what volume has been harvested in the past)
- Frequency of harvest (sporadic, continuous, once off..)
- Harvest method (destructive/ non-destructive)
- Quantities (material harvested)
- Part of the plant being harvested (removal of whole adult plant, seedlings/ juveniles, seed, leaves, bark, male cone, fruits, stems)

1.3. Management, monitoring and conservation:

- Existing management plan (incl. traditional systems)
- Prescribed methodologies exist and are being used for surveys & assessments;
- Adherence to management plan
- Regular monitoring is taking place (e.g. live/dead ratios, recruitment, recovery)
- Artificial propagation (in situ/ ex situ)
- Extent of illegal trade

2. Field methodologies and other sources of information.

2.1. Biological and species status data:

- Red data lists
- Population surveys
- Checklists and Floras
- ID manuals/ field keys
- Use of GPS; GIS
- Transect and plot methods; cluster sampling;
- GARP
- Interviews with stakeholders
- DNA methods (in development)
- Demographic models

2.2. Harvesting and trade data:

- Resource assessment
- Interviews with stakeholders
- Permit data
- Import/ export data
- Measurements of harvest
- Data from local markets
- Monitoring of recovery after harvest

3. Data integration for NDF elaboration

- Biological data (to determine production) and market data (to determine demand) integrated to determine whether offtake is likely to impact populations;
- spatial information on species abundance and harvesting to ensure that NDF accounts for possible clustering of trade in specific areas;
- Harvesting history and trends;
- Type, method, and frequency of harvesting and its impact on vulnerable stages
- management plan (with monitoring programme)
- information on threats (e.g. invasives, habitat degradation) with information on sites where harvesting occurs
- threat data, spatial distribution, and harvesting data
- legal and illegal harvest values (socio-economic information)

4. List and describe the ways data quantity and quality may be assessed

HIGH CONFIDENCE NDFs

1. Distribution range
2. Species Id
3. Population size
4. Population structure
5. Conservation status
6. Vulnerable stages
7. Genetic diversity data (structure)
8. Recruitment data
9. Recovery span of leaf-stems-flower removals
10. Life span
11. Harvest capacity
12. Trade frequency and intensity
13. Management plan
14. Monitoring actions / plots

MEDIUM CONFIDENCE NDFs

1. Distribution range
2. Species Id
3. Population size
4. Conservation status
5. Trade frequency and intensity
6. Vulnerable stages
7. Some data related to the recovery span of leaf-stems-flower removals

LOW CONFIDENCE NDFs

1. Distribution range
2. Species Id
3. Population size
4. Conservation status
5. Trade frequency and intensity
6. Basic life history information on vulnerable stages

5. Summarize the common problems, error, challenges or difficulties found on the elaboration of NDF.

- Identification of species in trade (species & commodities)
- Mixed sources of specimens in trade (wild & artificially propagated; in situ and ex situ nurseries)
- Limits to generalization
- Lack of finances
- Lack of information on resilience to harvesting
- Uncertainty about the extent of illegal trade
- Incomplete information across the range of the species
- Inadequate monitoring and feedback
- Climate change
- To avoid situations where ex situ production undermines in situ conservation efforts
- Challenge: good set of information for all the species listed on CITES
- Capacity in country to generate relevant information

6. Summarize the main recommendations which could be considered when making an NDF for this taxonomic group.

- Adopt a generally precautionary approach because these groups have a high number of threatened species;
- If there is certainty about the species and the source, and the trade involves a low risk activity, then its relatively easy to make an NDF from basic sources (e.g. Distribution range, Population size, conservation status, trade frequency and intensity, basic life history information on vulnerable stages)
- Cycads & succulents are relatively well known groups so scientific authorities should consult experts and utilize the substantial data sources;
- Compile a database of experts and primary data sources;
- IUCN Global Cycad Assessment will have very good basic information as a starting point for NDFs

7. Useful references for future NDF formulation.

- WCMC database
- National databases on trade
- IUCN/ SSC Cycad Action Plan / IUCN/SSC ‘cactus & succulent’ Action Plan
- IUCN Cycad conservation assessment database
- IUCN Red list and national red lists
- Published information (journals & books, including Floras and checklists)
- CITES identification manuals and checklists
- PlantNet website for cycads
- Catalogues of species in trade (including websites)
- Societies and specialist groups

GEOPHYTES AND EPIPHYTES WORKING GROUP FINAL REPORT

GEOPHYTES OUTPUT FORMAT
Taxa: *Galanthus* spp.
NDF Guidance Sheet

1. Information about the target species or related species

1.1. Biological and species status

Taxonomy. The accepted taxonomy for the genus *Galanthus* is the CITES Bulb Checklist (Davis et al. 1999). A copy of the checklist can be found at http://www.kew.org/conservation/CITES_Checklists/CITESBulbChecklist.pdf. This includes full distribution data and synonymy (other names). This reference should be used as a standard. Traders may use old or incorrect names.

Distribution. The following are key questions. Is the species confined to your country only? Is the taxon widespread or does it have a localized distribution? This information is likely to be available from the published literature. Additional questions such as what is the distribution of the harvested populations is likely to require field investigation or can be obtained from the traders or collectors. The former source would have higher confidence levels and therefore lower risk.

Abundance. Are the populations large throughout their range and throughout the harvested areas? Again, some of this information is likely to be available from literature and national experts. If large across the harvest range risk is low. Within populations, numbers can reach 40 plants per m^{-2} for *Galanthus elwesii* in Turkey.

Life form. All *Galanthus* are perennial geophytes which means that they survive below ground for part of the year. They can only be harvested when above ground, this limits harvest. Bulbs are harvested and some leaves need to be remaining to allow collectors to target plants.

Life cycle. *Galanthus* life spans are relatively short for perennial plants normally being less than 10 years. Individuals reproduce both sexually (by seeds) and asexually (by bulb production). Death risk is low for most of a plants life span, becoming high only in the oldest plants.

Capacity for populations to regenerate. Harvested populations of *Galanthus elwesii* are reported to recover after 3 years since harvesting adult plants (after reproduction). This is reflected in the traditional rotation period for harvesting in Turkey. This is likely to be similar for other species.

Role of species in the ecosystem. Does the collection of the species significantly impact the other wild species or habitat. Bulb harvesting could potentially involve a significant amount of disturbance given the nature of the harvest. How the harvest is carried out is therefore important.
RISK ANALYSIS: High risk- Restricted species, small populations, time of harvest, harvest intensity, harvest selection. Harvest should be after reproduction (flowering and seed set) has occurred and should preferentially select older (larger) individual bulbs.

Positive NDF for 1.1: Adequate abundance, low risk harvest

Note: CITES and Plants: A User's Guide Version 3.0 provides information on the application of CITES to plants and a list of references and resources it can be found at http://www.kew.org/conservation/cites-slidepack.html in English, French and Spanish.

1.2. Takes/uses (e.g. harvest regime)

Type of harvest. Harvesting of whole live plants. Bulbs are located by targeting visible leaves. Harvesting is only possible during the time between which they appear above ground to when they die back. The less detrimental harvest is after individuals have reproduced.

Harvest specificity. Is just the target species collected or are other species collected as well? In addition, are there other species which may be collected inadvertently? Are there rarer *Galanthus* species nearby or with an overlapping distribution? Information on distribution is available from the published literature. Data from the traders and collectors will be required to assess deliberate or inadvertent collection of other species.

Harvest regime. What life history stages are actually collected i.e. how big are the collected bulbs? Are only adults (individuals who have flowered/set seed) harvested? Is there a minimum bulb size for collection? This data can only be collected by overseeing harvest or directly from traders.

National/International use. Is the species harvested for local purposes or international trade? What are the relative quantities of these? Local trade in Galanthus is usually small, with limited material collected for gardens or national specialist collectors. Local botanists will be able to give an assessment. The risk is likely to be low.

Harvest source. Are plants harvested only from the wild or do any come from cultivated stocks Is it known whether the cultivated stocks conform to the CITES definition of artificial propagation? This is outlined in Resolution Conf. 11.11 (Rev. CoP14) which can be found at http://www.cites.org/eng/res/11/11-11R14.shtml. It is useful to develop guidelines on the national application of this definition and also carry out training to ensure that is being applied in a standardized fashion.
Are the bulbs collected from the wild and grown-on in cultivation fields prior to export? Such a process is a common method of 'storing' bulbs and this stock must be treated as wild for the purposes of an NDF. If you are uncertain whether plants are harvested from the wild or truly propagated its best to treat all of the material as wild until you can accurately assess propagation.

Harvest frequency. How frequently are the populations harvested from each collection site? For example a three year rotation period is traditionally adopted for *Galanthus elwesii* in Turkey. More frequent harvesting is likely to be detrimental.

Harvest volume. Can you estimate the fraction of the overall population and of the different bulb size/age classes removed from the collection sites? The traders will record actual harvest volume (and possibility bulb size as the market favours larger bulbs) for commercial purposes. Your local experts should be able to give a preliminary view on what percentage the harvest is of the local wild stock.

History of harvest. Is there a history of harvesting this bulbous plant? Is this a newly emerging harvest? In the absence of historical data, a precautionary approach is appropriate.

Harvest trends. Is the harvest stable or increasing/decreasing? This can be based on an estimate from the knowledge of local collectors and traders. An increasing harvest would suggest a precautionary approach is appropriate.

Regulation. Is the harvesting regulated?, i.e. government control at a regional or national level. A well regulated harvest is low risk.

Legal/Illegal use. Does the harvest conform to national or international legislation? Is there also unregulated harvesting? Is there illegal harvesting or trade? Are there any reports of illegal harvest form collectors or traders? In the case of Galanthus illegal trade is more likely the rarer the species is.

Reason for harvest. What are the forces driving the harvest? For example, to date the trade has been driven by demand for horticultural purposes at an international level with the majority of primary exports going to a limited number of countries. This has facilitated regulation of the trade and lowered the risk of detrimental trade.
Commercial destination. Are the plants being collected for specialist collections, widespread horticultural uses, scientific research, mother/parental stock? Is it for local, national or international uses?

Information quality. Where have the data originated from? How recent is it? How reliable and representative is it? Has the information originated from a national flora, from scientific literature or data, from national reports from high quality local knowledge? High quality low risk information is recent field based and obtained from reliable sources.

<u>RISK ANALYSIS</u>: High risk – frequent harvest, large harvest volume, all bulb sizes collected. Harvest should be after reproduction (flowering and seed set) has occurred and should preferentially select older (larger) individual bulbs.

<u>Positive NDF for 1.2:</u> Regulation of harvest, low volume, positive selection for bulb size.

1.3. Management, monitoring and conservation

Required for significant harvest of bulbs

Management. Is there a management plan or an equivalent? For example there may be a local/national/institutional management plan. [See Annex for template management plan]. If there is no management plan then implement a precautionary harvest quota based on the available information and export quota until such time as a formal management plan is in place. For example, a precautionary quota for 3-5 years. A medium term precautionary quota may give the CITES Authorities sufficient time to assess the impact of harvesting and establish an appropriate quota.

Monitoring. This includes the verification of the species being harvested, confirming that the correct age/sizes being harvested, and assessing the status of the source populations including the population size and the health of the habitat. Details of how to do this are given in Section 2.1.

Confidence in the harvest (legal and illegal). Is there sufficient confidence that the harvest is as reported? This can be improved by monitoring the harvest in the field and / or at the bulb holding points prior to export. For example, the bulb trade often utilizes central warehouses prior to export into international trade. In these warehouses bulbs are cleaned, graded and packed. This allows an opportunity for the CITES Authorities to inspect the consignments to verify bulb size, species and source. This can be a quick and easy way of checking for problems.
Is there legislation in place to control harvesting by bulb companies? If there is no legislation, are there guidelines approved by the CITES Authorities? The template management plan in the Annex includes elements that might be included in these guidelines.

History of harvest. Is there a history of harvesting this plant? Is this a newly emerging harvest? Historical data can assist in the setting of appropriate quotas and in adaptive management of the resource.

RISK ANALYSIS: High risk – no management plan or guidelines, no monitoring system, medium- quantitative system with medium to high confidence. Low- monitoring system

<u>Positive NDF for 1.3:</u> quantitative monitoring system with medium to high confidence.

2. Field methodologies and other sources of information.

2.1 Biological and species status data:

Biological data can be obtained from a variety of literature sources.
Biological information can be obtained from national and international experts, including local knowledge. Experts should confirm the identity of species subject to collection. Field inspections will also be required. Such inspections may be qualitative; for example short visits by a local expert to visually inspect the sites to confirm that the populations are healthy. If possible, quantitative data should also be collected. Quantitative assessments of the population include the overall abundance, size/age structure of the population. For example, random samples (using quadrats) could be taken to assess the overall abundance in the population (see references and resources).Randomly dug plots can be used to assess the size structure of the bulb population. This could also be assessed by inspecting the harvested bulbs. Permanently marked areas (Permanent plots) can be used to assess the long term trends in the populations and estimate birth and death rates of different age/size categories.

Population modeling could be used to estimate long term population trends and probabilities of extinction under plausible harvest methods and quotas (see annex). A key reference here is Sutherland W.J. (ed.) (2006) Ecological census techniques: a handbook, 2nd edition. Cambridge University Press.

Population Modeling Additional Sources:
VORTEX PVA Software: http://www.vortex9.org/vortex.html
Statistical package R (useful for population modelling): http://www.r-project.org/

Caswell, H. (2001). Matrix population models, 2nd edition. Sinauer Associates, Inc.
Bolker, B. J. (2008). Ecological models and data in R. Princeton University Press.
Menges, E.S. (2000). "Population viability analyses in plants: challenges and opportunities". Trends in Ecology & Evolution 15: 51–56.

2.2 Harvesting and trade data:

Harvest data can be confirmed by inspection of the harvest sites or of the annually harvested stocks held by traders in their warehouses prior to export.

The traders are likely to hold records of harvest stock for purposes of payment, and these can be used for purposes of monitoring. Records of the time taken to obtain a certain harvest level from individual populations (harvest per unit effort) can indicate the health of those populations. Again trader records can hold data that may assist you in assessing harvest per unit effort.

Records of what is actually exported. UNEP-WCMC trade data can be reviewed and compared with national records to check for inconsistencies and to confirm compliance with national quotas. Phytosanitary records can also assist in confirming the species and volumes exported.

Are there records of illegal trade in this species? This could be available from customs agencies, CITES authorities and international organizations (such as TRAFFIC). Is there any evidence of illegal collection from harvest sites, for example by local collectors or landowners?

Trade routes and ultimate destination. Large scale commercial trade in Galanthus mainly follows a restricted international trade route to The Netherlands for global distribution. Minor trade in rarer species is more likely to follow complex trade routes and be prone to illegal trade.
Population models could incorporate harvesting and trade data to allow estimates of most appropriate rotation periods, appropriate removal rates per site, the size limit for removing bulbs, and the effective area of land required to fulfill the quota.

<u>RISK ANALYSIS</u>: High risk is the in the case of rare species with restricted populations.

3. Data integration for NDF elaboration

Data integration is the integration of the biological data, harvest data, trade data and local knowledge to get an overview of the trade and its likely impact. A committee of experts, that extends beyond the normal expertise of a Scientific Authority, could meet annually to consider all of the relevant biological, harvest and trade evidence as well as local knowledge and knowledge of legislation. This group shared knowledge could add value to the decision making process on NDF's and quota setting.

Population modeling (mechanistic and/ or statistical) is a useful tool to bring together the population and harvest data to obtain predictions of the population dynamics and predictions of sustainable yield. (See Annex) Detailed biological data is usually needed to parameterize a model that could predict quantities of bulbs to any reasonable level of accuracy. However, even small amounts of data could be useful in allowing highly unsustainable harvesting quantities to be identified and alternative harvesting methods to be compared. For example, models allow for a variety of harvesting regimes to be explored to assess what may be more or less detrimental without the need for field studies.

4. List and describe the ways data quantity and quality may be assessed
How representative is the available data of the whole population? Your local expert may be able to assess this and give an informed view as a qualitative assessment. This could give a quick assessment. Quantitatively, this could be done by comparing data from collection sites. The area over which samples are made and the number of samples taken should be compared to the overall population distribution. Likely variation in abundance and population density can be obtained by making repeated random samples and observing how the variance stabilizes as more samples are made. Similarly, it is preferable to inspect as large a proportion of the harvested bulbs as possible (this could be aided if the traders use a central warehouse) to assess the status of the harvested bulbs as a whole. Quality of the data can also be assessed by correlating more accurate but more resource intensive quantitative measurements (such as measuring the number of bulbs per square metre for a whole population) with easier to collect, but generally less accurate measurements (such as estimating whole sites as “low”, “Medium” or “high” bulb density). This could form simple basis for risk analysis. **<u>RISK ANALYSIS</u>: High risk is the in the case where data quality is poor or no assessment has been made.**
5. Summarize the common problems, error, challenges or difficulties found on the elaboration of NDF.
• Maintaining and updating expert knowledge,- frequent changes of staff, no mechanism for maintenance of institutional memory. • Few quantitative records, lack of long term quantitative monitoring process, lack of data management systems. • Obtaining quality information from local collectors and bulb companies. • Obtaining qualitative information from local collectors and bulb companies. • Clarity of process to outside parties. • Understanding of the population dynamics and the variation in site productivity throughout the collection range not complete. • Scarcity of data, case studies, and examples. • Lack of a standardized process and guidelines- need a simple manual for geophtyes linked with staff training.
6. Summarize the main recommendations which could be considered when making an NDF for this taxonomic group.
• Implement an adaptive NDF setting methodology: a feedback process so that quotas can set and adjusted. • Utilise all sources of information including local and trader knowledge and experience. • Develop a simple population and harvest monitoring process can utilize the knowledge of collectors. • Maintain an institutional history of monitoring and expert knowledge. • Acquire knowledge on what is detrimental and clearly define it for all stakeholders, ensuring that you use simple indicators in your monitoring system.

ANNEXES

ANNEX A. Templates CITES Management Plant for *Galanthus* Species

Wild Harvest

- Harvest restricted to populations in the follow areas. Include map showing distribution of areas subject to collection
- Quota established for collection areas – portion of total quota
- Harvest rotation, harvest to be carried out on a 3 year rotation cycle, rotation to be indicated on collection distribution map
- Collection limited to x weeks in the time period a to b (may be altered in consultation with Scientific Authority, for example, in the case of unusual or extreme weather conditions).
- Collection limited to bulb size > x cm diameter, below size bulbs to left in soil or collected for planting in cultivation fields (Collector should be supplied with graded sieves to allow them to familiarize them selves with minimum size)
- Collector should fill in activity report (simple design prepared by CITES SA), indicating how long, person hours, it took them to collect quota and how far did they have to range
- X random samples taken in collection area, non collection area prior to annual harvest
- Y permanent sample plots established in collection areas and non collection areas, sampled y times per year. This may be done by local inspectors taking photographs for SA.
- Log of collection details held at sorting Warehouse, including source area, collector, weight of bulbs, number, time to collect.
- Random sampling of warehouse bulbs, seize weight, species, time taken to collect

Role of Scientific Authority

- Mapping of population distribution, delimitation of collection areas, definition of rotation times
- Selection of population sampling methods, initial sampling of populations to provide data for local quotas and national quota
- Selection and establishment of permanent plots
- Preparation of field sampling guidance, so sampling can be carried out by non specialist staff
- Preparation of Warehouse protocols and sampling guidance, so sampling can be carried out by non specialist staff
- Establishment of monitoring protocols and guidance, if required, selection of suitable population model
- Management and review of data collected
- Preparation of a simple collection plan to be agreed with quota holders. This will be key elements of the management plan relating to that quota with timetables
- Establish annual quota system, set at a precautionary level on 3 year cycle, reviewed during year 3.
- Overall management plan to be reviewed on a 5 year cycle.
- Organise scientific workshop on quota setting and management plan on a 3 year cycle

Scientific Authority role in Capacity Building

- Carry out workshops with quota holders to explain management plan and individual collection plans
- Carry out workshops with management authority regional staff to explain management plan and individual collection plans and their role in monitoring same
- Prepare generic briefing sheets for collectors on collection plan
- Carry out rolling programme of workshops for collectors to inform them and to get their input into the management programme

Role of Management Authority

- Liaison with SA over management plan and quota
- Confirmation of national quota
- Assignment of quota to traders
- Establishment of legal agreement with traders
- Organising workshops with traders and collectors
- Distribution of information to traders and collectors
- Allocation of time of regional staff to monitoring management plan implementation and population sampling if required

ANNEX B. The value of population modelling in making NDF´s – Why do modelling?

Modelling can assist the making of NDFs in several different ways

- Concisely summarising the available knowledge on the biology of the species. We strongly recommend that a life cycle diagram is constructed.
- Revealing aspects of the species biology that are most important in determining it's population dynamics and regenerative response to different harvesting strategies
- Investigating plausible harvesting scenarios and their possible and relative impacts without having to do anything in the field that may be detrimental to the survival of the target species.
- Predicting the dynamics of populations before and after harvesting
- Predicting the change in extinction probability as a result of harvesting
- Estimating uncertainty in the predictions of population dynamics and in the response of the population to harvesting
- Identifying important data to collect to more accurately predict the population dynamics and the effects of harvesting. i.e. knowing where the gaps in knowledge exist
- Indicating where additional information would improve confidence in making NDFs
- Indicating how precautionary NDFs need to be for species with a particular set of biological characteristics.

Decisions based on real data, and on models parameterised from real data, generally give a higher level of confidence than those based on educated guesswork.

What data should we consider collecting to parameterise a model?
Modelling can be performed with very little quantitative data. However, large amounts of data are usually required to be able to make meaningful quantitative predictions. In general, collecting more data and obtaining more details about the species concerned, will allow more accurate predictions to be made. The amount and type of data needed depends on the question to be answered.

Models to predict species population dynamics could incorporate data on

- Temporal changes in overall abundance
- Temporal changes in size or age or stage classes in the population
- Information on species life cycles
- Spatial data on the location and characteristics of individuals
- Data on the vital rates of the population such as birth and death rates
- The effects of environmental conditions (abiotic factors)
- The effects of other biological factors such as crowding and availability of mates
- Levels of variation in biological characteristics

Note that only collecting data on temporal changes in presence and numbers in populations can limit the insights that can be gained from models. Collecting more information about birth and death rates, and complete census data (data through time on every individual in a population), allows more information to be extracted and generally leads to more predictive models. Full population census data gives more trustworthy and accurate insights into the determinants of population change. This can be very useful in building accurate models.

Collecting sufficient data to parameterise models can be expensive and time consuming. However, this need not be the case. For example, data could be collected during harvesting or may be available from local or national records. Published information on similar taxa may be available but care must be taken as the dynamics of apparently similar species can be very different.

How is a model developed?
The precise form of a model depends on the question being asked. Standard approaches are available for most conceivable needs in relation to making NDFs.

Life cycle models can be developed by investigating the biology of the taxa through literature sources, and the collection of field data.

Models that represent the biology of a species in a simplified manner are used to estimate the impact of harvesting. This is because such mechanistic population models allow for the incorporation of the details of the harvest, e.g. the particular stages and ages of the population being removed, and the projection of their likely effects.

Transition matrix models are a commonly used formal way of modelling changes in the size/age/stage structure of the population through time. Rates of transition between the different population categories can be calculated from data and these can be used to predict future population dynamics. Note that the accuracy of such predictions depends on the quantity and quality of the data as well as the biological characteristics of a species.

Models can be continually improved as new data become available. Bayesian models allow the estimation of the likelihoods of parameters and biological mechanisms and can also be used to incorporate new data as they become available to update predictions. This could be particularly useful in developing models for species that are repeatedly sampled and / or harvested.

How do I test a model?
A variety of formal methods are used to test models. Almost all of these give an estimation of how well a given model predicts a particular situation. However if the model is being used to predict a novel scenario (such as a new level or method of harvesting), then the results of such model tests may be misleading. This is because the model may not incorporate important details that strongly affect the dynamics under the new scenario.

Naturally high variability in population behaviour will make forward projection risky for many species. Models that incorporate stochasticity in their structure can be particularly useful for such species to allow the additional estimation of uncertainty in the predictions.

Models analysed using maximum likelihood methods can be used to infer the characteristics of unknown processes and parameters.

EPIPHYTES OUTPUT FORMAT
Taxa: Epiphytic Orchidaceae
NDF Guidance Sheet

1. Information about the target species or related species

1.1. Biological and species status

Taxonomy. CITES has an accepted taxonomy for the Orchidaceae. These references are outlined in Resolution Conf. 12.11(Rev. CoP14) and can be found on the CITES website (http://www.cites.org/eng/res/12/12-11R14.shtml). The checklists are available on line at http://www.kew.org/conservation/cites-checklist.html. These references include full distribution data and synonymy (other names). These references should be used as a standard.

Distribution. The following are key questions. Is the species confined to your country only? If it occurs in other countries then data may be available on NDFs in that country. Is the taxon widespread or does it have a localized distribution? What is the distribution of the harvested populations?

Abundance. Are the populations large throughout their range and throughout the harvested populations? Epiphytes can be abundant in their habitats, but their habitats can be highly fragmented. Estimating the abundance of habitat fragments and/or host plant abundance could be more important than estimating the abundance of the epiphytes themselves.

Life form. Epiphytes are perennial plants that grow on the surface of a host plant. They are normally long lived and reproduce both sexually (from seed) and asexually (by off-shoots).
Habitat specificity. There are different degrees of site specificity in epiphytes generally but they are often site specific and this can make them high risk species to collection.

Life cycle. Epiphytes are generally long-lived. Plants can live for decades. Therefore any destructive harvest of the target species or its host is potentially a risk to the population.

Capacity for populations to regenerate. Epiphytes probably have a low capacity to regenerate. Recovery from harvesting is likely to take a long time. Successful pollination is usually dependent on a specific pollinator but artificial pollination can sometimes be used to improve pollination success. Artificial placement of seedlings (produced *in vitro*) could also improve recruitment.

Role of species in the ecosystem. The presence of epiphytes can indicate a healthy ecosystem. If harvest of the epiphyte also involves the destruction of the host then this could be detrimental to the health of the ecosystem.

RISK ANALYSIS: High risk – harvest intensity, method of harvest (remove whole plant, remove host). Low risk: seed collection or plant parts.

<u>Positive NDF for 1.1:</u> Adequate abundance, low harvest intensity and non-destructive harvest methods.

Note: CITES and Plants: A User's Guide Version 3.0 provides information on the application of CITES to plants and a list of references and resources it can be found at http://www.kew.org/conservation/cites-slidepack.html in English, French and Spanish.

1.2. Takes/uses (e.g. harvest regime)

Type of harvest. Harvesting of whole live plants and possibly including all or part of the host is more likely to be very detrimental, particularly the harvesting of reproductive adults. Harvesting methods that damage the roots usually eventually kill the harvested plant, and this can lead to repeated harvests. Nonlethal harvesting of seed and pods also occurs and is less detrimental.
Timing of harvest. Harvesting can happen at any time of year but usually happens during the periods of plant flowering (usually after rain or the rainy season). The presence of flowers is essential in the identification of the taxon being harvested but this does not need to be confirmed for every individual.

Harvest specificity. Harvesting is often indiscriminate and destructive. It may therefore damage the surrounding habitat and species, especially the host plant. Other species of orchids are likely to be collected as well as the target species. Harvesting by experts can be much more successful at collecting the target species and causing less damage to the ecosystem, and can be targeted to comply with best practice.

Harvest regime. Indiscriminate and opportunistic harvesting occurs therefore information on the harvesting regime is important.

National/International use. Epiphytes are harvested for private, national and international use for horticulture or medicinal purposes.

Harvest source. Are plants harvested only from the wild or do any come from cultivated stocks? In the case of artificially propagated plants an NDF needs to be made on the parental stock and the artificially propagated plants must fulfill the CITES definition of artificial propagation. This is outlined in Resolution Conf. 11.11 (Rev. CoP14) which can be found at http://www.cites.org/eng/res/11/11-11R14.shtml. It is useful to develop guidelines on the national application of this definition and also carry out training to ensure that is being applied in a standardized fashion.

Harvest volume. What fraction of the plants is removed from the collection sites? It is likely that all plants may be removed from a particular locality unless the harvest is subject to regulation and monitoring.

History of harvest. Is there a history of harvesting this taxon? Is this a newly emerging harvest? In the absence of historical data, a precautionary approach is appropriate.

Harvest trends. Is the harvest stable or increasing/decreasing? This can be based on an estimate from the knowledge of local collectors and traders. An increasing harvest would suggest a precautionary approach is appropriate.

Regulation. Is the harvesting regulated?, i.e. government control at a regional or national level. A well regulated harvest is low risk. Some countries have guidelines and legislation in place to ensure that collection complies with the CITES regulations. In some cases collections must be attended by an approved expert. Unregulated harvesting is more likely to be detrimental.

Legal/Illegal use. Does the harvest conform to national or international legislation? Is there illegal harvesting or trade? Are there any reports of illegal harvest form collectors or traders? Orchids to have a high risk of illegal trade, so unless sites are monitored for illegal collection this is a high risk for epiphytes which are horticulturally attractive or have a medicinal use.

Reason for harvest. What are the forces driving the harvest? For example, to date the trade has been driven by demand for horticultural and medicinal purposes. Specialist collectors may target the rarer species.

Commercial destination. Are the plants being collected for specialist collections, a wide range of horticultural uses, scientific research, mother/parental stock? Is it for local, national or international uses?

<u>RISK ANALYSIS</u>: High risk – Unregulated harvest, demand for plants from a wide range of sectors.

<u>Positive NDF for 1.2:</u> Well regulated harvest, limited sector demand.

1.3. Management, monitoring and conservation

Management. Is there a management plan or an equivalent? For example, there may be a local/national/institutional management plan or guidelines for management. If there is no management plan then you may want to implement a conservative harvest quota and export quota (or even a zero quota where the species is of restricted distribution and population size) until such time as a formal management or appropriate guidelines are in place. A medium term precautionary (or zero) export quota may give the CITES Authorities sufficient time to assess the impact of harvesting and establish an appropriate quota.
If the plants are artificially propagated, then do they strictly conform to the CITES definition of artificial propagation? Has the mother stock been subject to an NDF? Is there a nursery registration scheme?

Monitoring. This includes the verification of the taxon being harvested, confirmination that the correct age/sizes being harvested, assessing the biological status of the source populations and the habitat, and verification of the parental stock.

Confidence in the harvest (legal and illegal). This may be low due to a general lack of data on the population status of the taxon and the harvesting methods used.
Is there legislation in place to control harvesting? If there is no legislation, are there guidelines approved by the CITES Authorities?

History of harvest. Is there a history of harvesting this taxon? Is this a newly emerging harvest? Some orchids have been in trade for decades to centuries. Historical data can assist in the setting of appropriate quotas and in adaptive management of the resource.

<u>RISK ANALYSIS</u>: High risk – no management plan or guidelines, no monitoring system, medium-quantitative system with medium to high confidence. Low- monitoring system in place.

<u>Positive NDF for 1.3:</u> quantitative monitoring system with medium to high confidence.

2. Field methodologies and other sources of information.

2.1. Biological and species status data

Biological data can be obtained from a variety of literature sources.

Biological information can be obtained from national and international experts, including local knowledge. Experts should confirm the identity of species subject to collection. Field inspections are also advisable. Such inspections may be qualitative; for example short visits by a local expert to visually inspect the sites to confirm that the populations are healthy. If possible, quantitative data should also be collected. Quantitative assessments of the population include the overall abundance, size / age / life history stage structure (adults/flowering/seed set seedlings etc) of the population. For example, samples along transects or of population fragments could be taken to assess the overall abundance in the population. Permanently marked areas (or transects) can be used to assess the long term trends in the populations and estimate birth and death rates of different age/size/stage categories.
Generally, for epiphytes, obtaining confidence about the population trends would require monitoring over many years, probably decades.

Population modeling could be used to estimate long term population trends and probabilities of extinction under plausible harvest methods and quotas (see Annex).

Random or permanent transects can be used to assess the overall abundance in the population. The populations will generally be fragmented and this should be considered in survey design. Counts of epiphytes on host trees and the distribution of size and/or age classes could be particularly informative. Population modeling has been done for some epiphyte populations to investigate the population dynamics which may be informative. A core reference here is Sutherland W.J. (ed.) (2006) Ecological census techniques: a handbook, 2nd edition. Cambridge University Press.

Population Modeling Additional Sources:

VORTEX PVA Software: http://www.vortex9.org/vortex.html
Statistical package R (useful for population modelling): http://www.r-project.org/
Caswell, H. (2001). Matrix population models, 2nd edition. Sinauer Associates, Inc.
Bolker, B. J. (2008). Ecological models and data in R. Princeton University Press.
Menges, E.S. (2000). "Population viability analyses in plants: challenges and opportunities". *Trends in Ecology & Evolution* 15: 51–56.

2.2. Harvesting and trade data:

Harvest data can be confirmed by inspection of the harvest sites or of the harvested stocks held by traders. You can also interview the traders or collectors on an occasional basis. The time taken to obtain a certain harvest level from individual populations (harvest per unit effort) can indicate the health of those populations. An interview with collectors may reveal such information. The traders are likely to hold records of legally harvested stock for purposes of payment, and these can be used for purposes of investigation.

UNEP-WCMC trade data can be reviewed and compared with national records to check for inconsistencies in recorded data and to confirm compliance with national quotas. Phytosanitary records can also assist in confirming the species and volumes exported.

Are there records of illegal trade in this species? This will be available from customs agencies, CITES authorities and international organizations (such as TRAFFIC). Is there any evidence of illegal collection from harvest sites, for example by local collectors or landowners?

Internet trade surveys can indicate species that are in international trade, their relative demand (by price being charged) and their origin. A quick Google of a plant name will immediately reveal its interest to the legal and illegal trade.

Trade routes and ultimate destination (e.g. large scale commercial traders, small scale uses). International orchid shows can help to identify trade routes, the identity of taxa in international trade, and levels of demand.

Population models could incorporate harvesting and trade data to allow estimates of most appropriate harvest regimes, appropriate removal rates per site, and the effective area of habitat required to fulfill the quota.

RISK ANALYSIS: High risk is the in the case of rare species with restricted populations.

3. Data integration for NDF elaboration
A committee of experts (scientists, managers, growers) could meet regularly to consider all of the relevant biological, harvest and trade evidence as well as local knowledge and knowledge of legislation to broaden the information available on the species. This could help frame a harvest and export quota. Bringing all the relevant data, detailed above, into a central location (or a few connected locations) that can be accessed by the CITES authorities (e.g. UNEP-WCMC trade database) would aid in making NDFs. Population modeling (mechanistic and/ or statistical) is one useful tool to bring together the population and harvest data to obtain predictions of the population dynamics and obtain predictions of sustainable yield.
4. List and describe the ways data quantity and quality may be assessed
How representative is the sample of the whole population? Most countries have orchid experts and orchid societies- you may find someone in this environment who could estimate population size on a qualitative basis. Information quality: Where have the data originated from? How recent is it? How reliable and representative is it? Has the information originated from a national flora, from scientific literature or data, from national reports, from high quality local knowledge? Question the data sources. Are the data collected objectively and accurately?
5. Summarize the common problems, error, challenges or difficulties found on the elaboration of NDF.
• Maintaining and updating expert knowledge • Few quantitative records • Obtaining quality information from local collectors and traders • Clarity of process to outside parties • Understanding of the population dynamics and the variation in site productivity throughout the collection range • Scarcity of data, case studies, and examples. • Inadequate resources and personnel to undertake NDFs • Inadequate information on status of species in the wild • Lack of national management plans or guidelines for the sustainable use of orchids • Lack of standardized procedures and guidelines for NDFs and hands on training on same • High turnover of conservation and enforcement personnel • Minimal political will to approve and implement species management strategies • There is need for the development of standard NDFs procedure for Parties • Species in trade should be subjected to an NDF process before and after listing on the Appendices • There is need for Parties to develop an updated database on the status of species i.e. conservation and utilisation. Such a database should be linked to regional and global processes • There is need for continuous training in NDFs procedures of managers and scientists in relevant institutions • Parties should be urged to avail funds and resources for NDFs • Scientific Authorities need strengthening in their role in implementing CITES for plants

6. Summarize the main recommendations which could be considered when making an NDF for this taxonomic group.
• Implement an adaptive NDF setting methodology: a feedback process so that quotas can be adjusted • Monitor the time taken to fulfill quota • Acquire knowledge on what is detrimental, define it in a simple fashion and share same with all stakeholders, ensure you define simple indicators of same • Inspect harvested and unharvested populations and the harvested stock • Try to harvest after reproduction • Centralise the monitoring to allow overall assessments and comparisons to be made • Maintain a history of monitoring and expert knowledge

ANNEXES

ANNEX A. The value of population modelling in making NDF´s – Why do modelling?

Modelling can assist the making of NDFs in several different ways

- Concisely summarising the available knowledge on the biology of the species. We strongly recommend that a life cycle diagram is constructed.
- Revealing aspects of the species biology that are most important in determining it's population dynamics and regenerative response to different harvesting strategies
- Investigating plausible harvesting scenarios and their possible and relative impacts without having to do anything in the field that may be detrimental to the survival of the target species.
- Predicting the dynamics of populations before and after harvesting
- Predicting the change in extinction probability as a result of harvesting
- Estimating uncertainty in the predictions of population dynamics and in the response of the population to harvesting
- Identifying important data to collect to more accurately predict the population dynamics and the effects of harvesting. i.e. knowing where the gaps in knowledge exist
- Indicating where additional information would improve confidence in making NDFs
- Indicating how precautionary NDFs need to be for species with a particular set of biological characteristics

Decisions based on real data, and on models parameterised from real data, generally give a higher level of confidence than those based on educated guesswork.

What data should we consider collecting to parameterise a model?
Modelling can be performed with very little quantitative data. However, large amounts of data are usually required to be able to make meaningful quantitative predictions. In general, collecting more data and obtaining more details about the species concerned, will allow more accurate predictions to be made. The amount and type of data needed depends on the question to be answered.

Models to predict species population dynamics could incorporate data on

- Temporal changes in overall abundance
- Temporal changes in size or age or stage classes in the population
- Information on species life cycles
- Spatial data on the location and characteristics of individuals
- Data on the vital rates of the population such as birth and death rates
- The effects of environmental conditions (abiotic factors)
- The effects of other biological factors such as crowding and availability of mates
- Levels of variation in biological characteristics

Note that only collecting data on temporal changes in presence and numbers in populations can limit the insights that can be gained from models. Collecting more information about birth and death rates, and complete census data (data through time on every individual in a population), allows more information to be extracted and generally leads to more predictive models. Full population census data gives more trustworthy and accurate insights into the determinants of population change. This can be very useful in building accurate models.

Collecting sufficient data to parameterise models can be expensive and time consuming. However, this need not be the case. For example, data could be collected during harvesting or may be available from local or national records. Published information on similar taxa may be available but care must be taken as the dynamics of apparently similar species can be very different.

How is a model developed?
The precise form of a model depends on the question being asked. Standard approaches are available for most conceivable needs in relation to making NDFs.

Life cycle models can be developed by investigating the biology of the taxa through literature sources, and the collection of field data.

Models that represent the biology of a species in a simplified manner are used to estimate the impact of harvesting. This is because such mechanistic population models allow for the incorporation of the details of the harvest, e.g. the particular stages and ages of the population being removed, and the projection of their likely effects.

Transition matrix models are a commonly used formal way of modelling changes in the size/age/stage structure of the population through time. Rates of transition between the different population categories can be calculated from data and these can be used to predict future population dynamics. Note that the accuracy of such predictions depends on the quantity and quality of the data as well as the biological characteristics of a species.

Models can be continually improved as new data become available. Bayesian models allow the estimation of the likelihoods of parameters and biological mechanisms and can also be used to incorporate new data as they become available to update predictions. This could be particularly useful in developing models for species that are repeatedly sampled and / or harvested.

How do I test a model?
A variety of formal methods are used to test models. Almost all of these give an estimation of how well a given model predicts a particular situation. However, if the model is being used to predict a novel scenario (such as a new level or method of harvesting), then the results of such model tests may be misleading. This is because the model may not incorporate important details that strongly affect the dynamics under the new scenario.

Naturally high variability in population behaviour will make forward projection risky for many species. Models that incorporate stochasticity in their structure can be particularly useful for such species to allow the additional estimation of uncertainty in the predictions.

Models analysed using maximum likelihood methods can be used to infer the characteristics of unknown processes and parameters.