Guidance for Implementing the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP)

RESOURCE ASSESSMENT

A Guide to Implementing Principle 1:
Maintaining Wild MAP Resources

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International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants

PREFACE

This guide is intended to provide a general overview of resource assessment and its central role in management planning for users of the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP). It is important that users of this guide understand that assessment and management of important wild-collected resources, such as medicinal and aromatic plants, cannot be reduced to a "cook book" set of instructions that can be applied directly to the particular conditions found in real collection projects and commercial operations. In this guide, we have described the resource assessment process in five basic steps, and have provided a summary of procedures for each of these steps. These are intended for use as a checklist of the relevant tasks, rather than as a stand-alone methods manual. In this guide, we refer to several key published methods manuals, as well as to some case studies, that provide useful examples and advice. Users of this guide must be prepared to invest time and effort into understanding and working with the specific set of conditions for each project or collection operation. Users will need to consult more thorough methods manuals and case studies and seek professional advise on field study design and analysis methods appropriate to a particular collection project or operation. We hope that this guide will enable users to ask appropriate questions and seek pragmatic means to achieve sustainable wild collection of medicinal and aromatic plants and other wild-collected plant resources.

We acknowledge our particular reliance on the published work of the following individuals in compiling this guide: A.B. Cunningham, Charles Peters, Mary Stockdale, and Tamara Ticktin. Their work consulted, and other useful references, are listed in the bibliography at the end of this document. We also acknowledge unpublished contributions of Dagmar Lange to evaluating existing approaches to resource assessment, particularly related to part used and life form. We gratefully acknowledge the support of WWF Deutchland, the German Section of the World Wide Fund for Nature (WWF) for development of this guide.

This 1st draft, and an accompanying slide presentation, are intended for review and trial application to field projects implementing the ISSC-MAP in 2007-2008. Revisions of this guidance on resource assessment relevant to the ISSC-MAP is planned for the end of 2008.

Please send comments on this Resource Assessment guide and the accompanying PowerPoint to:

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Version 1.0 of the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP), and other information about the standard, can be found at the following website: http://www.floraweb.de/map-pro/.

For information about the current implementation phase of ISSC-MAP, please contact:

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OVERVIEW AND BACKGROUND

The International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) has been developed to meet the needs industry, governments, certifiers, resource managers, and collectors to understand whether wild collection activities are sustainable, and how to improve collection and resource management operations that are detrimental to the long-term survival of these resources. The ISSC-MAP is itself a generic set of principles and criteria intended for use in a wide range of circumstances. MAP resources include many different types of plants in a wide variety of habitats. The focus of the ISSC-MAP is on the ecological sustainability of wild plant populations and species in their natural habitat, but it also addresses the social and economic context of sustainable use (Figure 1). The ISSC-MAP and this guide meeting criteria for resource assessment is relevant for other wild-collected plant resources.

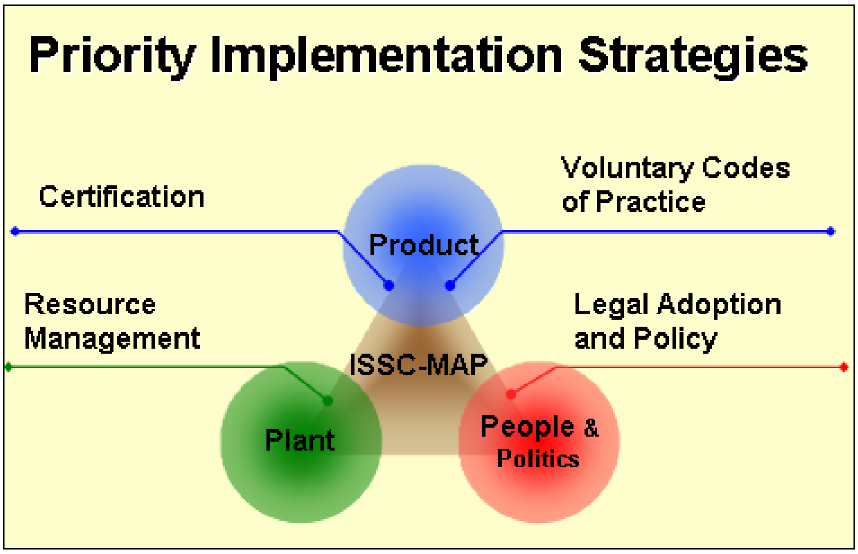

Figure 1. Priority implementation strategies for the ISSC-MAP

The objectives of this resource assessment guide are to help ISSC-MAP users:

- understand what information needs to be collected, monitored, and considered to conduct a resource assessment within the collection management process;
- determine the appropriate degree of resource assessment and monitoring accuracy and precision based on the actual project situation and target species;
- identify professional capacity, training, equipment, methods, and other information resources needed to design and implement resource assessments and management plans; and
- meet ISSC-MAP requirements for resource assessment, in particular Principle 1 and related criteria (Box 1).

Box 1. ISSC-MAP resource assessment and management requirements	
Principle 1	Maintaining Wild MAP Resources Wild collection of MAP resources shall be conducted at a scale and rate and in a manner that maintains populations and species over the long term
Criterion 1.1	Conservation status of target MAP species The conservation status of target MAP species and populations is assessed and regularly reviewed.
Criterion 1.2	Knowledge-based collection practices MAP collection and management practices are based on adequate identification, inventory, assessment, and monitoring of the target species and collection impacts.
Criterion 1.3	Collection intensity and species regeneration The rate (intensity and frequency) of MAP collection does not exceed the target species' ability to regenerate over the long term.

Resource assessment is an essential component of an adaptive management process. Resource assessments enable collectors and other resource managers to:

- estimate sustainable harvest limits for a specific resource within a particular collection area;
- observe and understand the impact of current harvest protocols (specific methods, often with agreed limits) on the recovery of the target resource; and
- make the needed adjustments in harvest protocols to maintain the target resource at sustainable levels.

These tasks therefore need to be included in the project or operation management plan. The management plan should:

- state the specific management purpose and the steps taken to achieve it (including the assessment and monitoring plan);
- clearly identify priority issues, species, and the appropriate management scale;
- incorporate and build the capacity of collectors, local communities, and other stakeholders to manage MAP resources sustainably;
- enable enforcement of management rules (such as collection limits);
- support the contributions of MAP resources to social, economic, health, and other local community goals;
- be reliable and sufficiently accurate; and
- be affordable in terms of time and other costs.

This guide gives an overview of five (5) basic steps needed to design and carry out a resource assessment and monitoring process that meets the requirements of the ISSC-MAP, and uses participatory and adaptive management approaches (Figure 2).

Step 1. Situation analysis to gather and evaluate existing knowledge about target or candidate species and the collection situation;

Step 2. Base-line inventory to understand how much of the target/selected species is present within the collection area;

Step 3. Yield and regeneration studies to understand how much of the desired raw material / plant part(s) the target species produces under natural conditions, the time required for seedlings to replace harvested individual plants and size-classes, and how productivity and regeneration vary across the collection / management area;

Step 4. Assessment of harvest impacts to determine whether current harvest levels and controls are resulting in adequate resource regeneration and productivity; and

Step 5. Periodic monitoring and harvest adjustments to revise the harvest protocol if the intensity, frequency, timing, and methods of harvest are not sustainable.

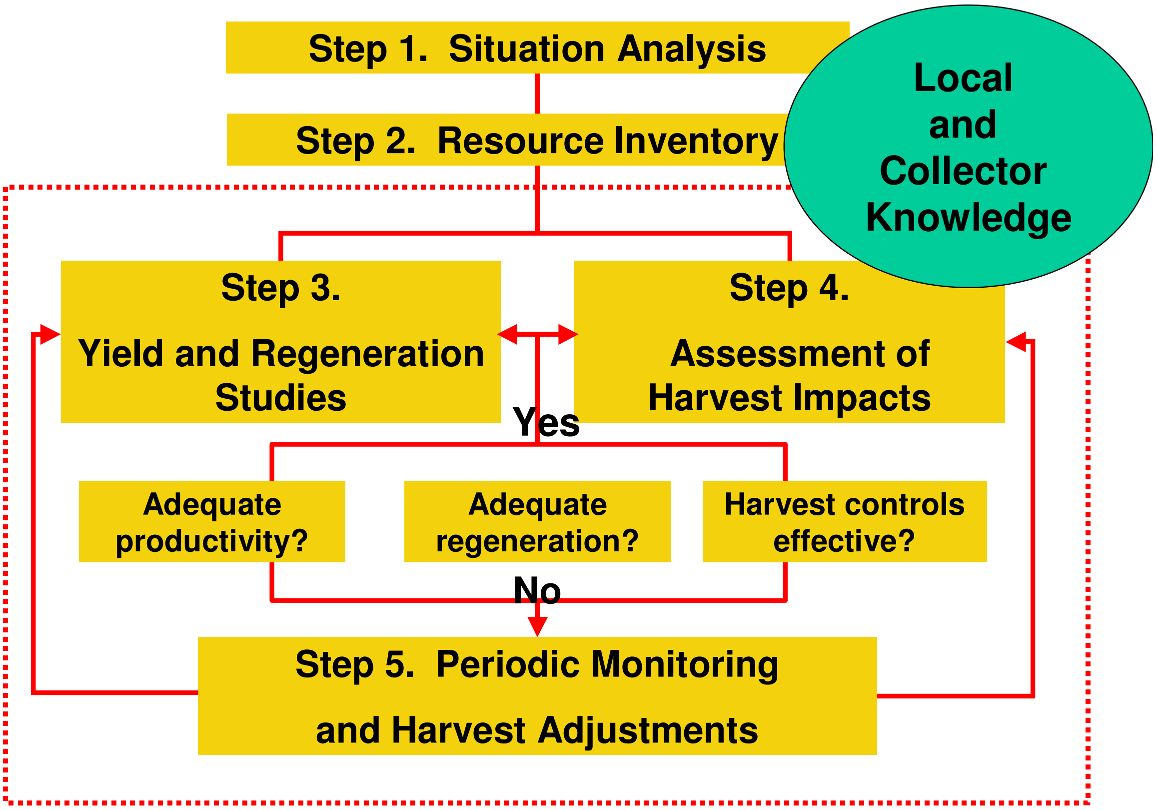

Figure 2. Resource assessment framework for ISSC-MAP within an adaptive management process

Each specific collection situation might involve a different starting point for designing a resource assessment and management plan (Box 2).

Box 2. Starting points for resource assessment

Planning a resource assessment may be considered from several distinct starting points:

A. A target species and collection area have already been identified (selected), and commercial wild-collection already exists in response to an existing market demand. The main resource assessment questions to be answered in this situation are:

- Does current demand exceed supply at sustainable levels of wild collection?
- Does the current collection operation meet resource management requirements for sustainable wild collection?
- If not, what changes are needed and possible, within limitations of time, effort, and capacity?

B. The target species identified (selected) is not yet wild-collected at commercial levels, but commercial collection is desired (a commercial level of demand exists or is likely). The main resource assessment questions to be answered in this situation are:

- Is sustainable wild-collection at commercial levels likely for the target species?
- If so, what resource management conditions are needed and possible, within limitations of time, effort, and capacity to meet requirements for sustainable wild collection?

C. A target species has not yet been identified (selected). Assuming that the relevant questions concerning market demand are also being addressed, the main resource assessment question to be answered in this situation is:

- For which species is wild collection at commercial levels most likely to be sustainable, least complex, and least costly in time and effort?

Management of wild plant resources, including medicinal and aromatic species, is complex and characterized by high levels of uncertainty about population size, growth rates, variation in yields and, not uncommonly, even the correct identity of the medicinal plants being harvested. There are great variations in the time and effort required for resource assessment depending on factors such as the terrain, species diversity, and expertise available in each situation. It is therefore very important, during the situation analysis, to carefully consider the impact of these factors on the costs and complexity of resource assessment and management (Box 3). Considering these impacts will lead to more effective design and implementation of resource assessment and monitoring as part of an adaptive management planning process, and therefore to more effective resource management outcomes. An adaptive management plan provides the foundation for developing a programme of sustainable use to reach a balance between resource demand and resource supply.

Box 3. Questions to ask yourself before you start

The costs and complexity of adaptive management plans for medicinal plants increase rapidly with increasing diversity of species and uses, larger number of harvesters or quantities harvested. Before designing a resource assessment and monitoring process within the overall management plan, you need to ask yourself several questions:

- What is the overall objective (e.g., maintaining a viable population of a target species; maintaining biodiversity values within the habitat, or maintaining ecological function, such as hydrology)?
- What resource assessment questions are you trying to answer? (See Box 2)
- What is the control? (For example, is the assessment comparing heavily harvested to unharvested sites?)
- What other factors are affecting the same resource (and how can these be distinguished from what you are monitoring)?
- At what spatial and temporal scales will you be working (i.e. what is the scale of change, how big, and where)? (See Box 4)
- How precise do you want (need) your surveys to be (e.g., precision of 5%, 10% or 20%) and what is the trade-off between cost and precision?
- Who will do the work, how participatory do you need to be, and what training needs are required before you start?
- Who will analyse the data?
- Who will act on the results (and who will translate the results into a suitable format for decision-makers)?
- How long will it be before decisions on resource management options will be made?

(Source: Cunningham, 2001)

Choices will need to be made concerning the degree of rigour needed to meet ISSC-MAP requirements (and compliance levels for ISSC-MAP) and who will do the monitoring (see Box 4). The main choices are: professional monitoring, participatory (collector / community) monitoring, or no monitoring at all. These choices imply different levels of precision, cost, and complexity. Decisions need to be carefully made, as assessment and monitoring can divert scarce resources away from conservation or other priorities while being of little management value (Sheil, 2001). On one hand, if the costs of a highly rigorous approach are unaffordable, then implementation is unlikely to happen, even at the basic survey stage, let alone relocation of a large sample size of randomly located plots. On the other hand, there is little management value in collecting anecdotal data.

Box 4. Participatory processes and "data-less management"

> *The results of inadequate monitoring can be both misleading and dangerous not only because of their inability to detect ecologically significant changes, but also because they create the illusion that something useful has been done.* (Legg and Nagy, 2006)

There are successful cases that bridge the gap between scientific rigor and the need for local participation for resource management action. There are two common "bridges" over this gap. First, through participatory research, supported by good scientists, leading processes that retain stakeholder ownership of indicators, while improving the accuracy, reliability and sensitivity of data collection (Reed et al., 2006). Second, through expert scientists partnering with local people to develop precautionary approaches through combined knowledge – a process termed "data-less management" (Johannes, 1989). What Johannes (1989) pointed out for the complex marine systems he studied is as valid for adaptive management of medicinal and aromatic plants:

> *Data-less management does not mean management without information. Even in the remotest un-researched areas…it comes from two sources. The first consists of the knowledge gained from research on other, similar systems. The second source…is the knowledge possessed by fishers concerning their local marine environments and fisheries. This knowledge can be extremely useful for management purposes; in some areas it has proven to be encyclopedic.*
>
> *Conventional biological training has focused our attention so single-mindedly on the rigorous quantitative description of … resources before committing ourselves to managing them, that we are liable to feel guilty if we diverge from this track – and worse still, may even criticize others who do so. But when vital resources are rapidly degrading…we often have neither the time nor the resources for such data-gathering. The choice is not between giving perfect or imperfect advice to managers. It is between giving imperfect advice or none at all.*
>
> *Data-less and data-poor management are, under the circumstances, not just valid alternatives. They are an imperative. It may be argued that such activities are not science. But surely this is immaterial. Doing them well will not be easy, and success will depend heavily on good scientists helping … communities and government management agencies to plan objectives and controls.*

Table 1 summarizes some of the methods used to enable the participation of local communities and collectors in resource assessment, with some notes on the contributions and advantages, as well as the challenges associated with these methods.

Table 1. Contribution of local knowledge and practices to resource assessment

Methods	Contributions / advantages	Challenges
Overall process Participation of local resource users / collectors in resource assessment and management	• Motivates and stimulates interest of local users / collectors • Reduced need for professional field staff and time in field • Local employment opportunities	• Need appropriate equipment, training, and compensation • Literacy and numeracy obstacles
Situation analysis Participatory mapping	• Mapping collection area • Mapping resource distribution	• Interface with “official” area maps
Situation analysis, assessment design Participatory Rural Appraisal	• History and general trends of resource use, collection, harvest impacts • Prediction of likely impacts of harvest levels and practices • Causes and history of other non-collection disturbances	• Participation of local communities / collectors in deciding what questions are important • Making local / collector engagement worth their time and effort
Harvest impact assessment and monitoring Local user / collector observations to collect field data	• Resource users perceptions as to why scarcity has arisen • Identify alternative harvest practices • Reassessment of local decisions on land-use options	• Setting quotas and human carrying capacities if appropriate • Development (or reassessment) of local rules which set limits on who or how many people will harvest from a set area and on harvest methods
Yield studies and monitoring	• Greater awareness of resource limits compared with demands • Change in harvest methods more readily understood and adopted.	• Use of local systems of measurement (with calibration to a more universal standard) • Development or reassessment of local rules / limits on harvest (e.g., number of harvesters per area)
Regeneration studies and monitoring	Local knowledge indicators • Change in distribution • Change in time required to collect a specific quantity	• Locate plots where a long history of collection has changed population structure, and at the resource frontier where the least collection has occurred.
Field work, record keeping Use of field computers / palm pilots to record observations	• GPS-linked data/records • Can overcome literacy and numeracy obstacles • Facilitates quick and easy data processing, storage, retrieval for analysis: o Large amounts o Over large areas o Over long time • Can also be low-tech, e.g., dbh rulers using visual rating system and size-class symbols rather than a number scale.	• High cost of equipment vs paper • Need strong technical support • Regular access to electricity, batteries, main computer to download data • May be most appropriate for conservation programmes and rural development projects • Use symbols or icons rather than numbers. E.g., icons need to illustrate rating systems, e.g., of harvest impacts

Source: Cunningham (2001)

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STEP I. SITUATION ANALYSIS

The situation analysis provides a foundation for later steps in the resource assessment process. The situation analysis should address not only the ecological factors that influence the sustainable use of a specific resource, but also social, legal, economic, and broader environmental factors[1]. The situation analysis contributes to:

- selection of target species with good potential for sustainable wild collection;
- information about the target species biology and what drives species population dynamics (see Box 5);
- correct identification of target species (even when collection is underway, local names or trade names may in fact cover several species in the same genus) (see Box 6);
- understanding and reducing the potential impact of resource assessment and monitoring methods on the target resource itself, on other species, and on the habitat;
- identification of gaps in knowledge and capacity; and
- understanding the level of effort and precision required in resource assessment methods and for ongoing resource management for the target species.

Box 5. Scale of disturbance and influence on medicinal plant resource management

Achieving sustainable harvest and effective management of medicinal plants requires us to deal with complex socio-ecological systems and in some cases, to support policy reform processes. Dealing with social, cultural and policy processes may seem complex enough – but we also have to realise that the factors driving the increase, maintenance, or decrease in plant populations may be beyond the species-population level. Dealing with factors causing habitat fragmentation is an obvious example. What is also required in many cases is to understand the disturbance requirements of species within particular habitats (fire, grazing, mowing). Forty years ago, as a last resort to save declining populations of *Orothamnus zeyheri* (Proteaceae), an endangered plant in the Cape region of South Africa, conservation staff used fire as a disturbance tool to stimulate germination from seed. In Europe, alpine pastures and meadows traditionally managed for hay have a high plant species diversity and high conservation significance (Myklestad and Sætersdal, 2004). In Switzerland, for example, viable *Arnica montana* populations are managed through maintaining grasslands by mowing, a disturbance regime that suits this species (Ellenberger, 1999). In temperate forest, the under storey medicinal shrub *Arctostaphylos uva-ursi* resprouts vigorously after the habitat is burnt or cut (Calvo et al., 2002). In forests, light demanding tree species grow best when canopy gaps form, or along forest margins, with some species geared to large-scale disturbance events (e.g.: due to hurricanes) (in “coarse-grained” forests), while others are suited to small gaps due to tree falls (“fine-grained”). This understanding is crucial for resource management plans.

At a global scale, even climate change through global warming can have serious implications for habitat-specific alpine medicinal plants. While it is not possible to deal with global warming in the short term, it is crucial to invest time in understanding what influences the population biology of medicinal plants at different spatial and time scales, so that we use appropriate tools to deal with each species.

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[1]These include other environment and habitat factors (ISSC-MAP Section I), legal and ethical factors (ISSC-MAP Section II), as well as management and business factors (ISSC-MAP Section III) that influence whether the target species / resource can be collected in a sustainable manner from wild populations. (Medicinal Plant Specialist Group, 2007).

Box 6. Know your species

Knowing exactly what species you are dealing with is crucial for design of a resource assessment within an adaptive management plan. This may seem obvious, but often it is not. Trade names and local names may, in fact, cover several species in the same genus or even different genera, each with different responses to harvest, different habitat preferences, and different conservation status. The popular Chinese medicine *duhuo,* for example, refers to several *Heracleum* species. Conversely, many local names may refer to a single species. The southern African medicinal tree *Curtisia dentata*, for example, has eight different Zulu names. In addition, rising scarcity often results in substituting one herbal product for another, such as aphrodisiac bark from *Pausinystalia johimbe* being mixed with bark from *P. macroceras*, or *Ocotea bullata* bark substituted with bark from *Cryptocarya latifolia* or *C. myrtifolia*. To make sure you get the correct needed for a resource assessment, make sure you know which species you are dealing with. Good quality herbarium specimens identified at a national or international herbarium provide a good start. (See, for example, Lawrence and Hawthorne, 2006.)

The type of information that needs to be gathered, analysed, monitored, and considered within the collection management process will be different for each target species and collection operation. Procedures for carrying out a situation analysis are summarized in Table 2. The principal output based on the situation analysis should be a situation report.

Table 2. Summary of procedures for situation analysis

	Task	Notes on methods / related guidance
1.	*Planning* Select target species for ISSC-MAP application.	• In many cases, the target species has already been selected, based on existing or demonstrated potential for commercial wild collection. • In cases where target species are not yet selected, evaluation of conservation status (see Box 7 and Task 4 in this table) and the potential for sustainable wild collection (See Task 5 in this table, and Table 3) should be undertaken for candidate species, along with appropriate market studies.
2.	*Field work* Ensure correct identification of target species	• Voucher specimens (with flowers, fruit, seed) from the collection / management area, authenticated by a taxonomist / botanical institution. • Field herbarium including identification aids (e.g. dried specimens, field guides, photographs, local knowledge of taxonomic indicators) for o target species in each stage of the life cycle (e.g., juveniles, bark and non-reproductive structures) o any other species that might be confused with the target species by the resource assessment team / collectors. • Training for resource assessment team / collectors. See Lawrence and Hawthorne (2006)
3.	*Desk and field work* Gather relevant information about the	• The ISSC-MAP principles, criteria, and indicators define much of the information required for the situation analysis. A

	Task	Notes on methods / related guidance

	target species and collection area.	questionnaire template based on the ISSC-MAP is provided in Annex 1. This template can be adapted for specific project situations.
		• Information sources should include:
		  o Published scientific sources
		  o Experts (ecologists, taxonomists, resource managers) familiar with the target species and the collection area
		  o Local community and collector knowledge and expertise (participatory processes, open-ended interviews)
		• Information about the target species should include:
		  o Conservation status (if known – see Box 7)
		  o Parts collected and related market requirements / quality preferences
		  o Current collection protocols (parts collected, preferred age/size-classes, methods, frequency and intensity
		  o Estimated volume/per area, history of collection
		  o Importance of the species for the company and collectors community
		  o Special functions in the ecosystem (e.g., ecological or cultural keystone species).
		• Information about the collection area should include:
		  o Ownership / resource tenure
		  o Ecological and social description of the area
		  o Identification of sensitive / protected species
		  o Protected or sensitive sites
		  o Maps
		  o Sites within the collection / management area not suitable for collection
		  o History of land use and management (e.g., wild plant collection, forestry, grazing, fire).

4.	*Analysis* Assess the conservation status of the target species	• The relevance of assessing conservation status according to IUCN Red List categories and criteria is summarized in Box 7. The IUCN Red List categories can be found in Annex 2 of this guidance document, and the complete categories and criteria in IUCN (2001). • To determine whether the global conservation status of the target species has been evaluated according to the IUCN Red List categories and criteria (version 3.1,2001): consult the website http://www.iucnredlist.org/search/search-basic and search for the target species (typing the Latin name in the text search box). • To determine whether the conservation status of target species has been evaluated according to national or sub-national (e.g., provincial) level criteria, consult the relevant species protection authorities of your country (e.g., national / provincial threatened species lists). • Collection must comply with any existing international, national, or sub-national requirements for protection. • Target species that do not appear on any of these lists may be threatened, but have not yet been assessed. These must be evaluated, at minimum, using IUCN RapidList

	Task	Notes on methods / related guidance
		(http://www.ramas.com/RapidList.htm), and preferably according to the full IUCN Red List global categories and criteria (IUCN, 2001). • Expertise in IUCN Red List assessment will likely be required (e.g., from the IUCN/SSC Medicinal Plant Specialist Group). In some countries, the botanical expertise required to complete conservation status assessments is available from botanic gardens, herbaria, and other research institutions. • For most ongoing collection operations, the collectors and resource managers will be able to contribute much of the information required on trends in population distribution and size required for conservation status assessment.
5.	*Analysis* Estimate the potential for sustainable wild collection.	• Information gathered during the situation analysis about the target species and the collection area can be used to make a preliminary estimate of the likelihood for sustainable wild collection (see the decision matrix in Table 3). • This information can also be used to estimate the levels of accuracy and precision likely to be required to conduct an adequate resource assessment and to monitor impacts of harvest. • This information can also be used to estimate the relative cost and complexity of resource assessment, monitoring, and management for target species. • These estimates are useful for selecting target species for commercial wild collection (Task 1 in this table), as well as for designing appropriate management plans.
6.	*Evaluation and reporting* Prepare a situation report	The situation report should include: • Descriptions of the target species and the collection area • Maps defining the boundaries of the collection / management area, key populations of the target resource, conservation or other sensitive areas for protection, trails and roads, communities, overlap with other management areas. • Proposed objectives of the resource assessment • Appropriate methods for resource assessment, including monitoring plans, levels of accuracy and precision • Available knowledge and capacity, as well as gaps in knowledge and capacity • Partners needed • Bottle-necks and critical interventions needed

Box 7. Conservation status assessment and the IUCN Red List

The IUCN Red List Categories and Criteria are intended to be an objective and widely applicable system for estimating and classifying the risk of extinction to species at the global level. This system for evaluating conservation status of species can be applied consistently by different people in different situations.

A Red List assessment can answer questions relevant to sustainable use of wild-collected resources, such as:

- How threatened is a particular species relative to other species?
- What are the threats to a species?
- How important are specific populations to the overall conservation status of the species?
- How do different factors (e.g., trends in population size and distribution) affect the risk of extinction?

Extinction is a chance process. Thus, a listing in a higher extinction risk category (see Annex 2) implies a higher expectation of extinction, and over the time-frames specified more taxa listed in a higher category are expected to go extinct than those in a lower one (without effective conservation action). However, the persistence of some taxa in high-risk categories does not necessarily mean their initial assessment was inaccurate. It may mean that they are receiving the careful and informed assessment, monitoring, and management needed to enable their survival.

The pre-assessment matrix in Table 3 outlines a number of conditions / factors of plant species and populations, many of which can be learned from the situation analysis. Using this knowledge, the pre-assessment matrix can be used to:

- assist projects in selecting species appropriate for ISSC-MAP applications (i.e., to give a rough indication of the likelihood of sustainable wild collection);
- identify important information gaps for conservation status assessment and resource assessment
- assist projects in determining the amount of accuracy and precision that will be needed to adequately assess and monitor the sustainability of harvest volumes and practices in the context of the ISSC-MAP; and
- estimate the relative cost and complexity of resource assessment, monitoring, and management for the target species and the collection area.

Table 3. Pre-assessment matrix for ISSC-MAP target or candidate species

Condition/factor			
***Geographic Distribution**	Wide	Limited	Restricted
***Habitat Specificity**	Broad (more even distribution)		Very specific (patchy distribution)
***Local Population Size**	Large	Medium to large	Always small
***Growth Rate**	Fast	fairly rapid	slow
***Part of Plant Used**	leaves, flowers, fruit	exudates, sap, dead wood *	whole plant, bark, roots, bulbs, apical meristems
***Single vs Multiple Use**	single or non-competing	few, low conflict between uses	multiple-use species
Single vs multiple groups of users	One company or community of collectors	More than one company / community collects, but with clear management agreements	More than one company / community collects without management agreements
Reproductive Biology			reseeders, weak resprouters
• **pollination**	wind, abiotic, asexual	common biotic (birds, insects)	highly specific (beetles, bees, bats) Australia/So. Africa
• **dispersal**	wind, water	common generalists (birds, small mammals)	large mammals and large birds
***Ecosystem complexity**	vegetation dominated by few species (<5)	low diversity (e.g., savannah) (<10 tree spp./ha)	high diversity systems
***Conservation status and value**	Collector knowledge and other indicators suggest stable and surplus species abundance, distribution, or quality		Collector knowledge and other indicators suggest reductions in species abundance, distribution, or quality
Phylogenetic distinctiveness	Large genus (e.g., *Astragalus*)	Medium – large genus	Monotypic family or genus (e.g., *Nardostachys*)
	↓	↓	↓
Likelihood of Sustainable Wild Harvest	**HIGH**	**MEDIUM**	**LOW**
Precision, accuracy required for inventory, monitoring, and management	**LEAST**	**MEDIUM**	**GREATEST**
Costs and complexity of monitoring and management	**LOW**	**MEDIUM**	**HIGH**

Based on Cunningham (2001) and Peters (1994).

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STEP 2. RESOURCE INVENTORY

The central question for a resource inventory, in the context of the ISSC-MAP, is:

How much of the target species is present within the collection area?

An inventory provides information about the quantity (sometimes called the "standing stock") of the target resource by estimating both resource density (number per unit area) and abundance (total number in a specified area).

An inventory of the target resource provides a base line for monitoring changes in resource quantity in the collection as a result of collection management or other impacts. Resource inventory results can also be used to:

- locate the most efficient and effective collection / management areas for a target resource (combined with information from vegetation and land-use mapping);
- define appropriate management and monitoring scales (e.g., population, species, habitat)
- estimate the sustainable harvest limit of the target resource (combined with yield study and recovery time data); and
- examine the population structure and dynamics of the target species (combined with regeneration and demographic study data).

A summary of procedures used for carrying out a resource inventory is outlined in Table 4. Appropriate methods and approaches for collecting baseline inventory data must be selected case-by-case, depending on characteristics of the target species, the collection site, and the collection operation that have been examined and documented during the situation analysis (Step 1). Important things to consider include:

- collector / community participation enables community members to plan and conduct the inventory, and to compile, own, and use the inventory results. Non-community members might be involved as facilitators, advisors, or trainers.
- using local knowledge and skills, as well as existing research capacity and skills;
- location and arrangement of sampling sites for inventory and subsequent monitoring (There are many factors to consider in the location and arrangement of sampling sites for inventory and monitoring. These are summarized in Annex 3.); and
- appropriate accuracy and precision versus costs/ time and budget constraints (e.g., equipment, expertise, time and labour, combining one study with other studies, ease of access to target resource collection area / terrain – see Box 8).

Table 4. Summary of procedures for base-line inventory

	Task	Notes on methods / related guidance
1.	*Planning* Define the focus and scope of the inventory	Purpose, area, target resources/populations, other data (e.g. habitat, landscape) – see Stockdale (2005), pp 146-7.
2.	*Planning & field work* Establish / select sample populations of the target	• Selection of appropriate sites for evaluation of harvest impacts; location of control plots If target species are

	Task	Notes on methods / related guidance
	species in plots or transects.	collected from different areas / habitats under different types of environmental pressures, it is important to assess these different conditions. • See Annex 3 on location and arrangement of sampling areas (plots, transects)
3.	*Planning* Determine minimum age/ size-class of individuals to be included in the inventory.	• Less abundant species → use smaller diameter age / size-class or plant height as cut-off = greater rigor/more precise inventory • Rules of thumb: o large canopy trees: ≥ 10 cm DBH o Understory trees: 5 cm DBH o Shrubs, small palms: 50 cm age classes or • Take the interval between largest and smallest individuals, divide by the number of size-classes desired / required (e.g., 6-10) to obtain size/age class intervals. • The smaller the minimum size, the greater the time and costs involved in the inventory. • See Box 9 on age / size-classes and recovery after harvest, and Box 10 on age / size-classes for bulbs.
4.	*Field work* Count or estimate the number of individual plants in the target population(s) within the defined collection area [sample populations] and, when counting, measure size	• Some methods suitable for different plant life forms and types of resources are summarized in Annex 4 (e.g., diameter-at-breast-height (dbh) for trees, height for herbs, smaller woody species). • Care is needed to select methods suitable for patchiness of species distribution and habitat/vegetation types in collection area.
5	*Field work* Other observations	• Habitat, vegetation type • Soil type, conditions (degradation) • Impacts of other / outside harvesters can affect species and size-class selection. • Impacts of other uses (browse, fire, management for other uses) can have a larger affect on population dynamics than harvest.
6.	*Analysis* Calculate estimated resource abundance and density (and precision)	According to habitat type, age/ size-class, other relevant relationships.
7.	*Reporting* Prepare an inventory report	Data results tables, purpose and objectives of inventory, methods, results, conclusions.
8.	*Analysis* Use size and number data to determine population structure/ size-class distribution of target species	Plot data as a histogram for collection area, or different habitat types in collection area (see Figure 4). Few data are available for size-class distributions of wild populations

Box 8. Precision and costs of resource inventory

In one of the few studies of the time costs of resource inventories for management planning and monitoring, a 23% decline in a rattan population was the minimum rate that could be detected with a 95% confidence by two surveys a year apart, each with a precision of 10% (Evans and Viengkham, 2001). Given that even further declines are likely before management action may take place, it is a serious concern that the low precision in detecting major population declines are so difficult to detect. The level of effort for this level of precision is very high, however, requiring a team of 6 people 55 days for transect surveys for a single rattan species in 10 km^2 of forest. In this case, the survey time costs made surveys with greater than 20% precision unaffordable. A precision level of 5% would detect a 1% population decline, but would require an even greater level of effort – 158 days for a team of six people to undertake transects in 10 km^2 of forest. In many cases, medicinal plant harvesters use far larger areas in very rugged terrain. This extent of effort is just not practical in many countries. Careful consideration therefore needs to be given to inventory and monitoring methods.

Box 9. Plant age, rotation times, and recovery after harvest

Being able to age medicinal plants is of great value for understanding recruitment, the time taken to shift from one size class or stage to another and in developing matrix models of plant populations. Slow growing plants take much longer to make the transition from one size-class to the next and how low yields. The first size classes regenerate either from seed or through vegetatively as clones from the parent plant. Information on how a plant population is regenerating provides valuable data for resource management purposes and is widely used in management planning for sustained-use management.

Although techniques have been developed for ageing plants (see Cunningham, 2001, Chapter 4), this is unknown for most lowland or montane tropical species. Therefore, in contrast with life-tables for animal populations, which are usually based on age, studies of plant populations are generally based on size-class distributions. Measurements of stem diameter (or length) are made on the basic assumption that stem diameter (trees, bulbs or corms) or stem height (palms, tree ferns) reflects plant age. One of the reasons for making this assumption is that accurately ageing plants is difficult for most species, particularly in the tropics and sub-tropics. Tree stems, bulbs and corms get thicker as these plants grow older and diameter size classes are therefore used as the most appropriate measure for grouping them into size classes. Most palms and tree ferns have an apical meristem, growing upwards (longer) as they grow older more than they increase in diameter. For these reasons, stem length rather than stem diameter is a more accurate measure for assessing the population structure of palms, cycads, grass trees and tree ferns. Plants within a sample population are then grouped into size classes based on stem diameter (trees, bulbs) or stem length (palms, tree ferns). Indications of population structure indicate the chance of plants in one size class have in surviving into the next size class. These are used as a tool to understanding plant population dynamics, most commonly for trees.

Information on the age of harvested plants is a key to many issues in resource management. It also leads to a better understanding plant life histories. Where it is possible to age perennial plants, this provides valuable information for resource users, managers and researchers in predicting yields, understanding recovery times after harvest, and appropriate harvest rotations that reflect how long a harvested population takes to recover before it can be harvested again.

Slow growing, slow reproducing plants are known to be vulnerable to over-exploitation, yet we rarely know how old individual plants are or how long they live. This information is not only of great interest in developing resource management programmes, but also to local resource users, who often underestimate the age of slow growing (and therefore vulnerable) plant species.

Box 10. Medicinal bulbs: how old is what's sold?

Harvesting of medicinal corms, bulbs or tubers results in the whole plant being dug up. The impact of this destructive harvesting at a plant population level depends on size-class selection of the corm, bulb, or tuber and on the reproductive strategies of the species. The size-class of geophytes that are harvested and the proportion of the population removed have an important influence on recruitment of young plants (as larger, older plants produce more seed). Size also influences the ability of the species population to survive fires or drought.

Few data are available for size-class distributions of wild populations of medicinal plants harvested for bulbs or roots. This can be a very useful measure of population size-class distributions in sample populations, using bulb or lignotuber diameter, just as diameter at breast height (dbh) is applied in resource assessments and management of medicinal tree populations.

One of the few studies of medicinal bulb age for resource assessments showed that bulbs of Blue Squill (*Merwilla plumbea* (formerly *Scilla natalensis*) take at least 15 years to get to the preferred harvestable size (Williams et al., 2007). Bulbs with known ages, up to 25 years old, were examined. Some individuals probably live more than 50 years, yet in 2006, nearly 2.1 million wild-harvested *M. plumbea* bulbs were sold. This recent study showed that accurate age estimates can be derived from counting persistent bulb scales. Where land and resource tenure is weak, frequent harvest has a high impact on *M. plumbea* populations. Although this endemic southern African species is still abundant along the Drakensberg Mountain escarpment in South Africa, there are conservation concerns about this species at the margins of its range in Swaziland and in Lesotho. With increasing trade in herbal medicines, the complex interplay of harvest impacts, fire ecology and tenure need to be faced if viable wild populations are to be maintained in the long-term.

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STEP 3. YIELD AND REGERNERATION STUDIES

Yield and regeneration studies, together, estimate the sustainable harvest yield of a target resource. The central question for these studies, in the context of the ISSC-MAP, is:

How much of the target resource (quality and quantity) can be harvested season after season without damaging the long-term stability of the target species populations?

Yield studies

The central question for yield studies, in the context of the ISSC-MAP, is:

How much of the desired raw material (quality and quantity) does the target species produce under natural conditions?

Yield studies estimate the total harvestable yield -- the average amount of the target resource that can be collected from the collection / management area in one harvest (or one season, for plants that regenerate the harvested material).

Yield study results can also be used to:

- provide a baseline needed to balance demand with supply of the target resource (see Box 11);
- monitor the ecological impacts of collection (and other factors) on population structure and regeneration of the target species;
- delineate management zones (e.g., for rotating harvests of approximately equal yield) by providing information about different levels of the target resource yield across the collection /management area (combined with resource inventory data).

A summary of procedures for carrying out yield studies is outlined in Table 5. As for resource inventories (Step 2), appropriate methods and approaches must be selected case-by-case, depending on characteristics of the target species, the collection site, and the collection operation. Methods that promote community participation and the use of local knowledge and skills, and that allow appropriate levels of accuracy and precision, should also be considered. Advantages and disadvantages of combining yield studies with other studies and harvest activities are summarized in Annex 3.

Table 5. Summary of procedures for resource yield studies

	Task	Notes on methods / related guidance
1.	*Planning* Define the focus and scope of the yield studies.	• Resources / species to be studied • Size-classes included in the studies (e.g., only the size-classes of resources that would be harvested in a commercial operation). • Specify a standard harvesting method for the yield studies. • Define the type of "yield" to be studied: o Harvested yield = actual amount of resource harvested,

	Task	Notes on methods / related guidance
		or o Potential yield = amount possible to be harvested (but not actually harvested in the study)
2.	*Planning* Select sample populations to reflect variables likely to affect yield.	• Age / size-classes as defined through analysis of inventory results (Step 2) • Vegetation / habitat types (identified during the resource inventory, Step 2) • Objective system of sample selection (random or systematic) • Samples drawn from across the collection / management area • For long-lived species, mark the sample individuals (e.g., with paint) so that they can be included in the monitoring • Accuracy and precision considerations: o minimum of 3-5 individuals per size/age class and vegetation type (but same number of individuals from each) o maximum of 6 age / size-classes See Annex 3 on location and arrangement of sampling areas (plots, transects)
3.	*Field work* Measure or estimate the target resource yield of each individual included in the sample.	• Direct measurement requires actually harvesting the target resource. For resources considered too valuable to harvest during a yield study, yield may be estimated. • Local / collector participation: for species currently harvested, collectors can weigh, count, measure the actual amount collected during the harvest season, and estimate the amount of the resource left unharvested. • Measurements should be appropriate to the resource type and the primary user of the information (see Annex 4). Options include: o Counting (e.g., fruits, leaves) o Standard measurements of mass, volume, weight o Local measurements (e.g., arm-span) • Sampling may differentiate (observe or measure) relevant quality classes or resource grades (e.g., size, colour, flavour, shape)
4.	*Field work* Include observations that enable examination of relationships between yield and relevant factors, e.g., environmental.	Information about the forest type, topography, soil type and condition may already have been gathered during the resource inventory (Step 1). If not, they should be included in the yield study.
5.	*Analysis* Calculate or estimate the total harvestable yield (number of target species individuals in each age/size class x productivity)	Total target resource quantity of collection site: (i) The yield of the target MAP plant part for each plot (e.g., yield of 1 plot) = number of individuals of 1st size class x average weight of plant part of 1st size class (g or kg) + number of

	Task	Notes on methods / related guidance
		individuals of 2nd size class x average weight of plant part of 2nd size class (g or kg) + etc. (ii) (Maximum) yield of the target resource in the collection site = $$\frac{\text{sum of the yield of all plots (kg or tonnes) x size of collection area (}m^2\text{ or ha or }km^2\text{)}}{\text{size of 1 plot x number of plots (}m^2\text{ or ha)}}$$ Other useful calculations using yield data: • relative yield per hectare, indicates vegetation types (or locations in the collection / management area) with the highest / lowest yields of the target resource • relative yield per age / size-class, indicates the most / least productive age/size classes in the collection / management area Stockdale (2005) describes these calculations.
6	*Ongoing field work and analysis - monitoring* Repeat yield studies over several years. Use multi-year data to construct an average yield curve.	• Yield can vary from year to year (season to season), depending on weather and other variables. • Use data collected over several years to produce a yield curve (see Figure 3). • Yield curves can predict estimated annual production of harvested products according to plant size-class or on yields on a standing biomass/area basis.

Sources: Cunningham (2001), Peters (1994, 1996), Stockdale and Corbett (1999), Stockdale (2005), Wong et al. (2001).

Box 11. Factors affecting yield

In trying to reach a balance between demand and resource supply, it is important to know how much of a resource is produced within a known area. In the long-term, yields are influenced by the regeneration rate of the medicinal plant populations, which are influenced in turn by other factors such as the effects of harvest, seed predation or animal browsing.

Methods described elsewhere (Cunningham, 2001) for measuring plant size (diameter, length), volume, age, stem or foliage biomass, bark volume or directly counting annual leaf or fruit production are useful tools in this process. The study area would usually have been mapped on the basis of information from harvesters and an inventory of selected species carried out. In even-aged stands of fast growing species with annual aboveground production, such as *Cymbopogon* grass, an estimate of annual yield can be a relatively simple task, particularly when there is just a single use or where harvest impacts do not conflict with one another. In most cases, however, yield assessment is more complex, requiring measurement of yields of products from marked plants in different size-classes and plant density and size-class data from inventories to extrapolate annual yields to an area basis (eg: tonnes/ha/yr).

Yields often vary from year to year as well as with site differences in addition to variation with plant size (or age) class. For this reason, yields need to be measured over several years. Yield curves can then be developed to predict estimated annual production of harvested products according to plant size-class or on yields on a standing biomass/area basis. This information is of great practical value in making resource management decisions. Involving local harvesters in yield assessments can usefully lead to a greater awareness of the limits to resource yields compared to demand. This in turn can lead to development (or reassessment) of local rules which set limits who or how many people will harvest from a set area, on harvesting methods. In common with stakeholder participation in other forms of monitoring, local participation in yield studies requires motivated people back up by training and good export advice (see Pilz et al., 2006).

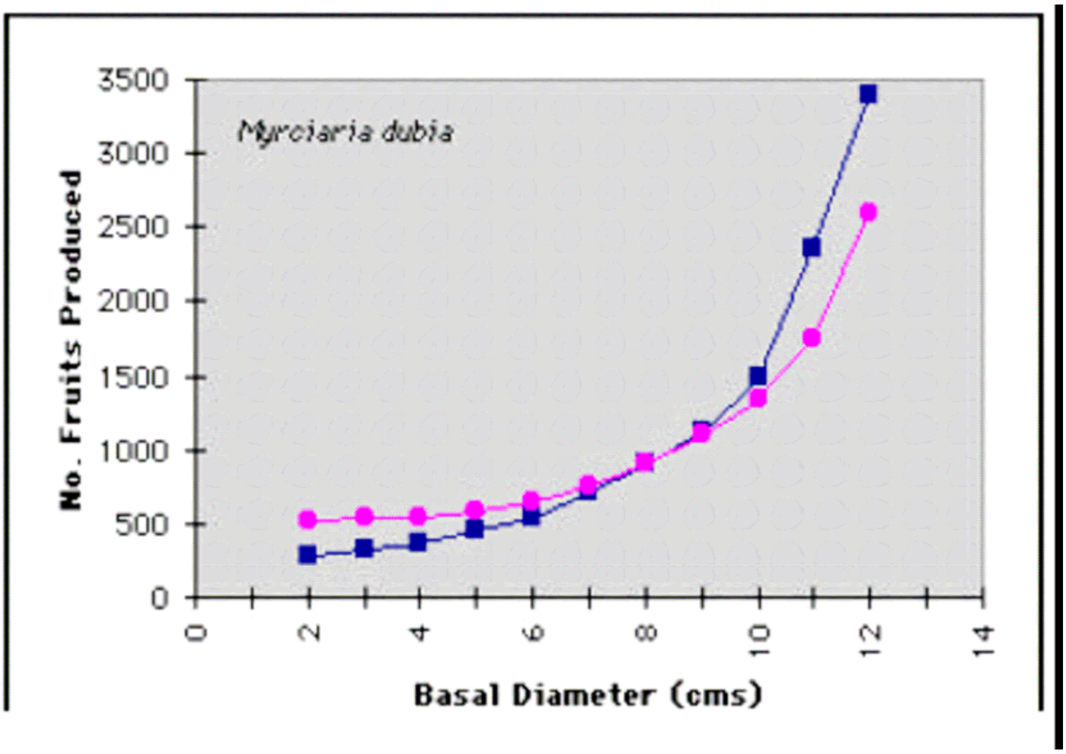

Figure 3. An example of yield curves showing annual fruit production as related to tree size for *Myrciaria dubia* plants growing in the lowlands of Peruvian Amazonia. Two years of fruit production data are shown. (Source: Peters, 1994)

Regeneration studies

The central questions for regeneration studies, in the context of the ISSC-MAP, are:

How does harvest affect recruitment of young plants into the population?

What is the regeneration rate of harvested populations / individuals?

Combined with resource inventory and yield data, regeneration studies estimate the sustainable harvest limit of the target resource. Regeneration studies can also be used to:

- compare the impact of different harvest treatments or management practices on target resource populations;
- monitor changes in population size and structure of a target resource; and
- estimate recovery time (the time taken for new plants to grow from seed to harvestable size);

Regeneration studies provide information about the impact of harvest on the long-term productivity and quality of the target resource by:

- detecting changes in the size-class distribution of the target species populations;
- monitoring the rate of establishment of new seedlings in the target population; and
- monitoring the density of seedlings and saplings in the target resource populations.

A summary of procedures for carrying out regeneration studies is outlined in Table 6. As for resource inventories and yield studies, appropriate methods and approaches must be selected case-by-case, depending on characteristics of the target species (see especially differences between "reseeders" and "resprouters", Boxes 12 and 13), the collection site, and the collection operation. Methods that promote community participation and the use of local knowledge and skills, and that allow appropriate levels of accuracy and precision should also be considered. To reduce field time and effort, regeneration studies can be undertaken together with resource inventories and harvest impact assessments.

Table 6. Summary of procedures for regeneration studies

	Task	**Notes on methods / related guidance**
1.	*Planning and field work* Establish a network of permanent regeneration plots throughout the collection / management area.	• Number of plots depends on current abundance of seedlings and samplings in different parts of the collection area. • High density populations require a smaller number of plots; scattered low-density populations require a more intensive sample. • Permanently mark each plot, map its location, or describe in sufficient detail to enable re-location. Forestry or plant ecology expertise may be needed to lay out an appropriate network of plots.
2.	*Field work* Observations and measurements	• In each plot, count and record the number of seedlings/saplings that are smaller than or equal to the minimum age/size class included in the inventory (Step 2). • Correct identification of young age classes of the target species is essential, and may require assistance of a taxonomist and training for field team members. • Data collection will be easier and faster if plants can be tallied according to size-class rather than measuring every individual included in the sample (e.g., group tree seedlings and saplings into height classes 0-50 cm, 50-100 cm, 100-150 cm, 150-200 cm; diameter classes 1-10 cm, etc.) • Smaller size-classes will be needed for herbs, shrubs, smaller trees, etc.
3.	*First analysis* Prepare a size/age class structure histogram and compare with inventory (baseline) results.	• Group plot results into the different vegetation types in the collection area and average the measurements for each size-class. • Estimate density and abundance for each combination of factors, e.g., vegetation type, size-class. • Combine these results with inventory data to construct a

	Task	Notes on methods / related guidance
		size-class histogram, providing a complete picture of population structure from seedlings to large adults (see Figure 4).
4	*Analysis* Assess current regeneration status of target resource	Use histogram to evaluate whether the number of young individuals in the target population(s) = the number of adults that will need to be replaced due to collection, natural death, other impacts.
5	*Ongoing field work and analysis - monitoring* Re-inventory regeneration plots periodically and compare with previous results.	• Re-inventory regeneration plots to monitor change in the number of seedlings and saplings recruited every approx. 5 years (or more frequently for recovery time studies). • Observations should include the survival or death of individual plants, and the size of the surviving plants. • Reduced rate of seedling establishment can be an indicator of over-harvest amongst obligate reseeders (see Boxes 12, 13) • Other factors (such as lack of disturbance, for example fire) may also play a role (as for *Orothamnus* described in Box 5). • If seedling/sapling numbers are declining (below base-line regeneration rates), harvest levels/practices are not sustainable and need to be reduced (see Figure 5). • If seedling/sapling densities remain above the base-line regeneration rate, the current level of harvest is likely sustainable. (Population structure and regeneration – see Stockdale 2005, p. 67)

Box 12. Regeneration surveys

Regeneration surveys add to the knowledge required for sustainable harvest. Harvesting roots, bark, exudates or stems from adult trees can result in reduced flower and fruit production. If this occurs, then the number of young plants in the population may decline. Even the efficient collection of an excessive numbers of large seeds from trees that produce relatively few large fruits can have a long term impact. The way in which plants reproduce therefore needs to be taken into account in better understanding resilience or vulnerability. Categorising plant species in terms of where they are on the continuum from "reseeders" (which regenerate primarily from seed) to "resprouters" (which reproduce clonally through production of new shoots) (Appendix XX), gives useful insights into the potential for sustained yield harvest and for the design of regeneration studies.

An investment of time and effort in long-term regeneration surveys monitoring the fruit harvesting impacts may be very appropriate in tall tropical forest, for example, where many canopy trees regenerate from seed (Peters, 1994). Medicinal seed harvests of *Carapa guineensis* would be a good example. A similar focus on regeneration from seed would not be a priority for long-lived medicinal species that are vigorous resprouters, as relatively few seedlings may bear no relation to frequency of those species in the forest or thicket canopy.

Regeneration is generally studied through establishing a series of plots scattered throughout the harvested area. Seedlings and saplings of focal species are counted within each plot. Where the focal species are medicinal trees, these young plants are usually tallied into height classes. For medicinal bulbs and corms, diameter size classes are used. Regeneration plots are then periodically re-assessed. Depending on the time and resources available, separate samples of young seedlings can be tagged to assess survivorship. Where possible, particularly in cases where medicinal species are not yet exploited, it is important to locate plots within unharvested areas for comparison. In many circumstances, this isn't feasible, but if it is possible, comparisons between harvested and unharvested sites are the most straightforward way to assess harvest impacts. Many factors can lead to population decline, so careful studies are needed to assess harvest impacts in relation to other factors.

Box 13. Characteristics across a continuum: long-lived reseeders vs. resprouters

Reseeders

- examples are common in the Proteaceae, Pinaceae, Ericacae and Podocarpaceae
- regenerate from seed, some maintaining canopy seed-banks ("serotiny")
- are single-stemmed, not multi-stemmed. Examine smaller shrubs closely. Some reseeders are single stemmed, but branch off close to the ground, giving the incorrect impression that they are multi-stemmed reseeders.
- don't resprout when the stem is cut
- usually are self-pollinated or have diverse pollinators
- vulnerable to extinction if dependent on specialist pollinators or seed dispersers
- seeds often germinate faster than those of reseeders
- produce abundant seedlings (a large "seedling bank")
- have higher growth rates than resprouters, as they allocate nutrient resources into growing upwards, rather than into underground storage organs. As a result, reseeder species in a particular vegetation type tend to be taller than resprouters.
- most short-lived compared to clonal resprouters
- often are habitat specialists (wetlands, moist montane sites, cool temperate forests)
- annual reproductive output is generally higher than in resprouting species

Resprouters

- maintain "bud-banks" rather than seed-banks, regenerating clonally by sprouting rather from seeds
- often multi-stemmed, some shedding stems as they get older
- produce new stems from buds which are above or below ground level (basal or upper trunk sprouting)
- cut stems show obvious signs of resprouting (but be careful here : resprouting vigour declines when trees are cut low down and with tree size or age)
- may have large underground storage organs (rhizomes, tubers, ligno-tubers) or lateral runners (eg: many forest lianas)
- recruitment from seed is infrequent and irregular
- may be pollinator limited, but can still maintain long-lived clonal populations consisting of a genetically identical clonal organism (the **genet**) which is made up of **ramets**, sprouted from buds each of which has the potential to grow and reproduce as independent, individual plants.
- few seedlings in the population, most small plants are ramets;
- grow slower than reseeders, as they have to put resources into underground storage organs and into protection and production of buds
- usually generalists, found in a wide variety of habitats, rather than habitat specialists

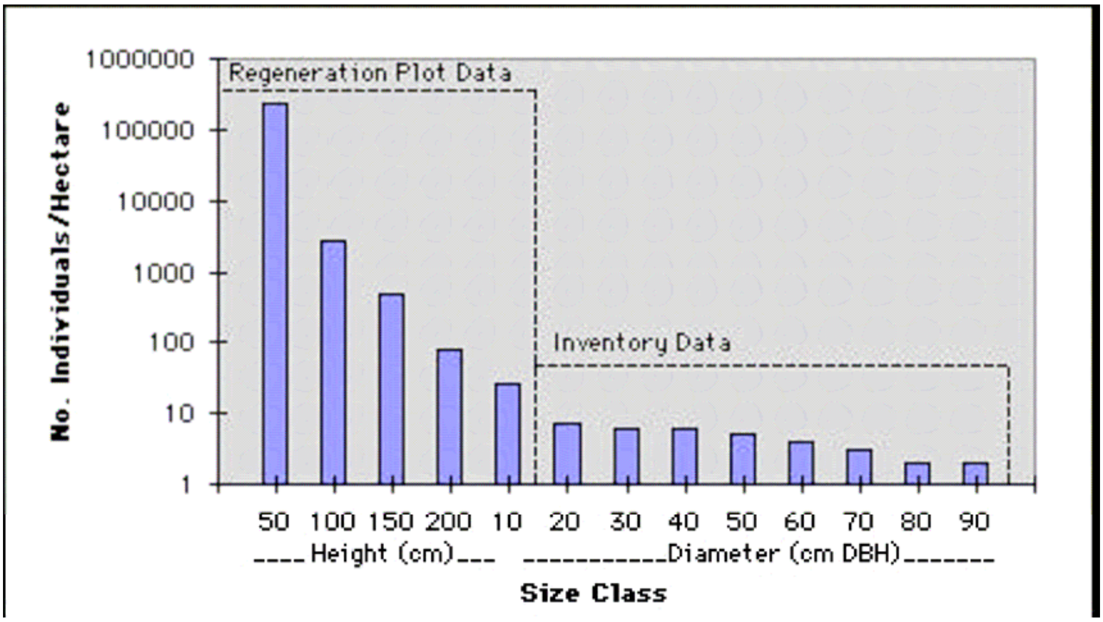

Figure 4. Size-class histogram for *Shorea atrinervosa* population illustrating the use of both height and diameter classes. Data from regeneration plots have been grouped into four 50 cm height classes and one 1.0 - 10.0 cm diameter (DBH) class. Inventory results are divided into eight 10 cm (DBH) diameter classes. Numbers shown along x-axis represent the upper size limit of each class. Note compressed, logarithmic scaling of y-axis due to the large range in values (e.g. from 3 to 250,000). (Source: Peters, 1994)

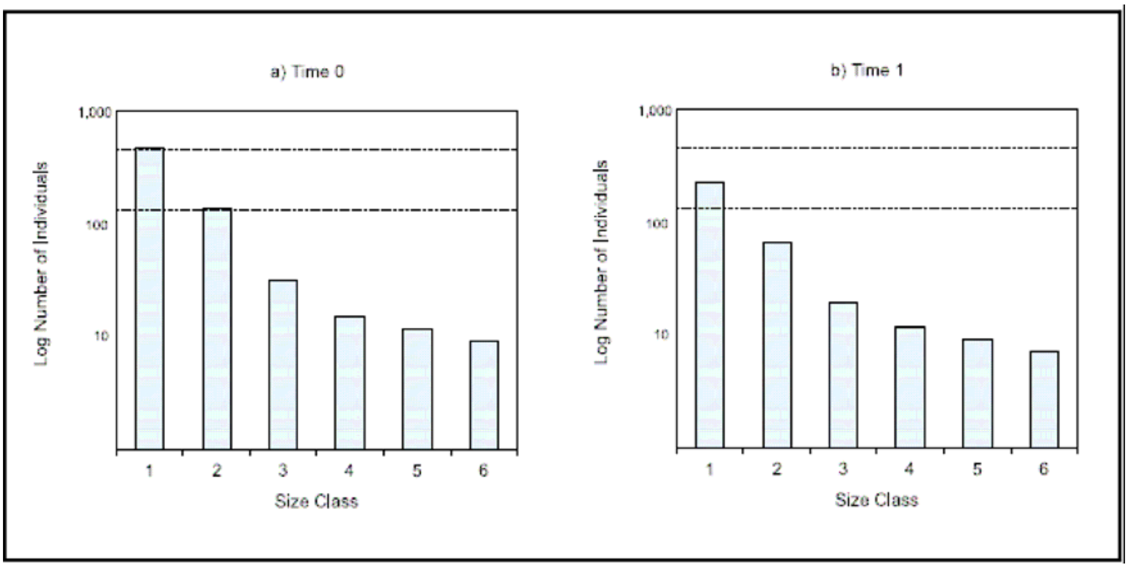

Figure 5. The regeneration size class structure at: a) the time of the first study; and b) five years later (adapted from Peters, 1996, by Stockdale, 2005). In this example, the number of young plants has dropped, indicating over harvesting.

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STEP 4. ASSESSING HARVEST IMPACTS

The central questions for assessing harvest impacts, in the context of the ISSC-MAP, are:

What is the impact of the current harvest protocol on the target population and ecosystem?

A harvest impact assessment provides information about the effect of specific harvest treatments (different intensities, frequencies, and methods) on the target resource (reproduction, growth, survival, vigor, yield, quality). This information is needed to define a sustainable harvest protocol for the target resource that takes into account site-specific variables.

Harvest impact assessments can also be used to:

- evaluate whether current harvest protocol is more or less successful in maintaining the target resource than alternative harvest treatments;
- evaluate the costs in time, money, and equipment of different harvest treatments;
- provide a visual appraisal of productivity and quality of target resource during ongoing harvest activity, enabling early detection of negative impacts, before a reduction in the rate of seedling recruitment occurs; and
- improve management practices (adaptive management).

Harvest impact assessments need to consider Important variables that influence harvest impact, including:

- nature, frequency, and intensity of harvest;
- whether harvest methods are destructive or non-destructive. (It can't be assumed that all harvest of fruit, for example, does not damage individual plants or the resource population. Often branches are removed or whole trees felled to harvest fruit.);
- recovery and regeneration time (see Step 4);
- climate and other environmental factors (e.g., temperate species may be more vulnerable to over-harvest than tropical species); and
- management practices (use of additional management techniques) and scale of management (individual, population, species, collection area, community / ecosystem).

A summary of procedures for carrying out harvest impact assessments is outlined in Table 7. Appropriate methods and approaches must be selected case-by-case, depending on the characteristics of the target species and the nature of the harvest. Local (collector) knowledge and skills can provide important insights to identify relevant harvest variables to test, and to design efficient test methods that can be carried out by harvesters during the normal harvest period.

Table 7. Summary of procedures for assessing harvest impact

	Task	**Notes on methods / related guidance**
1.	*Planning* Define the resource population to be sampled.	Some assessments may need to focus on more than one species or more than one plant part. Most assessments of harvest impact should focus on individuals in the age /size-classes considered harvestable.
2.	*Planning* Define the harvest practice or practices/treatments to be tested, and the impacts on individual plants and populations to be examined.	<u>Individual plants</u>: effects of seasonal timing of harvest, timing of harvest in the plant life cycle, nature / frequency / intensity of harvest, size of individuals harvested on rates of growth, survival, reproduction; vigour, yield, quality. <u>Populations</u>: effects of seasonal timing of harvest, timing of harvest in the plant life cycle, nature / frequency / intensity of harvest, size of individuals harvested on population structure and dynamics. Include among experimental treatments: • practices actually used by collectors • non-harvested control individuals / populations, if available, or • harvesting along an intensity / frequency/ etc. gradient, most to least.
3.	*Planning & field work* Select appropriate sampling units and design (random, systematic)	<u>Permanently marked resources</u> (impact on target resource individuals) • Best for testing harvest impacts on resource growth, survival, vigour, yield, quality • Only useful for resources non-destructively harvested • May be less costly in time and effort or <u>Permanent plots</u> in the collection area (impact on target resource populations) • Best for testing harvest impacts on population structure, regeneration • Can be used for destructively or non-destructively harvested resources • May be more costly in time and effort (however, plots established for yield studies can be used for harvest assessments, because they include a representative sample of different size-classes and vegetation types in the collection area). High density populations require smaller number of plots; lower density, scattered populations require a larger number of plots For species that require more rigor and precision, caution, etc.,

<table>
<tr><th></th><th>Task</th><th>Notes on methods / related guidance</th></tr>
<tr><td></td><td></td><td>an experienced ecologist should be engaged to assist in laying out the plot network.</td></tr>
<tr><td>4.</td><td>Training
Pilot assessments, trials to ensure consistency and accuracy of observations.</td><td>Hold field-based workshops to ensure that collectors and other members of the monitoring team understand and properly record the specified observations.</td></tr>
<tr><td>5.</td><td>Field work
Record harvest impact observations for individuals or plots selected.</td><td>Observations of harvest impact can be made during the regular harvest period. Visual rating systems for some types of harvest impact (e.g., crown health, bark removal, and root damage) facilitate involvement of collectors in making and recording these observations (see Box 14 and Figures 6-8).

<u>Individual plants</u>
• Survival and vigour
    o Signs of mortality / sickness
    o Evidence of harvest (cut stumps or leaves, bark or root removal) (See Figures 6-8)
• Reproduction (number of seeds, fruits produced per individual; aborted flowers, fallen young fruits)
• Yield of target resource (e.g., fruit production) by long-lived individuals (periodic monitoring)
• Growth rates / growth increments (diameter, length, height, number of stems per clump, percentage ground cover, etc.)
• Retrospective observations (Cunningham, 2001, p. 133)
• Simulated harvest (control vs increasing, successive levels of harvest, e.g., 25, 50, 75, 100% / 30, 60, 100%)

<u>Populations</u> of the target species
• Demographic changes in the sample populations.
• Shifts in regeneration.
• Shifts in yield curves.

Plant <u>communities</u> / <u>habitat</u>
• Trampling of seedlings, damage to other plants
• Changes in species composition, relative abundance and density.
• Observed population level changes for:
    o Pollinators, frugivores, granivores who rely on the target species
    o Alien and invasive species.</td></tr>
<tr><td>6.</td><td>Field work
Other observations potentially relevant to harvest impact response of target species</td><td>Use of additional management techniques vs individual and population growth rates:
• Sparing of individuals
• Size restrictions
• Overstory light management
• Thinning
• Transplanting
• Coppicing</td></tr>
</table>

	Task	Notes on methods / related guidance
		• Replanting plant parts (seeds or vegetative) Kinds and levels of anthropogenic pressure: • Forest cutting (creation of secondary forest) • Frequency, intensity, time since burning • Types of timber extraction practiced in conjunction with harvest of target species Other pressures: • Fungal / pathogen infestation • Insect attack • Browsing Management of habitat: • Agroforestry • Enrichment planting Impacts on communities • Effects of fruit, seed, and flower harvest / enrichment planting on composition and diversity of frugivores, granivores, pollinators • Creation of habitat for invasive species and other changes in species composition Impacts on ecosystems • Biomass removal and soil nutrient levels • Plant harvest (esp. roots) and soil erosion Costs of different treatments in time, effort, money.
7.	Estimate sustainability of current level of harvest	Data from harvest records (± level of precision), compared with sustainable harvest limit (Step xx). These data can be broken down into different quality classes, different users, different uses, if these data have been recorded. These data can be helpful in distributing the resource harvest equitably among different harvesters.
8.	Monitor harvest impact	Compare data from harvest records with previously collected data. • Destructively harvested resources: yield per unit area a good indicator of resource quantity in the study area. • Non-destructively harvested resources: yield in combination with resource quality, reproduction, growth, survival, vigour indicates harvest impact.
9.	Carry out long-term studies	Some species reallocate stored reserves to growth and reproduction after defoliation and other harvest stress. Short-term studies will therefore not adequately assess harvest impacts over the longer term.

Box 14. Harvest impact assessment methods

Ideally, the effects of harvesting need to be studied on the same sample population over time in established permanent plots, which are periodically resurveyed. In many cases there have been no previous field studies of focal medicinal species and consequently no permanent plots for comparative work. It is useful to establish permanent plots, but harvest protocols can also be developed through assessing harvest impacts along a gradient from places where harvesting impacts are high to where they are low (or absent).

It is often useful to combine quantitative botanical or forestry methods with methods that incorporate the insights of local people, but this can influence your choice of sampling method. If local resource users are involved in resource inventories or monitoring impacts, then it can be worthwhile using systematic sample plots along transects rather than randomly located plots, which local resource users often feel "waste time" (due to the time required to set up the plots). The limitation that this places on statistical analysis due to lack of random plots is often repaid by the insights of local resource users during joint fieldwork. Issues such as size-class selection can be linked to the practical field assessments of stem and leaf harvesting, root removal, bark damage or tree crown condition.

Crown conditions reflect tree health generally (Cunningham, 2001). Trees or shrubs can show die-back of the canopy as a result of age, bark or root removal, or fungal infection as a result of bark or root damage. The crown health rating system, developed by Dawkins (1958), can be used together with the rating systems for bark or root damage, described in Boxes C.3 and C.4, respectively, for a fuller understanding of plant health and its causes. The ratings are defined as follows (see Figure C.1):

0 = *Perfect:* excellent size and development, wide, symmetrical and generally circular.
1 = *Good:* slightly asymmetrical with some dead branch tips.
2 = *Tolerable:* marked asymmetry, some dieback.
3 = *Poor:* extensive dieback, leaves form less than half the original crown size.
4 = *Very poor:* badly damaged, unlikely to survive.
5 = *Dead.*

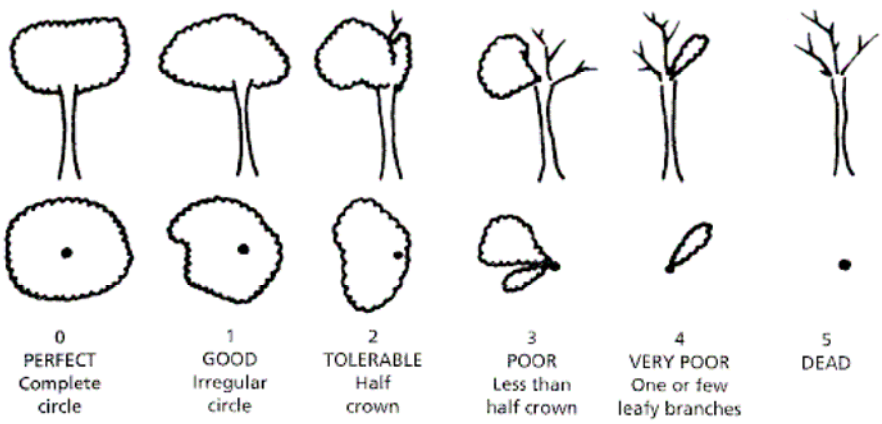

Figure 6. A visual rating system for tree crown health. (Source: Stockdale, 2005, from Cunningham, 2001, based on Dawkins, 1958).

Cunningham (2001) has developed a rating system for assessing the level of damage due to bark removal. The ratings are defined as follows (see Figure C.2):

0 = No damage.

1 = Small patches removed (<10% of trunk bark).

2 = Larger patches removed (10-25% trunk bark).

3 = Large strips removed (26-50% trunk bark).

4 = Extensive bark removed (51-75% of trunk bark).

5 = Ring-barking or girdling, where bark is completely removed around the trunk. This leads to death in many tree species.

6 = Complete girdling, all bark removed. At this stage, trees or large branches may have been felled or trees climbed to maximize bark removal.

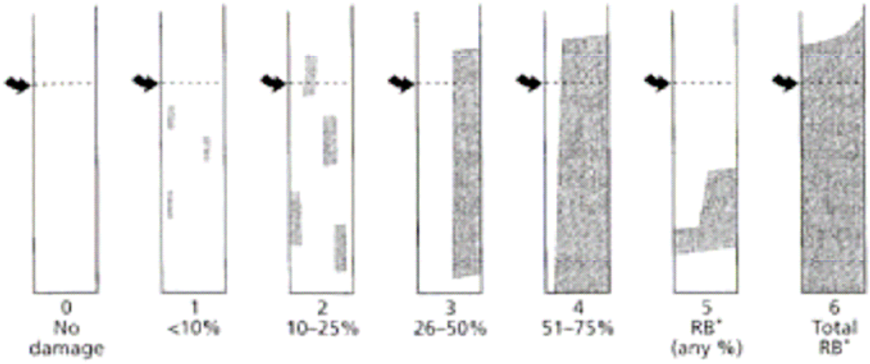

Figure 7. A visual rating system for bark damage (Source: Stockdale, 2005, from Cunningham, 2001).

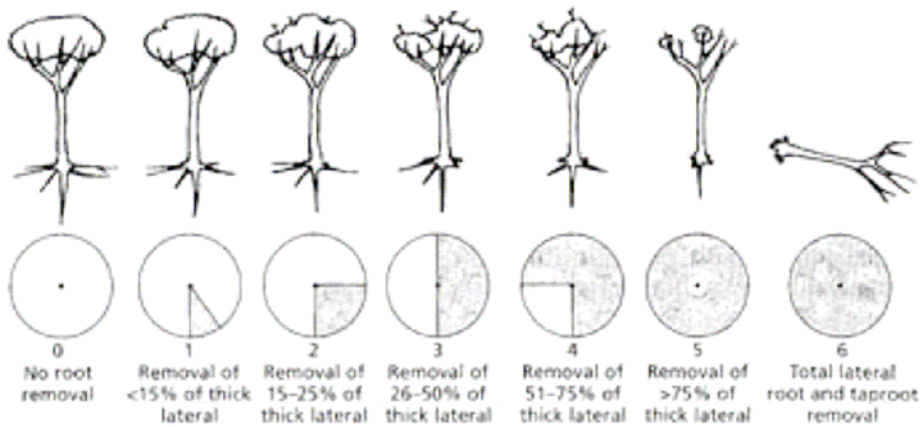

Figure 8. A visual rating system for root damage. (Source: Stockdale, 2005, from Cunningham, 2001).

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STEP 5. PERIODIC MONITORING AND HARVEST ADJUSTMENTS

The central questions for monitoring and harvest adjustments, in the context of the ISSC-MAP, are:

Is the management action (harvest protocol) successful in sustaining harvest quality and quantity?

Is the target resource maintaining base-line yields and population regeneration?

What adjustments can / should be made to allowed harvest protocols to maintain resource quality and quantity for future collection cycles, and to avoid undesired impacts on the target resource and the environment?

Monitoring provides periodic qualitative and quantitative information about:

- yield, growth, and vigor of harvested (long-lived, non-destructively harvested) individuals in response to harvest and other impacts;
- yield and regeneration of the target resource population in response to harvest and other impacts; and
- sustainability of the collection operation using the current harvest protocols.

Caution: if conservation status assessment of the target species (see Step 1) indicates that the species is threatened (small or declining populations, increasing fragmentation and habitat degradation, etc.), the base-line inventory, yield, and regeneration data cannot be treated as those of stable and self-sustaining populations. Adjustments of harvest protocols and other management interventions must have reducing harvest impacts and increasing yields / regeneration to sustainable levels as their principal objectives.

A summary of procedures for periodic monitoring and making harvest adjustments is outlined in Table 8. Important things to consider include:

- the purpose of monitoring;
- participatory monitoring by the harvester community (see Box 15); and
- third-party monitoring for certification / consumer assurance.

Table 8. Summary of procedures for periodic monitoring and harvest adjustments

	Task	**Notes on methods / related guidance**
1.	*Planning* Design a monitoring plan	• Define monitoring objectives • Select monitoring indicators • Decide on methods for measuring and monitoring indicators • Develop a plan for monitoring and evaluation activities
2.	*Field work* Monitor target resource individuals and	• Focus on target resources (individuals) included in normal harvest activities

	Task	Notes on methods / related guidance
	populations	• Include any additional target resource populations selected for monitoring
3.	*Field work* Monitor and record relevant environmental conditions	Keep site-specific records of: • Temperature and rainfall • Fire, grazing, and other disturbances
4.	*Paper work* Keep harvest records	Harvest records should include: • Amount of targeted resource harvested (% of yield) • Quality of target resource • Harvesting practices used • Observations of harvest impacts <u>Destructively harvested resources</u>: • Yield per unit effort: quantity harvested vs time spent looking for harvestable individuals or distance walked between harvestable individuals <u>Non-destructively harvested resources</u>: • Permanently marked resources, monitored for harvesting practices, yield, quality, reproduction, growth, regeneration / survival, vigour.
5.	*Analysis* Estimate current harvest level	Relevant information includes: • Quantity requested by buyer • Quantity harvested (different sites, age & size-classes, etc.) • Quality of material harvested (size, colour, flavour, shape, etc.) (different sites, age & size-classes, etc.) • Quantity/quality sold • End use(s)
6.	*Adaptive management* Make adjustments to the harvest protocol if required	Given the following conditions, current harvest levels and protocols can be considered sustainable: • The global and local populations of the target resource are not threatened (See Step 1, IUCN categories and criteria) • Regeneration studies and monitoring indicate that seedling / sapling densities remain equal to or above baseline levels • Yield studies indicate that availability of the target resource is not decreasing • Harvest assessments indicate that vigour, productivity, and other factors are not a concern If any of the above conditions are negative (loss of vigour, decreased productivity, reduced regeneration or yield), adjustments must be made in the frequency, intensity, and/or manner of harvest. Possible adjustments include: • Reduce the number or alter the size-class of harvested individuals; • Reduce the proportion of the collection area harvested in a given season;

	Task	Notes on methods / related guidance
		• Adjust harvest methods to make them less damaging to individual plants or the surrounding habitat.
7.	*Monitoring, field work* Carry out long-term studies	• Some species reallocate stored reserves to growth and reproduction after defoliation and other harvest stress. Short-term studies will therefore not adequately assess harvest impacts over the longer term. • Changes in other factors (settlement, land-use changes chance events such as fire, annual climate variations and climate change, etc.) can also affect yield and regeneration.

Box 15. What ecological, economic conditions favour participatory monitoring?

There are many cases where a long history of medicinal plant harvest is reflected in traditional / local collector knowledge of the resource (an example involving *Nardostachys grandiflora* and *Neopicrorhiza scrophulariiflora* is described by Ghimire et al., 2004). This knowledge represents a useful resource for participatory monitoring as well as the option of "data-less management" (Johannes, 1989). These may provide cost-effective alternatives to professional monitoring, but will require expert evaluation for verification that the ISSC-MAP criteria are being met. To help with decision-making on the effectiveness of participatory monitoring programs compared with options such as harvest closure or unmonitored exploitation, Hockley et al (2005) developed a framework for determining when stakeholders could be expected to adopt monitoring programs and how much they may be expected to contribute. In doing so, they asked several key questions, which are equally relevant to medicinal plant monitoring and management:

- Under what ecological and economic conditions will local communities want to manage and monitor their resources?
- If these conditions are met, are local communities are able to establish institutions to undertake monitoring and management?
- When is it desirable that local stakeholders should monitor (i.e., not just when people will have the incentive to monitor)?

The main factors influencing stakeholder "Willingness to Contribute (WTC)" were: **resource values** (cultural values and the lost opportunity costs of sustainable harvests (or not harvesting) compared to over-exploitation), **security of resource tenure**, **vulnerability to overexploitation**, **ease of monitoring** and finally, whether monitoring and management did improve yields (i.e.: **what benefits were there**?). Resilient resources benefited little from monitoring and management. Nor was there WTC to monitoring and management of highly vulnerable resources with low sustainable yields that required intensive monitoring and management. In testing their decision framework on a high value (freshwater crayfish) resource harvested by local people in Madagascar, Hockley et al (2005) found that a monitoring programme with sufficient statistical power to detect declines would be extremely costly in terms of local people's effort. As a result, they concluded that stakeholders WTC was unlikely to be high enough to make direct monitoring crayfish populations a viable option. Catch Per Unit Effort (CPUE) methods, on the other hand, could yield useful results, but were poor at detecting declines and could be misleading. Similar conclusions are likely for medicinal plants: what is most likely to succeed is participatory monitoring of high value, less vulnerable species that are relatively easy to monitor. (See Table 3)

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CONCLUSION: RESOURCE ASSESSMENT AND MANAGEMENT PLANNING

Resource assessment is an essential part of managing a sustainable wild-collection project or commercial operation. Resource assessment supports the development of collection protocols that do not deplete harvested populations of the target resource or damage their long-term survival.

Some wild-collection operations may need to develop stand-alone management plans. In many cases, however, a management plan for a target resource will need to connect with a larger management framework, such as an existing multi-species area management plan. Within any scale of management framework, however, the resource assessment should:

- document and define sustainable yield, regeneration, and harvest levels
- describe the methods used to determine these values, as well as their accuracy and precision;
- specify sustainable collection protocols, including collection limits, frequency, intensity, and methods;
- describe how specified protocols will be adopted, encouraged, or enforced;
- set out a schedule of monitoring and review of collection protocols;
- document harvest adjustments made over time, and why; and
- assign responsibilities, including those of local communities and collectors, for each part of the resource assessment process
- estimate the associated costs and provide a financial mechanism to cover them.

A management plan that fulfills these expectations will need to be written down. For most organized commercial operations, this will be essential. Commercial wild-collection that relies on a large number of small-scale collector groups or individual collectors will find a written management plan to be a larger challenge. Local harvesters rarely make formal written management plans. However, there can be advantages for them to do so. Developing a management plan enables stakeholders to communicate their planned management approach to people not as actively involved in the decision-making process (a third-party certifier, for example). However, recording a plan in a written document may challenge traditional ways of transmitting knowledge and alter power relations in favour of those with a formal education. Moreover, developing a management plan may prove too challenging for the existing resources or capacities in the community. Developing and implementing a management plan that meets requirements for sustainable wild collection under these circumstances will require participatory methods, financial support, and long-term commitment from all involved.

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GLOSSARY

Bark (stem / twig)	overlaying wood as the outer layer of stems, branches and roots of woody plants, namely trees. It usually consists of three layers: cork, phloem and vascular cambium
Collection area	= management area
Cryptic species	a cryptic species complex is a group of species which satisfy the biological definition of species, that is, they are reproductively isolated from each other, but they are not morphologically distinguishable (or at least are not readily or reliably distinguishable on a morphological basis)
Dioecious species	Male and female flowers on separate plants
Exudates	include gums, rubber, resin, balsam, and plant sap; exudates extracted from plant parts after harvest are treated as the respective plant part or plant part group
Geophyte	Plants with underground storage organs
Herb	refers to the aerial plant part of herbaceous MAP, and to (annual) vegetative, green or soft shoots of woody MAP
Leaf	above-ground plant part used for photosynthesis; plant organs of respiration and transpiration
Method	A means or manner of procedure, especially a regular and systematic way of accomplishing something. Orderly arrangement of parts and steps to accomplish an end.
Monocarpic species	Plant species that flowers and sets seed only once during its life cycle.
Monoecious species	Male and female flowers on different parts of the same plant
Population structure	Size-class distribution of a population
Procedure	A method or manner of proceeding; a way of performing or effecting something.
Protocol	A plan, as for a scientific experiment; or a code of conduct.
Recovery time	The time required for plants to grow from seed to a specified (e.g., harvestable) size.
Recruitment	Addition of new individuals to a population (for plants, by growth and reproduction)
Regeneration	Replacement or repair of tissues or organs lost through damage (e.g., harvest); used commonly to refer to vegetative propagation in plants.
Reproductive parts	include all organs and parts of inflorescences and flowers at all different stages from flowering to fruiting; e.g., calyx, petal, stamen, pistil, fruit, and seeds
Resource abundance	The total number of resources in a specified area.
Resource density	The number of resources per unit area.
Resource inventory	An estimate of the quantity of a resource population in a specified area.
Size-class	A division or group within a sample population defined by a size range (e.g., diameter, height)
Strategy	A plan of action intended to accomplish a specific goal.
Stratagem	A clever, often underhanded scheme for achieving an objective.
Underground parts	depending on harvesting methods, it is further divided into two groups: (1) partial harvest possible (e.g. rhizomes), and (2) partial harvest impossible (e.g. often in the case of bulbs)
Whole plant	includes the aerial and the underground part of a plant
Wood (stem / twig)	solid material derived from the stems, branches, and roots of woody plants, namely trees and shrubs; wood is mostly secondary xylem and consists of cellulose, hemi-cellulose and lignin

ANNEX 1.
SITUATION ANALYSIS QUESTIONNAIRE FOR ISSC-MAP IMPLEMENTATION

The following sets of questions are related to each section, principle, and criterion of the ISSC-MAP (MPSG, 2007).

- These questions indicate the scope of the situation analysis needed to prepare for management planning, including the elements of management planning that address conservation status assessment and resource assessment.
- Each project may adapt this approach to the specific project situation.
- Some of these questions may be answered through literature reviews. Others will likely require interviews with resource management authorities / government officials, traders, collectors, and affected communities.
- Participatory processes are encouraged.
- These questions provide a useful framework for a situation analysis report for implementation projects.

SECTION 1: WILD COLLECTION AND CONSERVATION REQUIREMENTS

Principle 1. Maintaining Wild MAP Resources

Wild collection of MAP resources shall be conducted at a scale and rate and in a manner that maintains populations and species over the long term.

1.1 Conservation status of target MAP species

The conservation status of target MAP species and populations is assessed and regularly reviewed.

- What is the conservation status of this species (national, regional or global)?
- How recent is this assessment?
- Have any population assessments been conducted (collection area, national, regional or global)?

1.2 Knowledge-based collection practices

MAP collection and management practices are based on adequate identification, inventory, assessment, and monitoring of the target species and collection impacts.

- What collection and management practices are in place for this species (this must capture any formal and community based management systems whether functional or defunct)?
- How is this species identified (need to find out if there is any taxonomic confusion)?
- Have any inventories or assessments of this species been conducted (e.g. is the collection area well defined)?
- Is there any ongoing monitoring of this species?

1.3 Collection intensity and species regeneration

The rate (intensity and frequency) of MAP collection does not exceed the target species' ability to regenerate over the long term.

- Is the harvest volume known and monitored (e.g. trade studies, harvest monitoring results)?
- Is there any known illegal/unmonitored trade
- Have any species regeneration assessments been conducted?
- Have any assessments into the long-term sustainability been conducted?

Principle 2. Preventing Negative Environmental Impacts

Negative impacts caused by MAP collection activities on other wild species, the collection area, and neighbouring areas shall be prevented.

2.1 Sensitive taxa and habitats

Rare, threatened, and endangered species and habitats that are likely to be affected by MAP collection and management are identified and protected.

- Are current collection practices known to negatively impact on other species or habitats?
- Does the collection area contain or overlap with any protected species (i.t.o. national, regional or international laws)?
- Does the collection area contain or overlap with IUCN Red List species?

2.2 Habitat (landscape level) management

Management activities supporting wild MAP collection do not adversely affect ecosystem diversity, processes, and functions.

- Are current collection practices known to negatively impact on the functioning of the MAP eco-system?

SECTION II: LEGAL AND ETHICAL REQUIREMENTS

Principle 3. Complying with Laws, Regulations, and Agreements

MAP collection and management activities shall be carried out under legitimate tenure arrangements, and comply with relevant laws, regulations, and agreements.

3.1 Tenure, management authority, and use rights

Collectors and managers have a clear and recognized right and authority to use and manage the target MAP resources.

- What is the land tenure regime in the areas where this species is being harvested (e.g. communal land, private land, etc)?
- Who is carrying out the harvesting (e.g. local people in the communal areas, employees of landowners, external traders etc.)?
- Who has the authority to authorise and manage collection?

3.2 Laws, regulations, and administrative requirements

Collection and management of MAP resources complies with all international agreements and with national, and local laws, regulations, and administrative requirements, including those related to protected species and areas.

- What is the permit system used for the harvesting of and trade in this species?
- Are there any problems with the current permit system?
- Are there any ways in which the permit system could be improved?
- Is there any unmonitored, unregulated or illegal harvest and trade?

Principle 4. Respecting Customary Rights

Local communities' and indigenous peoples' customary rights to use and manage collection areas and wild collected MAP resources shall be recognized and respected.

4.1 Traditional use, access rights, and cultural heritage

Local communities and indigenous people with legal or customary tenure or use rights maintain control, to the extent necessary to protect their rights or resources, over MAP collection operations.

- Are there any customary rights of access to the species (what are they)?
- If so, are these protected or honoured in the existing management or harvest regime (describe)?
- Are there any conflicts in relation to these customary rights (describe)?

4.2 Benefit sharing

Agreements with local communities and indigenous people are based on appropriate and adequate knowledge of MAP resource tenure, management requirements, and resource value.

- Are there any use (e.g. harvest, commercial, research or traditional) agreements in place with local communities?
- If so, what is the legal basis for these agreements (e.g. national, provincial, municipal or traditional)?

SECTION III: MANAGEMENT AND BUSINESS REQUIREMENTS

Principle 5. Applying Responsible Management Practices

Wild collection of MAP species shall be based on adaptive, practical, participatory, and transparent management practices.

5.1 Species / area management plan

A species / area management plan defines adaptive, practical management processes and good collection practices.

If answer to Q.1.2 confirms that there is a management plan then:

- Describe the management plan? (make sure answer includes reference to adaptive, practical and GCP's!)

5.2 Inventory, assessment, and monitoring

Management of MAP wild collection is supported by adequate and practical resource inventory, assessment, and monitoring of collection impacts.

- Describe the resource inventory and monitoring systems in place for this species?

5.3 Transparency and participation

MAP collection activities are carried out in a transparent manner with respect to management planning and implementation, recording and sharing information, and involving stakeholders.

- Who is involved in the management planning process and its implementation?
- Describe how these management plans are reviewed and revised?
- How do stakeholders participate in the day-to-day implementation of the management plan (need to find out specifically how affected communities, collectors, middlemen are involved)?

5.4 Documentation

Procedures for collecting, managing, and sharing information required for effective collection management are established and carried out.

- What are the procedures for collecting and sharing information required for implementing the management plan.

Principle 6. Applying Responsible Business Practices

Wild collection of wild MAP resources shall be undertaken to support quality, financial, and labour requirements of the market without sacrificing sustainability of the resource.

6.1 Market / buyer specifications

The sustainable collection and handling of MAP resources is managed and planned according to market requirements in order to prevent or minimise the collection of products unlikely to be sold.

- Is the collection of the species following specific volume and quality instructions from the buyer?
- If not, how do collectors decide how much and what quality of material required
- Further questions you could ask:
  - How is processing carried out by the harvesters before the material is sold?
  - What is the quality sold by the collectors?
  - Are there any problems with quality (e.g., insufficiently dried, dirty, includes taproots, confusion with other species during collection)?
  - How are these problems currently dealt with?

6.2 Traceability

Storage and handling of MAP resources is managed to support traceability to collection area.

- Are the main stages in the commodity chain from harvesting to export or sale known and documented (e.g. harvesters in the communal areas sell to buyers, who export directly, or sell to exporters)?
- Identify the main actors in the commodity chain (e.g. harvesters in North West Province, harvesters sell to company X or company Y.)
- Can the processed medicinal product in the market place be traced back to its point of collection?

6.3 Financial viability

Mechanisms are encouraged to ensure the financial viability of systems of sustainable wild collection of MAP resources.

- What are the current arrangements for purchasing the target resource from harvesters?
- What are the prices received by collectors / middle traders / wholesalers/exporters?
- Is it possible for collectors to ask higher prices for better managed and higher quality material in the current market situation? (e.g, are there very few sources of the material for the buyers, or do the collectors have to compete with many other collection sources?
- How is the price determined?

6.4 Training and capacity building

Resource managers and collectors have adequate skills (training, supervision, experience) to implement the provisions of the management plan, and to comply with the requirements of this standard.

- What are the strengths and weaknesses / gaps in the current knowledge and skills of resource managers (resource management authority, collection operation) in:
    - Resource assessment and monitoring?
    - Adaptive management process?
    - Participatory processes (working with collectors to assess and monitor harvest impacts)?

6.5 Worker safety and compensation

MAP collection management provides adequate work-related health, safety, and financial compensation to collectors and other workers

- What are the working conditions of the collectors?
- Are there health, safety, and economic risks associated with collection of this resource? What are they?
- How are illness, injury, financial losses related to collection of this resource handled, and by whom?

ANNEX 2. IUCN RED LIST CATEGORIES

EXTINCT (EX)
A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available.

In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Source: IUCN (2001)

ANNEX 3. LOCATION AND ARRANGEMENT OF SAMPLING SITES FOR RESOURCE ASSESSMENT AND MONITORING

Sampling option	Relevant tools & methods	Advantages	Disadvantages (cautions)	Supporting guidance and information sources
Type of sampling area	Plots: square, rectangular, or circle	More efficient in capturing / characterizing diverse vegetation types or varied vegetation Easier to create larger sample sizes	Frustrating to local resource users / collectors participating in inventory and monitoring – individuals of the target species left out of sample plots Plots on sloping ground – location and measurements need to corrected for slope – the distance along a slope is greater than the corresponding horizontal distance)	Campbell 1989 Durr et al., 1988 In: Cunningham, 2001, pp. 163-64
	Square / rectangular		More plot perimeter (edge) effects per unit area sampled Greater chance of bias / error in deciding which individual plants on the border are “in” or “out” Measurements need to be taken more carefully	Peters 1996
	Circle plots	Least edge effects		

Sampling option	Relevant tools & methods	Advantages	Disadvantages (cautions)	Supporting guidance and information sources
	Transects • Belt transects allow sampling of vegetation at equal distances on both sides of a transect line	More habitats covered Inventory more representative of study area – cover a wider spectrum of microhabitats, allowing detection of subtle changes density or structure of sample populations Widely used method Accessibility: Narrow transects at right angles to a forest path Apparently preferred by local resource users	Edge effects Less efficient: sample size = 1 Need more short transects rather than a few long ones to enable statistical analysis	Cunningham, 2001, p. 161
	Point-centred quarter (PCQ) – determines patterns of species distribution from analysis of associated plants within patches = near-neighbour analysis	Enables sampling of micro-habitats Efficient in characterizing vegetation Minimizes damage to forest understory	No permanent plots or transects, therefore does not cover an exact area each time. Species richness is not related to area sampled Only 4 trees/sampling interval Labour intensive if large sample sizes are needed for statistical analysis	Cunningham, 2001, p. 162 / fig. 5.7a Campbell 1989
Arrangement of sample plots / transects Size of plots / length of transects	Random – selected by drawing numbers from a hat, using a random number table	Avoids bias Better for statistical analysis	Time consuming to locate, esp. in rough, forested terrain	Cunningham, 2001, p. 162

Sampling option	Relevant tools & methods	Advantages	Disadvantages (cautions)	Supporting guidance and information sources
	Systematic – arranged at regular intervals following a set pattern	Quicker and easier to locate for resampling	Acceptable for statistical analysis in situations where the individual plants are randomly distributed, but this rarely occurs in nature. Statistical assessment of precision or sampling error is not possible.	Peters 1996
	Stratified random			
	Depends on size and abundance of species and individuals in the target populations			
	Larger number of small plots / transects (more replicate plots)	Better for sampling target species in which small size-classes are preferred / collected Small plants with low populations density Better for statistical analysis	Labour intensive Greater chance of error in estimates of plant density If plots are too small, may get many plots without any individuals of the target species	
	Fewer but larger plots / transects	Better for target species in which the minimum cut-off size-class for sampling is relatively large (larger dbh) e.g., large trees Less time consuming Less error	Less statistical accuracy If plots are too large, too much time is required to sample all individuals of the target species in the relevant size-classes.	

Sampling option	Relevant tools & methods	Advantages	Disadvantages (cautions)	Supporting guidance and information sources
	Tiered plots (combine larger plots with smaller sub-samples within each plot)	Smaller diameter size classes can be more readily included Allows for equal amount of time spent sampling each of the relevant size classes.		Alder and Synott 1992
Sampling intensity – number of sampling units	Less intense (e.g., forest surveys, 5-10 % common)	Less precise	May not achieve appropriate level of precision	
	More intense	More precise	May not be required to achieve appropriate level of precision Require a random sampling design	Philip 1994 Peters 1996
Combining different types of studies requiring sampling	Inventory + yield studies • All relevant resources of harvestable size included in yield study • Systematic sub-sample included in yield study	Can save time, effort, and other costs if well planned	Yield study samples may not be: • objectively drawn from the sample resource population (systematic or random) enumerated in the inventory • evenly distributed across the management area • drawn in equal numbers from the relevant age / size-classes, vetation types, etc.. Additional sampling for yield study may be needed after the inventory is completed	Stockdale (2005)

Sampling option	Relevant tools & methods	Advantages	Disadvantages (cautions)	Supporting guidance and information sources
	Yield studies + on-going harvest of target resource	• Harvested resources are not wasted • Real-life harvesting practices are used	• Too many resources may be sampled from locations, age / size-classes, etc., and not enough from others. • Sampling may not be evenly distributed across the management area; • Additional sampling may be needed.	Stockdale (2005)
Statistical analysis		•		Sokal and Rohlf (1987); Zar (1998)

Source: Cunningham (2001) chapters 2 & 6

ANNEX 4. MEASUREMENTS USED FOR DIFFERENT RESOURCE TYPES AND PLANT FORMS

Resource type / plant part	Age	Size-class	Yield	Impacts of harvesting	"Typical" harvest protocols
Leaves	Time to die-off of marked / tagged new leaves	Length Petiole width		Experimental defoliation: effects of defoliation levels (eg., control, 30, 60, 100 percent) on growth rates (e.g., leaf size and production rate) of different size-classes. (Cunningham, 2001)	Specified % of the average annual biomass production of the individuals of each size class every xth year..
Fruits, flowers, seeds				Population level - of most concern for commercial harvest of reseeder plants that are dioecious or monocarpic Population level if whole plant is removed (of most concern for tall, difficult to reach) Individual level effects if branches are pruned. Philips (1993)	Monocarpics: seeds, fruit, flowers are allowed to be harvested from <u>specified % of all flowering individuals</u> every year; or specified % of seed, fruit, flowers produced in 1 year can be harvested
Exudates (gums, resins, latexes)				• Few studies • Bark and root tapping: Individual level, damage to bark layer, growth rates under different tapping frequencies and intensities, reproduction • Fruit: population level	
Bark	See woody trees	See woody trees	Thickness	• Point-scale rating of visible bark damage vs dbh.	Specified % of the average annual biomass production of

Resource type / plant part	Age	Size-class	Yield	Impacts of harvesting	"Typical" harvest protocols
				(Cunningham, 2001)	the individuals of each size class each xth year.
Stems / branches				Regeneration rates from seed, resprouting	Specified %of the average annual biomass production of the individuals of each size class each xth year.
Whole plant / apical meristem					Target plant parts of individuals ≥ minimum age class are allowed to be harvested Target plant parts of specified % of each size class are allowed to be harvested, every x years; x = time to reach minimum age class
Roots, bulbs, tubers, corms	Annual rings in perennial corms Leaf-base counts from longitudinal sections of bulbs Spent remains of annual corns and stem tubers	Diameter (growth is outward with age)		Few studies Field rating scale for root damage (recent harvest) vs dbh.	Specified % of the average annual biomass production of the individuals of each size class each xth year.
Woody trees	Annual rings in wood cores	Diameter at breast height (dbh) = 1.3 m from ground (but see Cunningham,		Rating scale for crown die-back (effect of bark or root damange) Non-destructive sampling methods in woody trees (Swart, 1980).	

Resource type / plant part	Age	Size-class	Yield	Impacts of harvesting	"Typical" harvest protocols
		2001, on tough customers) Canopy diameter			
Palms, cycads, grass trees, tree ferns, grasses	Leaf scars + known leaf production rate Stem height, length indicate plant age, but also growing conditions	Height, length (apical meristem grows upwards)		Palms well studied Retrospective counts of harvested leaves (Cunningham, 2001)	
Climbing palms, grasses		Length (rather than height, as much of the growth may be horizontal) Bamboo: diameter at a specific internode (e.g., 5th internode from the base) and height	Rattan: estimate of total length, converted to total wet weight using size-class specific conversion factors (Stockdale et al., 2003)		
Lianas / vines		Length and diameter			
Shrubs		Height and dbh			
Herbs		Height (most common)			Annuals: Target plant parts are allowed to be harvested from <u>specified % of the total</u>

Resource type / plant part	**Age**	**Size-class**	**Yield**	**Impacts of harvesting**	**“Typical” harvest protocols**
					harvestable yield every year. Biennials: Target plant parts are allowed to be harvested from specified % of the total harvestable yield every second year.
Special cases: clonal species, monocarpics, Fungi, etc.		Clonal species: clumps, stems, outer diameter, etc (Sutherland, 1996) in Stockdale 2005			Monocarpics: seeds, fruit, flowers are allowed to be harvested from specified % of all flowering individuals every year; or specified % of seed, fruit, flowers produced in 1 year can be harvested.

Sources: Cunningham (2001), Stockdale (2005), Lange (unpublished)

ANNEX 5. EQUIPMENT AND CAPACITY NEEDED FOR RESOURCE ASSSESSMENTS

Main skills required (Cunningham, 2001):

- Understanding what you see in the field
- Understanding what you hear from local resource users/harvesters
- Knowing key measurements needed to predict supply and monitor impact

(Source: Stockdale 2005)

Equipment and skills	Situation analysis	Base-line inventory	Yield studies	Regeneration studies	Harvest assessments	Monitoring
To establish and mark permanent plots and plants						
Scale map of the collection / management area	X	X		X	X	X
GPS recorder	Opt	Opt		Opt	Opt	Opt
Compass		X		X	X	X
Clinometer (to correct for slope)	Opt	Opt		Opt	Opt	
Surveyor's chain or nylon rope (30-50 m, marked in decimeters and meters)		X		X	X	
Compass staff and survey sticks		X		X	X	X
Bush knife	X	X		X	X	X
Durable wooden posts with metal tags (or metal stakes, PVC plastic pipes, or concrete beacons)		X		X	X	
Exterior grade emulsion (water-base) paint and/or metal alloy tags attached with metal wire (copper) or corrosion-resistant alloy nails		X		X	X	X
To measure plants						
Exterior grade emulsion (water-base) paint to mark the point of measurement		X			X	X
3 meter diameter at breast height (dbh) tape		X			X	X
Calipers (to measure the diameter of small stems)		X		X	X	X
Telescopic height stick (or long pole, marked in decimeters and meters)		X		X	X	X
Meter tape (10-30 m long)		X		X	X	X
Ruler (to estimate height)		X			X	X
Clinometer (to estimate height)		Opt			Opt	
Weighing scales		X			X	X
Binoculars		X			X	X
To record data						
Pencils and notebooks (or clipboards with data sheets)	X	X		X	X	X
To analyze data						
Calculator		X		X	X	X
Computer with spreadsheet software		Opt		Opt	Opt	Opt
Skills						
Planning and designing plots and tests		X		X	X	X
Statistical survey design and analysis		X	X	X	X	X
Taxonomy	X	X		X		
Plant ecology	X	X	X	X	X	X
Participatory research methods	X	X	X	X	X	X