PROGRAMA DE FORMACIÓN DE RECURSOS HUMANOS PARA LA INNOVACIÓN

BECAS PARA FORMACIÓN

OTORGADAS EN EL MARCO DEL PREMIO A LA MUJER INNOVADORA EN AGRICULTURA 2006

INFORME

Conservación y evaluación de poblaciones naturales de especies medicinales nativas

FIA-FP-P-2006-1-A-002

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Talca, 28 de enero de 2007 **Hermine Vogel**

SECCIÓN 1. ANTECEDENTES GENERALES DE LA PROPUESTA

NOMBRE DE LA ACTIVIDAD

Conservación y evaluación de poblaciones naturales de especies medicinales nativas

INSTITUCIÓN O ENTIDAD RESPONSABLE QUE DICTA U ORGANIZA LA ACTIVIDAD DE FORMACIÓN

University of Birmingham, Gran Bretaña http://www.biosciences.bham.ac.uk
Universität Hohenheim, Stuttgart, Alemania www.uni-hohenheim.de
Bund für Naturschutz, Bonn, Alemania www.floraweb.de/map-pro
PhytoConsulting, Marklkofen, Alemania www.phyto-consulting.de

LUGAR DE REALIZACIÓN DE LA ACTIVIDAD

Indicar el nombre de la localidad o ciudad, provincia y/o región y pais donde se realizará la actividad de formación. En caso de haber más de un lugar, listarlos todos.

Birmingham, Inglaterra
Stuttgart, Baden-Württemberg, Alemania
Singen/ Lottstetten, Baden-Würtemberg, Alemania
Bonn, Alemania
Marklkofen, Bavaria, Alemania

FECHA DE INICIO Y TÉRMINO DEL PROGRAMA DE ACTIVIDADES

Indicar la fecha de inicio del programa de actividades de la propuesta y la fecha de término.

Inicio: 07-12-2006 **Término:** 17-01-2007

CUADRO RESUMEN DE LA PARTICIPANTE EN LA ACTIVIDAD DE FORMACIÓN

Nombre del participante	RUT	Lugar o entidad en donde trabaja	Actividad que realiza (productor, investigador, docente, empresario, etc)	Región
Hermine Vogel		**Universidad de Talca**	**Investigador y docente**	**VII**

OBJETIVOS DE SU PARTICIPACIÓN EN LA ACTIVIDAD DE FORMACIÓN

Objetivo general:

Conocer métodos de conservación y evaluación de poblaciones naturales de especies medicinales nativas de Chile

Objetivos específicos:

1. Conocer aspectos prácticos de los sitios, monitoreo y manejo de la diversidad de los recursos vegetales silvestres que se conservan *in situ* en proyectos de especies silvestres y recursos genéticos locales.

2. Conocer métodos estadísticos de evaluación de poblaciones naturales

3. Conocer ejemplos de aplicación de la genética de poblaciones en plantas silvestres

4. Conocer ejemplos de manejo de poblaciones silvestres para su conservación

5. Adquirir libros especializados

6. Discutir el caso de bailahuén con especialistas en plantas medicinales (Dr. Ernst Schneider, PhytoConsulting, y Dr. Uwe Schippmann, organizador del taller técnicas de recolección de plantas medicinales silvestres, BfN), buscando consejos y recomendaciones

RESUMEN

Resumir en no más de una página la justificación, actividades globales, resultados e impactos alcanzados con la propuesta completa. Estos resúmenes deben sintetizar los aspectos principales de la propuesta y cada una de sus iniciativas en forma general.

En el marco de los proyectos de estudio, domesticación y cultivo *ex situ* e *in situ* se vio que muchas plantas seguirán recolectándose desde su hábitat silvestre. Para que la producción de estas especies siga siendo una actividad comercial debe ser sustentable. Para ello estamos trabajando en forma paralela en distintos enfoques:

- domesticación y cultivo (Proyecto FIA V99-0-S-032)
- cultivo *in situ* (FIA-PI-C-2004-1-A-94), sensibilización y capacitación de recolectores.
- Ensayos de recolección sustentable de plantas silvestres

Sin embargo, con el fin de planificar y ejecutar estudios con poblaciones silvestres se vio la necesidad de adquirir conocimiento básico de la conservación de recursos genéticos vegetales.

La formación realizada en Inglaterra y Alemania se compuso de dos áreas temáticas:

- Curso conservación in situ: conceptos básicos adquiridos en la University of Birmingham, Inglaterra
- Plantas medicinales de recolección silvestre: entrevistas con especialistas del tema y expositores del taller "Assessing the sustainable yield in medicinal and aromatic plant collection", realizado en la Isla Vilm, Alemania, en Septiembre de 2006

La entrega de información de parte de todos los especialistas visitados superó lejos mis expectativas. Se me entregó mucho material en formato digital, entre ello libros enteros sobre principios de la conservación *in situ* y un manual ilustrado sobre la recolecta sustentable, el curso de conservación completo, presentaciones y publicaciones, además del material completo del taller mencionado arriba, presentaciones, abstracts, lista de participantes, a pesar de no estar publicado aún. El tiempo de estadía no alcanzó para estudiar la cantidad de documentos entregados, pero tengo el material y los contactos para seguir perfeccionándome en el tema.

Por otra parte, las conversaciones sobre nuestro trabajo despertaron gran interés, solicitándome enviar publicaciones sobre el bailahuén.

Las ideas que se me plantearon en las entrevistas coincidieron bastante entre los diferentes especialistas. Se planteó, por ejemplo, la necesidad de conservación de las especies *ex situ* (bancos de germoplasma) junto con la de *in situ*, o de mapear las zonas de distribución en base a datos ecológicos y luego comparar con los sitios donde la especie se encuentra efectivamente.

Adjunto se encuentra un CD con los documentos entregados. En el anexo se adjuntan copias de los documentos impresos o copia del título e índice de contenidos. Los libros adquiridos como material de trabajo se han encargado por Internet, pero todavía no llegan. Además, el Dr. Schippmann también envió un paquete de libros y material por correo (barco), el que tampoco ha llegado a la fecha.

Finalmente, deseo plantear mi plena satisfacción con la formación, la que ha superado lejos mis expectativas y me ha mostrado los pasos a seguir en nuestros estudios con plantas nativas.

Programa Actividades Realizadas		
Nº	Fecha	Actividad
1	7-8 dic 2006	Viaje a Alemania
2	10 dic 2006	Viaje a Birmingham, Inglaterra
3	11-21 dic 2006	Curso Conservación *in situ*, University of Birmingham. La Universidad cerró el jueves 21. Por ello y por los altos costos de alojamiento en Inglaterra se adelantó el viaje a Alemania, originalmente programado para la primera hora del sábado 23 a la noche del jueves 21.
4	22-26 dic 2006	Feriado
5	27-29 dic 2006	Lectura material entregado (no fue posible ubicar o entrevistar a otro profesional durante este tiempo)
6	30 dic-1 ene	Feriado
7	2 ene 2007	Contacto y organización de visitas y entrevistas en Alemania
8	3 ene 2007	Visita Dr. Tremp, Singen; Universidad de Hohenheim
9	4 y 5 ene 2007	Visita a Dr. Schneider, PhytoConsulting, Marklkofen
10	6-7 ene 2007	Fin de semana
11	8-9 ene 2007	Viaje a Bonn, entrevista Dr. Schippmann y U. Eberhardt, Pelargonien-Fischer (Koblenz)
12	10-12 ene 2007	Stuttgart - Universidad Hohenheim; Visita campus y entrevistas con profesores Weber, Parzies y Wünsche
13	13-14 ene 2007	Fin de semana
14	16-17 ene 2007	Viaje a Chile

RESULTADOS

Descripción detallada de los conocimientos y/o tecnologías adquiridos y/o entregados. Explicar el grado de cumplimiento de los objetivos propuestos, de acuerdo a los resultados obtenidos.

Universidad de Birmingham, Inglaterra
Curso "*In Situ* Conservation"
11 al 21 de diciembre de 2006

Este curso se dictó para alumnos de postgrado de la Facultad de Ciencias Biológicas de la University of Birmingham. Lamentablemente el curso terminó una semana antes de lo informado (15 en vez del 22 de diciembre). Sin embargo, el coordinador, Dr. Nigel Maxted, me entregó toda la información en un CD, dejando la segunda semana (18 al 21 de diciembre) para una enseñanza personalizada en base a mis preguntas e inquietudes. La Universidad de Birmingham cerró el 21 de diciembre por las vacaciones de Navidad.

1. CLASES en curso de postgrado: Detalle ("handouts") en el anexo

1.1 Nigel Maxted: Conservación y uso de los recursos genéticos vegetales; Introducción a la conservación *in situ*

Definiciones

Resumen de requerimientos básicos para establecer reservas genéticas *in situ*

Metodología para conservación en reservas genéticas

Conservación de plantas *in situ*: introducción, modelo, estrategias, definiciones

Reserva genética *in situ*: evaluación de sitios, evaluación de factores socio-económicos, tamaño, número, distribución y diseño

Sustentabilidad del taxón y de la reserva

Formulación de un plan de manejo y monitoreo de la reserva

Uso tradicional, general y profesional

Vinculación con la conservación *ex situ*, duplicación, investigación y educación

Productos

1.2 Nigel Maxted: En búsqueda de variedades locales: experiencia en Reino Unido y planes para Europa

Biodiversidad

Amenazas para las plantas

Recursos genéticos vegetales: diversidad nacional; proyectos *in situ* y ex *situ* en RU, inventario de variedades nacionales del RU, estructura de la base de datos, metodología

Proyectos financiados por la Unión Europea

1.3 Nigel Maxted: Conservación y uso de los recursos genéticos vegetales; diseño de la reserva

Fuentes

Diseño óptimo

Beneficios biológicos y sociales de "buffer" (zona amortiguadora)

Tamaño de la reserva

SLOSS debate (single large or several small = uno grande o varios pequeños)

Población y tamaño de la reserva

Corredores

Forma de la reserva

Diversidad de hábitat

Factores políticos y económicos que afectan el diseño de la reserva

1.4 Nigel Maxted: Conservación y uso de los recursos genéticos vegetales; Manejo y monitoreo de la reserva

Categorías del manejo de áreas protegidas del IUCN

Manejo y monitoreo de reservas genéticas *in situ*

- Fuentes
- Metas del manejo de conservación
- Planes de manejo para reservas genéticas
- Los cambios son naturales
- Intervención en el manejo
- Proceso de elaboración de un plan de manejo de una reserva genética
- Revisión del manejo
- Monitoreo de una reserva genética
- Manejo de recursos genéticos fuera de áreas protegidas

1.5 Nigel Maxted: Desarrollando una estrategia nacional de "Crop Wild Relative" (CWR) (= Parientes silvestres de cultivos)

- Contexto
- Recursos genéticos vegetales (PGR) y Parientes silvestres de cultivos (CWR)
- *In situ* versus *ex situ*

- ¿Qué son CWR?
- ¿Por qué los CWR son críticos?
- Requerimientos para una estrategia nacional de CWR
- Inventario nacional de CWR
- Análisis ecogeográfico y genético de prioridades de CWR
- Análisis de la discrepancia ("Gap analysis") CWR
- Desarrollo de prioridades de conservación de CWR *in situ* y *ex situ*
- Implementación de las prioridades de conservación de CWR
- Estrategia global para la conservación y uso de CWR

1.6 Joana Magos Brehm: Práctica en ArcGIS

1.7 Edwin Chiwona: Metodología para la conservación *on-farm* (en granjas)

- Introducción y publicaciones
- La necesidad de una metodología y el problema de desarrollo
- El marco general de la metodología para la conservación *on-farm* de la diversidad genética vegetal
    1. Planificación y establecimiento del proyecto
    2. Manejo y monitoreo de *on-farm* proyectos
    3. Uso de la diversidad

<u>2. SALIDAS A TERRENO</u>

2.1 Banco de germoplasma de hortalizas de la Universidad de Warwick (Warwick HRI)

- problemas de financiamiento a largo plazo de la conservación de recursos genéticos, especialmente de los bancos de germoplasma
- centros de diversidad, ejemplo coliflores en Italia
- deshidratado, envasado, almacenamiento y distribución de semillas guardadas
- producción de semilla en *Brassica oleracea* (repollo y coliflor), *Raphanus* (rábanos), *Allium* (principalmente puerro, cebolla y ajo), *Daucus* (zanahoria) y *Lactuca* (lechuga)
- visita a invernaderos, cámaras de producción de semilla, instalaciones de vernalización, sala de deshidratado y envasado, laboratorios de la Universidad
- problemática de las altas temperaturas durante este invierno en la propagación de las especies
- proyecto de investigación sobre recursos genéticos en accesiones de lechuga y su susceptibilidad al pardeamiento para futuros proyectos de mejoramiento genético (empresa semillera ZWAN Holanda con la Universidad de Warwick)

2.2 "Peatlands" Reserva Natural Nacional de Pantanos de Fenn´s, Whixall y Bettisfield

- Ubicado en la frontera entre Inglaterra y Norte de Gales
- Proyecto de conservación de los pantanos los que han sido destruidos debido a la producción de turba en el siglo pasado
- Origen de los pantanos (glaciares)
- Función de los pantanos como
  a. reserva de agua dulce (ácido y pobre en minerales)
  b. fijación de carbono
  c. hábitat para musgos (especialmente *Sphagnum*), plantas, invertebrados, pájaros y mamíferos adaptados a este ambiente específico
- Necesidad de conservar los pantanos
- Destrucción del hábitat por el drenaje del pantano, lo que permitió
  a. extraer turba (uso casero: lecho para animales domésticos y combustible), después también producción industrial
  b. usar los terrenos para agricultura (por su bajo contenido de minerales principalmente pastoreo)
  c. plantación de árboles (pino)
- Recuperación de los pantanos
  a. necesidad de subir el nivel del agua
  b. eliminar los árboles (pino)
  c. adquirir y manejar adecuadamente los terrenos aledaños
  d. estudios hidrológicos, conducción de aguas y monitoreo de los niveles de agua para lograr que la turba quede otra vez empapada en las áreas antes drenadas
  e. planes de manejo que permitan la recuperación de especies nativas
  f. planes de manejo que permitan que la turba crezca (meta a muy largo plazo)
  g. educación y manejo de la opinión pública
  h. requerimiento de fondos públicos a largo plazo (Proyecto Nacional)
- Visita al pantano, a áreas de explotación de turba artesanal (los derechos terminarán con la muerte del productor tradicional), a canales y tubería para la conducción de agua, a bosques de pino talados y por talar, a áreas recuperadas, al "jardín del pantano" donde hay una gran diversidad de flora nativa. Por la fuerte lluvia que estaba cayendo no se pudo observar la diversidad de pájaros típica de los humedales.
- Discusión sobre dificultades técnicas de talar árboles en un pantano

Fue una experiencia muy interesante a pesar que quedamos empapados y congelados.
Se adjunta material de difusión en el anexo.

3. MATERIAL ENTREGADO

3.1 Fotocopias de las clases, publicaciones y esquemas

- ver temas descritos en punto 1, además:

- Joana Magos Brehm: Sistemas de Información Geográfica (GIS)
    - ¿Qué es GIS?
    - ¿Cómo funciona?
    - Modelamiento espacial
    - Formatos de representación de datos
    - El uso de GIS en la conservación
    - Algunos software: DIVA-GIS, FloraMap, ArcGIS

- Edwin Chiwona: Definición de "landraces" (razas o variedades locales)
    - Fuentes
    - Definición

- Hawkes J.G. (1980): Crop Genetic Resources Field Collection Manual. International Board for Plant Genetic Resources and EUCARPIA

3.2 Libro

- Stalton S, Maxted N, Ford-Lloyd B, Kell S, Dudley N (2006): Food Stores – Using protected areas to secure crop genetic diversity. WWF The Arguments for Protection Series

3.3 Publicaciones y presentaciones en formato digital (se adjunta copia de CD)

3.3.1 Presentaciones en formato PowerPoint

Introducción a la conservación:

* ¿Qué es Biodiversidad?
* ¿Por qué es necesario conservar Biodiversidad?
* ¿Qué son PGR (recursos genéticos vegetales)?
* Modelo de conservación de recursos genéticos vegetales
* Conservación de biodiversidad sustentable e integrada

CWR contexto (Crop Wild Relatives = Parientes Silvestres de Cultivos)

- CWR y PGR (Parientes silvestres de cultivos y recursos genéticos vegetales)
- PGR Forum
- Catálogo y bases de datos europeos de CWR
- Estrategia global de la conservación y del uso de CWR

Conservación y uso de los recursos genéticos vegetales; Introducción a la conservación *in situ*

Ver 1.1

Conservación y uso de los recursos genéticos vegetales; diseño de la reserva

Ver 1.3

Conservación y uso de los recursos genéticos vegetales; Manejo y monitoreo de la reserva

Ver 1.4

Desarrollando una estrategia nacional de "Crop Wild Relative" (CWR) (= Parientes silvestres de cultivos)

(ver 1.5)

Análisis de discrepancia de recursos genéticos vegetales: fijando CWR como objetivo para la conservación *in situ* y *ex situ*

- ¿Qué es análisis de discrepancia?
- Metodología ejemplo *Vigna*
    1. Descripción del taxón y del área objetivo
    2. Evaluación de la diversidad natural *in situ*
    3. Evaluación de estrategias de conservación en curso
    4. Dando prioridades para la conservación

Erosión genética y contaminación genética: Algunos pensamientos

- Definición de erosión genética
- Estrategia global para la conservación y el uso de CWR
- Ejemplos Leguminosas
- Evaluación de la erosión
- Especies en peligro de sufrir erosión genética y factores que la pueden gatillar
- Indicadores de la erosión genética
- Contaminación genética

Selección de la especie objetivo

- Asignando prioridades de conservación
- Factores que afectan las prioridades de la conservación

3.3.2 Publicaciones en formato digital

Crop Wild Relative Conservation and Protected Area Management

Desarrollo de una estrategia nacional de CWR (parientes silvestres de cultivos)

1. Diversidad botánica nacional
2. Inventario de CWR nacionales (que tenga el mismo género del cultivo) e identificación de algunos lugares para la conservación in situ
3. Priorizar CWR especies/ diversidad en base a valor económico y amenazas
4. Análisis ecogeografico y genético de las CWR prioritarias (áreas con alta incidencia)
5. Identificar las amenazas de la diversidad de los parientes silvestres de cultivos
6. Análisis de discrepancia y establecimiento de metas de conservación
7. Desarrollo de prioridades de conservación de CWR *in situ/ ex situ*
8. Definir unos 10 áreas protegidas nacionales relacionadas con CWR
9. Uso general y profesional
10. Investigación y educación

Desarrollo de una estrategia de área protegida CWR individual

1. Evaluación del sitio
2. Evaluación de factores locales socio-económicos y políticos
3. Diseño de la reserva
4. Adaptación del plan de manejo del área protegida
5. Monitoreo de la reserva
6. Uso
7. Educación e investigación
8. Vincular con la conservación *ex situ* y duplicados

Crop Wild Relatives Catalogue, Threats, Conservation and Use

Parientes silvestres de cultivos – catálogo, amenazas, conservación y uso

PGR (Recursos genéticos vegetales) y CWR (parientes silvestres de cultivos)

Definiciones

Las amenazas de CWR - ¿para qué conservar?

Inventarios, planes de acción, conservación *in situ* y *ex situ*

Desarrollo de una estrategia CWR nacional (ejemplo *Vigna*, Africa)

IUCN categorías de la lista roja, *Vigna*

Análisis de vulnerabilidad del taxón, *Vigna*

Técnicas *in situ* y *ex situ*

Indicadores CWR: científicos, directos, indirectos, fuentes de datos, datos de terreno

Datos científicos directos:

- diversidad genética: marcadores moleculares de muestras *ex situ* o poblaciones en el mismo momento
- indicadores taxonómicos

Datos científicos indirectos:

- indicadores demográficos (densidad, frecuencia, cobertura, dispersión, fertilidad)
- indicadores de nomenclatura
- indicadores etnogeográficos
- indicador ecológico
- indicadore de amenaza
- indicadores socio-económicos y políticos

CWR Global Strategy Draft 1

Hacia una estrategia global de conservación y uso de CWR

- importancia global y local de CWR
- situación actual
- objetivos y acciones requeridas para los próximos 5 a 10 años

CWR National Red Listing

Enfoque nacional de la clasificación de CWR: ¿es tan difícil como creemos?

- obligación de los países que suscribieron el CBD de identificar a los componentes importantes de diversidad genética
- Estudio de amenazas (categorías de la lista roja IUCN)

CWR Oaxaca

Conservación y uso sustentable de CWR

- Definición CWR
- Necesidad de inventarios y sistemas de información
- La integración de la conservación de CWR en programas nacionales, regionales e internacionales
- Desarrollo y aplicación de un mecanismo de determinación de prioridad
- Evaluación de las amenazas de CWR y efectividad de acciones de conservación
- Sensibilización
- Desarrollo político y marco legal

Estudios de caso de México: especies de cactus

Arveja (*Lathyrus)* y especies relacionadas

Ecogeographic Surveys

Componentes principales de investigaciones eco-geográficos:

- distribuciones de especies particulares en regiones/ ecosistemas particulares
- patrones de diversidad intra-específica
- relaciones entre sobrevivencia y frecuencia de variantes y condiciones ecológicas asociadas

Un estudio ecogeográfico es un proceso de recolección y síntesis de información ecológica, geográfica y taxonómica.

Fase I: Diseño del proyecto

Fase II: Recolección y análisis de datos

Fase III: Generación del producto (informe) – identificación de prioridades de conservación

- Delimitación del taxón objetivo
- Clasificación usada y por qué
- Modo de selección de especimenes representativas
- Elección de hardware y software
- Estructura del archivo de la base de datos eco-geográficos y relaciones
- Discusión del contenido de la base de datos
- Discusión de la ecología del taxón objetivo
- Discusión de la fito-geografía, patrones de distribución, resumen de distribución (tabla)
- Cualquier variante taxonómica encontrada
- Usos actuales y potenciales
- Relación especies cultivadas con parientes silvestres
- Cualquier problema particular de identificación
- Actividades de conservación *in situ* y *ex situ*
- Amenaza de erosión genética
- Prioridades y estrategia propuesta para la conservación
- "Conspectus" eco-geográfico (en el anexo)

Ejemplos de construcción de un "conspectus" (Vicia)

Ecogeographic and Genetic Diversity

El uso de diversidad eco-geográfica y genética como guía para una conservación genética vegetal

Análisis multivariado de colecciones de

Beta vulgaris,

Brassica rapa,

Calluna vulgaris,

Chamaemelum nobile y

Trifolium repens

en muestras de poblaciones naturales en Reino Unido con Popgene, TFPGA, NTSYS, EXCEL con GenAl ex_V

GAP Analysis: a tool for effective genetic conservation assessment of agrobiodiversity

Análisis de discrepancia en la conservación de la diversidad

1. identificar y clasificar biodiversidad
2. localizar áreas manejadas principalmente para biodiversidad
3. identificar biodiversidad de áreas poco representadas
4. definir prioridades para la conservación

Ejemplo *Vigna*; pasos:

1. Descripción del taxón y del área objetivo
2. Evaluación de la diversidad natural (diversidad taxonómica; genética; ecogeográfica y evaluación de las amenazas)

   Muestrear una gran cantidad de plantas en muchas poblaciones cubriendo un rango ecogeográfico amplio
3. Evaluación de estrategias de conservación en curso (*in situ* y *ex situ*)
   a. Técnicas de conservación *in situ* (reservas genéticas u *on-farm*)
   b. Conservación *ex situ* (www.ipgri.cgiar.org/germplasm/dbintro.htm)
4. Definir prioridades para las acciones de conservación

Conclusiones:

1. Una estrategia de conservación se puede desarrollar en base a un análisis de discrepancia tradicional
2. La cuantificación de la cobertura de las acciones de conservación a través de estudios en herbarios y accesiones de germoplasma junto con datos ecogeográficos.

Genetic erosion and genetic pollution

Erosión genética y contaminación genética en parientes silvestres de cultivos (CWR)

Definición de erosión genética: Reducción permanente en riqueza e igualdad de alelos locales comunes o pérdida de combinaciones de alelos en el tiempo y en un área definido

Definición de contaminación genética

Medición de erosión genética

- en base a la erosión pasada
- predecir erosión genética futura (modelo de cuantificación de la amenaza. General: distribución, sequía, inundaciones)

Indicadores de contaminación genética:

- introducción de diversidad genética ajena

- un genoma con potenciales efectos perjudiciales
- forma: a propósito, natural, accidental

Prioridad alta: taxón pariente de cultivos, raro; con diversidad genética única; restringido a hábitats amenazados; vulnerable debido a cambios en la agricultura

Prioridad media: especies de recolección silvestres; restringido a localidades en las cercanías a ciudades y hábitats raros o restringidos; susceptible a desastres naturales

Prioridad baja: no existente en áreas protegidas; no hay duplicados en conservación *ex situ*

Planning plant genetic conservation

La conservación de recursos genéticos vegetales vincula la diversidad genética de una planta con su uso o explotación humana

Un modelo de conservación genética vegetal

Ejemplos de legislación sobre la conservación de plantas internacionales

El concepto de los "gene pools"

Fuentes de información usadas para establecer el estatus actual de conservación

Guía de colecciones de germoplasma

Identificación de metas (objetivos, taxón y áreas a estudiar)

Definición y ejemplos de estudios eco-geográficos

Fase I: Diseño del Proyecto (y cuadros dónde encontrar información..)

Fase II: Recolección de datos y análisis (listado de germoplasma conservado; estudio de información geográfica, ecológica y taxonómica publicada; colección de datos eco-geográficos; selección de ejemplares; verificación de datos; análisis de datos geográficos, ecológicos y taxonómicos: distribución de frecuencias, mapeo de datos eco-geográficos, análisis multivariados)

Fase III: Producción: Base de datos eco-geográfico; conspectus, informe (y ejemplos)

National PGR Strategy 1 CWR

Desarrollando una estrategia nacional de recursos genéticos vegetales: CWR

Modelo para el desarrollo de estrategias nacionales de CWR (ver abajo) y descripción detallada

Ejemplo de un plan de acción de CWR: *Trifolium incarnatum* ("Long-headed clover")

PGR Planning

Planificando conservación genética vegetal (muy completo)

Contiene también información dada en la publicación antepasada del mismo título

- uso socio-económico
- amenaza percibida (IUCN)
- distinción taxonómica y genética

- Distinción eco-geográfica
- Importancia biológica
- Importancia cultural (Cedro del Líbano)
- Costo relativo de la conservación
- Sustentabilidad de la conservación
- Legislación (ejemplos internacionales)
- Consideraciones éticas y estéticas
- Las prioridades de agencias de conservación

Comisión del proyecto de conservación

Estudios eco-geográficos

Un modelo eco-geográfico (ver esquema abajo) – descripción muy detallada de cada fase (diseño del proyecto, recolección y análisis de datos, producción)

Mapeo también en detalle

Towards the Selection of Taxa for Plant Genetic Conservation

Hacia la selección de taxa para la conservación genética vegetal

Factores a considerar cuando se prioriza un taxón para la conservación y discusión:

- estatus de conservación actual
- uso económico potencial
- amenaza de erosión genética
- distinción genética
- distribución eco-geográfica
- importancia biológica
- importancia cultural
- costo
- factibilidad y sustentabilidad
- legislación
- consideraciones éticas y estéticas
- prioridades de la agencia encargada de la conservación

Cuadro: umbrales de categorías de amenaza (ver tabla abajo)

Informe: St. Katherine Protectorate Management Plan Reference January 2003

Introducción

Evaluación y descripción de los lugares

Priority Management issues, constraints and obligations

Metas y objetivos del manejo

Zonas internas de manejo

Principios, política y estrategias de manejo generales para el protectorado de St Catherine

Herramientas y actividades de manejo

Recursos de manejo

3.3.3 Libros en formato digital

Stalton S, Maxted N, Ford-Lloyd B, Kell S, Dudley N (2006): Food Stores – Using protected areas to secure crop genetic diversity. WWF The Arguments for Protection Series (También impreso)

Maxted, N., Ford-Lloyd, B.V., Hawkes, J.G. (1997). Plant genetic conservation: the in situ approach. Chapman & Hall, 451 p. (el CD contiene los siguientes capítulos):

2. Complementary Conservation Strategies
3. Selection of target taxa
4. Ecogeographic surveys
5. Technical and political factors, constraining reserve placements
6. Plant population genetics
7. Plant population ecology
8. Reserve design
9. Management and monitoring
10. Locally base crop plant conservation
11. Genetic conservation information management
12. Estimation of genetic diversity
13. Conserving the genetic resources of trees in situ
14. Integrating plant and insect conservation
15. Case study 1: The Ammiad Experiment
16. Case Study 2: In situ conservation of genetic diversity in Turkey
17. Case study 3: Genetic conservation: a role for rice farmers
18. Case study 4: Ethiopean in situ conservation
19. Peruvian in situ conservation of Andean crops
20. Central Asian in situ conservation of wild relatives of cultivated plants
21. Plant conservation in situ for disease resistance
22. A practical model for in situ genetic conservation
23. Towards the future

References

4. ENTREVISTAS PERSONALES CON EL DR. NIGEL MAXTED

11 de diciembre de 2006

El Dr. Maxted quiso conocer mis intereses para confeccionar un CD con información relevante publicada y en vías de publicación.

Se acordó el plan de trabajo.

18 de diciembre de 2006

Entrevista para aclarar dudas y preguntas sobre el material entregado. Para revisar un ejemplo de estudio eco-geográfico me prestó un libro:

> Maxted N.,P. Mabuza-Dlamini, H. Moss, S. Padulosi, A. Jarvis y L. Guarino (2004): An ecogeographic study: African Vigna. IPGRI, Roma, Italia.

Conversación sobre la situación en Chile. El Dr. Maxted recomienda:

- en el caso de la conservación de papa contactarse con el CID quienes tienen fondos para este objetivo
- buscar variedades locales antiguas, por ejemplo en vid, para comercializar el producto de estas variedades en forma exclusiva (le comenté que se está haciendo el caso del Merlot)

Entrega de algunos software sobre análisis de datos en la conservación para revisar. Facilitó los siguientes:

- FloraMap (mapeo), disponible en Internet
- ArcInfo y ArcView (mapeo, muy bueno pero muy caro, revisar si hay en Chile)
- KCV MultiVariate Statistical Package (www.kovcomp.com)
- Density from Distances. A program for calculating animal and plant densities using plotless and distance sampling method. PISCES Conservation LTD. (www.irchouse.demon.co.uk y pisces@irchouse.demon.co.uk) Me parece un programa adecuada para la evaluación de poblaciones naturals de especies medicinales silvetres
- ECOM. Ordination & clasification of biological and environmental data.
- Species Diversity & Richness III
- Community Anaysis Package. A program to search for structur in ecological community data.

Los tres últimos también de PISCES Conservation LTD. Son programas ecológicas enfocadas en la evaluación de comunidades.

Entrega de categorías y criteria de especies amenazadas (www.iucnredlist.org/info/categories_criteria2001)

21 de diciembre de 2006

Entrega de material sobre grupo de trabajo de parientes silvestres de cultivos:

Las 5 primeras ediciones de la revista "Crop wild relative" del European crop wild relative diversity assessment and conservation forum (www.pgrforum.org)

1. Octubre de 2003

- Introducción al PGR Forum
- ¿Por qué los parientes silvestres de los cultivos (CWR) son importantes?
- PGR Forum actividades, participantes y logo

2. Julio de 2004

- Manejo in situ racional de especies silvestres de *Beta*
- Manejo de poblaciones de CWR
- PGR Forum workshop 5: Evaluación de erosión y contaminación genética
- La iniciativa de micro-reserva de plantas de la comunidad de Valencia y su uso para conservar poblaciones de CWR
- *Pistacia terebinthus* monoica encontrado en Bulgaria
- Haciendo base de datos de especies interoperable: un taller avanzado

3. Abril 2005

- Monitoreando cambios evolutivos en árboles forestales: conceptos generales y un estudio de caso en el álamo europeo (*Populus nigra*)
- Una iniciativa global para conservar CWR in situ
- Distribución de *Apium repens* poblaciones en Hungaria
- Metodologías de evaluación de erosión y contaminación genética
- Cambios en el manejo de pastizales y su efecto sobre la diversidad de plantas
- Novel sewerage treatment Technologies: a new group of potential crop plants emerges to be conserved in situ
- Variación genética en Brassicas silvestres en Inglaterra y Gales

4. Julio 2005

- Introducción al Sistema de información del PGR Forum CWR
- Evaluación de amenaza y conservación de parientes silvestres de cultivo

5. Octubre 2005

- 1st Internacional Conference on CWR conservation and use
- Establecimiento del IUCN/SSC CWR grupo de especialistas
- Hacia una estrategia global para la conservación y el uso de CWR

- PGR Forum: un proyecto termina pero la misión continúa

PGR Forum European Crop Wild Relative Diversity Assessment and Conservation Forum:

Crop Wild Relative Case Studies 1 – 5:

1. Ecotypic exploration and characterization trials to promote conservation of *Arnica montana* L. in Northern Europe
2. *Lupinus hispanicus* Boiss.& Reut. in the Iberian Peninsula: a crop wild relative traditionally harvested for fodder
3. *Linum dolomiticum* Borbás a strictly protected wild relative of cultivated flax in Hungary
4. *Avena strigosa* (Schreb.) in North-Western Europe: a historical landrace without crop wild relatives?
5. The PGR Forum Crop Wild Relative Information System (CWRIS): information management for CWR illustrated with case studies

Un modelo de conservación genética vegetal (adaptado de Maxted *et al.*, 1997a).

Diversidad genética vegetal

Selección del taxón objetivo

Comisión del proyecto

Inspección eco-geográfica / Misión preliminar de inspección

Objetivos de conservación

Exploración en terreno

Estrategias de conservación

Ex Situ
(Ubicación, muestreo y traslado)

- almacenamiento de semilla
- banco de germoplasma en terreno
- jardín botánico
- almacenamiento *in vitro*
- almacenamiento de polen
- almacenamiento de ADN

In Situ
(Ubicación, caracterización y manejo)

- reserva genética
- on-farm
- huertos caseros

Productos de conservación
(Semilla, plantas vivas y muertas, explantes *in vitro*, ADN, polen, datos)

Deposición y diseminación de productos conservados
(Bancos de germoplasma,
reservas, jardínes botánicos, laboratorios de conservación, sistemas on-farm)

Caracterización / Evaluación

Uso de recursos genéticos vegetales
(Mejoramiento genético / biotecnología / recreación)

Uso de productos
(Nuevas variedades, nuevos cultivos, uso farmacéutico, investigación básica y aplicada, diversidad on-farm, contemplación estética, etc.)

Un modelo esquemático de una inspección eco-geográfica (Maxted et al., 1995)

FASE 1 **DISEÑO DEL PROYECTO**

Identificación de pericia del taxón

Selección de la taxonomía del taxón objetivo

Delimitación del área objetivo

Identificación de colecciones del taxón

Diseño y construcción de una estructura de base de datos ecogeográficos

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FASE 2 **COLECCIÓN Y ANÁLISIS DE DATOS**

Listado de germoplasma conservado

Estudio de datos geográficos, ecológicos y taxonómicos existentes

Recolección de datos ecogeográficos

Selección de ejemplares representativos

Verificación de datos

Análisis de datos geográficos, ecológicos y taxonómicos

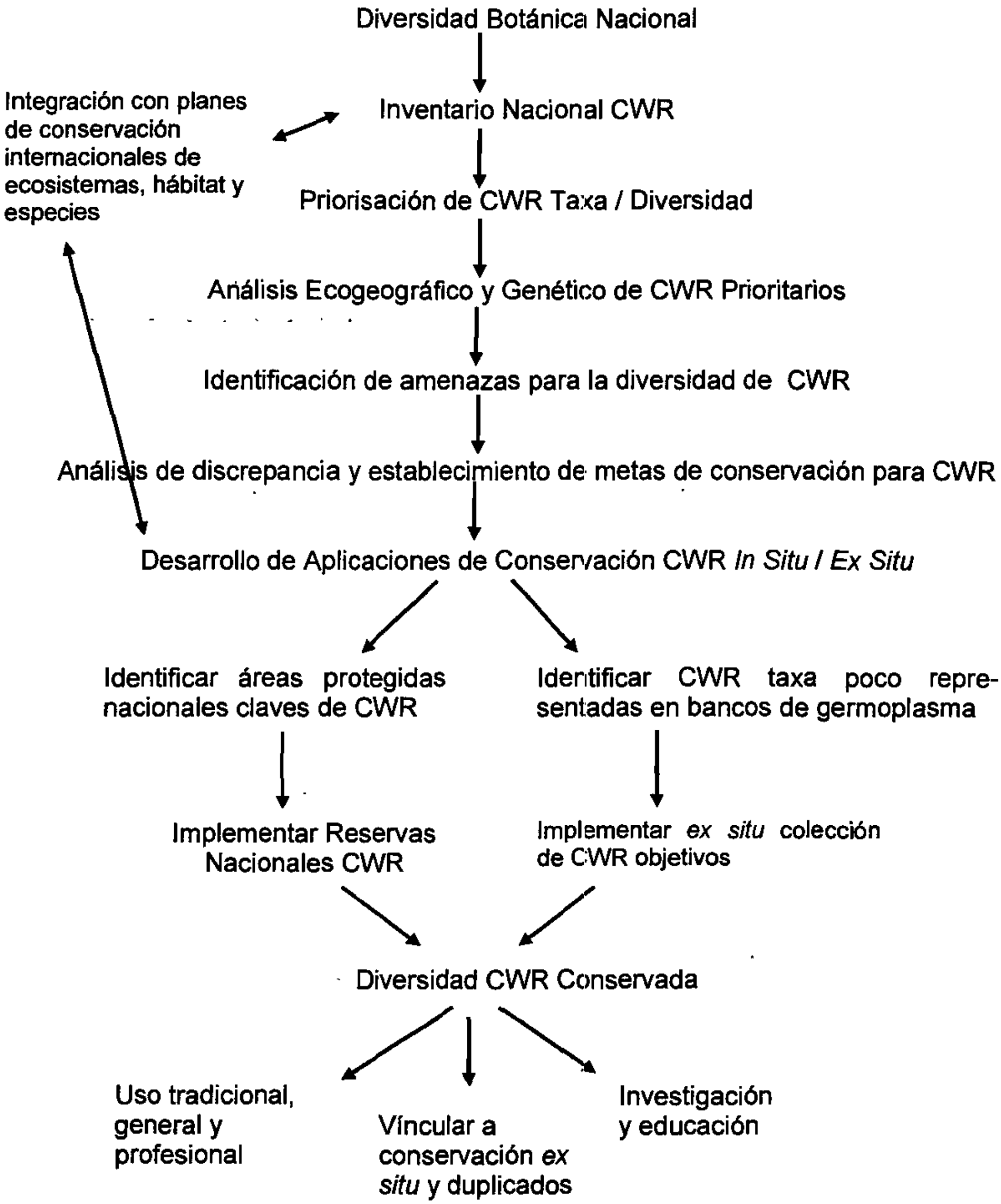
FASE 3 **PRODUCCION**

Análisis de datos

Base de datos ecogeográfica | Conspectus ecogeográfico | Informe ecogeográfico

Identificación de prioridades de conservación

Un Modelo para el desarrollo de estrategias nacionales de diversidad botánica en CWR



IUCN Criteria (ver "Gap Análisis, p.10)

Para ser listado en una categoría de la Lista Roja es necesario cumplir al menos uno de cinco criterios:

A) Reducción de la población: descenso medido por un periodo de más de 10 años o tres generaciones
B) Extensión del hábitat geográfico
C) Tamaño de la población pequeño o en descenso
D) Población muy pequeña o restringida
E) Análisis cuantitativo que muestre la probabilidad de extinción en los próximos 100 años

También en Libro "An ecogeographic study African Vigna", 2004, aparece evaluación de la vulnerabilidad en base a 7 criterios:

- Rareza (N° de especimenes y accesiones en bancos de germoplasma de cada taxón en la base de datos ecogeográfico)
- Rango de distribución (suma de los círculos alrededor de cada lugar de colección)
- Representación global en colecciones *ex situ* (accesiones en bancos de germoplasma deben ser al menos el 10% de los especimenes en herbarios – cualquier especie con una proporción menor es vulnerable)
- Cobertura geográfica de colecciones *ex situ*
- Cobertura de colecciones *ex situ*
- Utilidad
- Evaluación de extinción

Tabla 1. Umbrales de categories de amenaza, según Department of Environment (1996).

Criterios	Umbrales numéricos principales		
	Crítico	En peligro	Vulnerable
A. Deterioro rápido	>80% por 10 años o 3 generaciones	>50% por 10 años o 3 generaciones	>50% por 20 años o 5 generaciones
B. Hábitat pequeño (fragmentado, en deterioro o fluctuando	Presencia en <100 km² o área de ocupación <10 km²	Presencia en <5,000 km² o área de ocupación <500 km²	Presencia en <20,000 km² o área de ocupación <2,000 km²
C. Población pequeña (en deterioro)	<250 individuos maduros	<2,500 individuos maduros	<10,000 individuos maduros
D1. Población muy pequeña	<50 individuos maduros	<250 individuos maduros	<1,000 individuos maduros
D2. Hábitat muy pequeño	-	-	<100km² o <5 ubicaciones
E. Análisis de viabilidad de la población no favorable	Probabilidad de extinción >50% dentro de 5 años	Probabilidad de extinción >20% dentro de 20 años	Probabilidad de extinción >10% dentro de 100 años

Dr. Horst Tremp
Universidad de Hohenheim / Limnoterra
3 de enero de 2007

Informa sobre su participación en el taller "Assessment for maximum sustainable yield of medicinal and aromatic plants (MAPs)" que se realizó en septiembre en el INA Vilm, Alemania, y las contribuciones más relevantes. Las exposiciones se encuentran en los sitios web de ISSC-MAP y Bundesamt für Naturschutz y www.floraweb.de/map-pro.

El Dr. Tremp participó por su vasta experiencia en el monitoreo de poblaciones naturales de diversas especies. Plantea que el trabajo con poblaciones de plantas medicinales es como el estudio de cualquier otra especie, medicinal o no, y que no ve razón porqué limitar el tema a este grupo de especies.

Destaca la labor de Jennifer Wong en el taller quien trabaja en los "Assessment Guidelines" que está elaborando la FAO, los que saldrán muy probablemente durante el año presente y que marcarán la pauta para todo el rubro. En el anexo se adjunta un flujo de trabajo propuesto.

También destaca el trabajo participativo de Anna Lawrence del Environmental Change Institute, Universidad de Oxford en India. En el anexo se adjunta la fotocopia entregada "Participatory science for sustainable forest harvesting", no disponible en el sitio web indicado. En el flujo destaca como parte central un diseño experimental riguroso para cada especie.

Una contribución entretenida dio Maximilian Weigend de Berlin con varios ejemplos de la importancia de la taxonomía en la cadena de comercialización de las plantas medicinales.

Para aprender sobre la evaluación y el monitoreo de poblaciones silvestres recomienda el libro:

Elzinga, C.L., Salazar D.W., Willoughby J.W., Gibbs J.P. 2001. Monitoring Plant and Animal Populations. Oxford: Blackwell Science disponible en Amazon

Tambien: Handbook of Biodiversity Methods de los editores D. Hill, M. Fasham y G. Tucker (aunque estos temas también se tratan e el primer libro)

Finalmente, conversamos sobre algunos casos concretos de especies medicinales de recolección silvestre en Chile, en primer lugar el caso de bailahuén.

Dice que es fundamental tener datos exactos sobre las poblaciones. Si sospechamos que existan poblaciones no conocidas recomienda trabajar con el sistema de información geográfica. Hay que observar en terreno las características de los sitios donde las especies se desarrollan y propagan naturalmente para conocer los factores limitantes. Luego esta información (datos climáticos, edáficos, altura, exposición, etc.) se puede mapear y encontrar posibles sitios donde la especie encuentra las condiciones para su desarrollo. Hay que verificar en terreno si la especie se encuentra en estos lugares.

También destaca que para elaborar guías de recolección hay que diferenciar entre las poblaciones. Poblaciones que se encuentran en un rejuvenecimiento constante podrían intervenirse en mayor grado que poblaciones que no tienen las condiciones para propagarse efectivamente. Propagación efectiva es cuando las plantas de una especie se propagan y también forman plantas adultas. Dice que algunas poblaciones sólo se propagan cada 20 o más años cuando las condiciones están dadas para que las plantas germinadas se establezcan y formen plantas adultas. Estos ciclos largos son bien frecuentes en arbustos o árboles, sobre todo en condiciones semi-áridas (cuenta de su experiencia con algunos estudios en España y compartimos también nuestra experiencia en orquídeas silvestres- cuenta de errores frecuentes en le monitoreo de especies raras en la zona). Estas poblaciones deben intervenirse con menor frecuencia.

Otra recomendación podría ser que se recolecte en un área más grande o que algunas poblaciones simplemente no deben cosecharse.

Para diseñar una estrategia de conservación es importante especificar los factores de peligro para cada especie y población.

Para el caso de bailahuén propone estudiar y elaborar estrategias de producción sustentable primero para una sola especie para desarrollar un modelo el cual se podrá aplicar posteriormente a otras especies.

Dice que un monitoreo no necesariamente hay que hacer en el tiempo, sino se pueden hacer conclusiones al estudiar y evaluar bien diferentes poblaciones al mismo tiempo. Muchos proyectos tienen el financiamiento limitado, por eso propone diseñar estudios más baratos con una buena preparación, los cuales siempre encontrarán financiamiento.

También cuenta de experiencias muy positivas en trabajos donde participan eco-sicólogos (ejemplo Arnica en Romania).

El Dr. Tremp ofrece su ayuda en caso de cualquier duda a través del correo electrónico.

Conclusiones:

- contactar especialistas en GIS (geographic information system) en la Universidad de Talca o en otras instituciones en Chile (p.ej. CONAMA)
- comprar y estudiar el libro de Elzinga sobre principios de monitoreo
- determinar las condiciones ambientales en las cuales se desarrolla *Haplopappus taeda*
- seguir con los ensayos de producción sustentable

Dr. Ernst Schneider
PhytoConsulting
Freinberg, Marklkofen
5 de enero de 2006

En entrevista con el Dr. Ernst Schneider se entregaron varios documentos relacionados con las plantas medicinales en formato digital (ver abajo)

Elaboró una presentación sobre el estudio de las poblaciones naturales de *Iberis* en Europa, proyecto en el cual está trabajando.

Novedades en instancias y personas relacionadas con las plantas medicinales y el majeno de los recursos genéticos:

- Congreso CWR en Sicilia
- Grupo MAP en IPGRI (E. Schneider fue inicialmente miembro representando Alemania)
- En el ZAG, Quedlinburg (Alemania) se jubiló Dr. Pank. Su sucesor es Dr. Marthe. Trabajo en Umbeliferas; mientras que la colección ex situ de cebada se encuentra en Gatersleben, Alemania y la de Leguminosas europeas en Austria
- Dr. Netzadal, geobotánica
- Los indicadores de factores ecológicos ("Ecological Fact Sheets") se publicaron por primera vez por Heinz Ellenberg en "Scripta Geobotanica IX"
- Jolita Radusiene, Lituania; importante referente en trabajo banco germoplasma de plantas medicinales
- Taller "Assessing the sustainable yield in medicinal and aromatic plant collection", realizado en la Isla de Vilm, Alemania del 14 al 17 de septiembre de 2006. Se adjunta todo el material en formato digital. Destaca la presentación de J. Wong, Inglaterra, junto con el Profesor Klein, Alemania, quien trabaja en una propuesta para FAO de productos forestales no madereros. También menciona el trabajo de Moerman: etonobotánica nativa de América.
- También destaca la labor de Dr. Uwe Schippmann (entrevista personal abajo)

Se discutió la situación sobre el bailahuén. Cabe mencionar que el Dr. Schneider ha elaborado un estudio de mercado de esta especie en el mercado alemán. En conversaciones con los principales investigadores, empresas fitofarmacéuticas y brokers se encontró con respuestas vagas de parte de Matthias Lorenz, de las cuales pudo concluir que bailahuén se está utilizando en grandes cantidades por algún compuesto químico interesante. El hecho que las grandes cantidades de bailahuén que se están exportando se colectan en áreas donde habita *Haplopappus taeda* le hizo sobreponer el especto químico con patentes. Llama la atención la similitud de la estructura de diosmetina y 3-acetoxyflavona. El primer compuesto es buscado por la industria cosmética y el segundo se encuentra en *H. taeda*. Esta similitud coincide con la alta demanda de esta especie, recolectado en su hábitat natural y exportado a Alemania.

Se conversó sobre los siguientes puntos para una iniciativa de producción sustentable, p.ej. en bailahuén (muchas coincidencia con nuestros puntos de vista y con las entrevistas que he tendido anteriormente con Nigel Maxted y Horst Tremp)

- Análisis de discrepancia de mapas de distribución y mapas con los lugares de presencia
- Perfil ecológico de la especie
- Indicadores de factores ecológicos
- Calidad (p.ej. mapa fitoquímica)
- Factores que influyen en la distribución, p.ej. competencia

- Dinámica de poblaciones (sustentabilidad)
- Áreas de observación permanente (p.ej. en cooperación con CONAF)
- Calidad y variabilidad en el tiempo
- Cooperación con los lugareños (aspecto socio-económico)
- Zonas de protección (conservación in situ)
- Formación e instrucción de recolectores (preparación manual y pósteres)
- Marco legal y realización administrativa
- Conservación ex situ del recurso (banco de germoplasma con descripción exacta de acuerdo a las normas IPGRI)
- Domesticación
- Cultivo en caso de un aumento de la demanda

Material entregado:

1. Presentación y discusión sobre cómo evaluar las poblaciones silvestres de plantas medicinales, con mira a bailahuén

2. Puntos de discusión sobre le caso bailahuén; Listados elaborado por el Dr. Schneider para nuestra entrevista. Incluye las siguientes recomendaciones citadas arriba

3. Comparación estructural del compuesto "diosmetina" con 3-acetoxyflavone encontrado en *Haplopappus taeda*

4. CD con material diverso con las siguientes carpetas o archivos:

   4.1 Vilm 2006
   Taller "Assessing the sustainable yield in medicinal and aromatic plant collection", realizado en la Isla de Vilm, Alemania del 14 al 17 de septiembre de 2006
   - Conferencias
   - Abstracts
   - Bibliografía sobre métodos de evaluación de recursos vegetales de productos forestales no madereros enfocado a plantas medicinales y aromáticas preparado por Uwe Schippmann y Dagmar Lange
   - Participantes
   - Programa

   4.2 CWR-PGR Forum (ver punto 8)

   4.3 Material IPGRI MAP working group
   - Working Group on Medicinal and Aromatic Plants
   - Proposal for a MAP Descriptor List
   - Draft descriptors list *Artemisia absinthum* L.
   - Draft descriptors list *Salvia officinalis* L.
   - Comments

   4.4 Otros (Material sobre plantas chilenas encontrado por Dr. Schneider en internet)
   - CONAMA: Flora. Recursos Bióticos (Biodiversidad)
   - Ministerio de Agricultura: "Investigarán los secretos ancestrales del amqui y el bailahuén"
   - Presentación de la publicación de una tesis doctora de L. Klingenberg: Monografía de los géneros sudamericanos de *Haplopappus* y *Notopappus*. (Estudio realizado con la Universidad de Concepción donde, después de la publicación, posiblemente se encontrará un ejemplar)

- Presentación de una trabajo de boldo de Gloria Montenegro en Trieste, Italia, Mayo 2005
- "Productos forestales no madereros en Chile", preparado por Jorge Campos, Corporación de Investigación Tecnológica, INTEC, Chile. 1998.
- "Grupos funcionales en arbustos desérticos del Norte de Chile, definidos sobre la base de las fuentes de agua utilizadas" de F.A. Squeo et al, Gayana Bot. 56(1): 1-15. 1999.

5. CD: "Illustrated Handbook for Sustainable Harvest in semi-wild Populations of *Harpagophytum procumbens* and Preparation of Good Quality"

6. CD: FAO Productos Forestales No Madereros: Evaluación de los recursos de productos forestales no madereros. Experiencia y principios biométricos

7. PGR Forum CD-ROM:
   - European Crop Wild Relative Diversity Assessment and Conservation Forum
   - PGR Forum introduction
   - Crop wild relative species
   - PGR Forum project themes
     - CWR Catalogue for Europe and the Mediterranean
     - Threat and conservation assessment
     - In situ conservation data management
     - Population management
     - Genetic erosion and pollution assessment
   - PGR Forum participants
   - PGR Forum partner institutes
   - PGR Forum publications
   - Welcome to CWRIS: the PGR Forum Crop Wild Relative Information System
   - PGR Forum meetings
   - First International Conference on Crop Wild Relative Conservation and Use
   - Web links

8. Informe del grupo de trabajo Plantas Medicinales y Aromáticas del IPGRI, septiembre de 2002 en Slovenia

9. Revista "Medicinal Plant Conservation", Volume 12, Newsletter of the Medicinal Plant Specialist Group of the IUCN Species Survival Commision

10. Publicación de E. Schneider sobre *Iberis amara* en "Zeitschrift für Phytotherapie" 2/06

Dr. Uwe Schippmann
Head Dept. Plant Conservation
Federal Agency for Nature Conservation
Bonn, 9 de enero

El Dr. Schippmann fue el organizador del Taller "Assessing the sustainable yield in medicinal and aromatic plant collection", realizado en la Isla de Vilm, Alemania del 14 al 17 de septiembre de 2006.

Las publicaciones y conclusiones todavía no están listas. Estaban a cargo de la colega Dagmar Lange quien no ha tenido tiempo y a quien responsabilizó por el hecho que el taller podría haber tenido mucho mejores resultados con una mejor preparación.

Coinicidió con las otras personas antes entrevistadas en calificar la contribución de Jennifer Wong "Non-timber forest products" (FAO) como la más importante del taller por la elaboración de manuales metódicos para poder evaluar estadísticamente (ver en material entregado por E. Schneider).

Otra contribución importante es de Mary Stockdale: "Steps to sustainable and community-based NTFP management" (2005).

Destaca también el trabajo de Tamara Ticktin;

Anthony Cunningham: Applied Ethnobotany, 2001;

Elzinga et al.: Measuring & Monitoring Plant Populations (ver también recomendación de Dr. Tremp).

Finalmente, me propuso publicar un trabajo sobre le Mercado de bailahuén en la revista que edita: Medicinal Plant Conservation.

Conversamos sobre el funcionamiento del grupo plantas medicinales que él coordina. Me muestra las instalaciones, me presenta a sus colaboradores, me muestra la colección de hierbas.

Propone que yo integre el grupo de especialistas de plantas medicinales de IUCN-WWF.

Material entregado:

- Un paquete de libros, monografías, revistas y otro material de interés se enviarán por correo
- CD: Taller Vilm (ya incluido en el material entregado por Dr. Schneider)

Dr. Heiko Parzies
Institute of Plant Breeding
Universität Hohenheim
Hohenheim, 11 de enero de 2007

El Dr. Parzies está trabajando en la conservación in situ de *Sorghum* en África. Están, entre otros, estudiando la variabilidad genética mediante marcadores moleculares y morfológicos.

Los bancos de germoplasma que tienen las "core-collections" (bancos de germoplasma especializados en una o varias especies) deben entregar el material. Se busca el uso de este material conservado, por ejemplo en conservación on-farm.

Se agrupan los genotipos en cluster, los que se siembran en terreno para su caracterización. Esto a la vez hace que el material se puede utilizar en programas de mejoramiento genético.

En los proyectos en África están realizando intercambio de material genético, polinización cruzada del material y cultivo de tipos silvestres.

El material genético se está conservando en jardines botánicos y por otra parte se le entrega a agricultores y lugareños.

Como iniciativas muy interesantes ve las mezclas de diferentes genotipos, las que se entregan a agricultores de diferentes localidades, donde se espera que por selección natural se desarrollen tipos o mezclas adaptadas de una variación genética interesante.

En cuanto al tema de conservación de plantas medicinales nativas se conversa lo siguiente:

- con la estadía con Nigel Maxted de la Univerity of Birmingham en Inglaterra ya se ha visto y entregado material importante para entender de la conservación in situ y on-farm
- para especies específicas y su protección recomienda comunicarse con CONAMA quienes están responsables de aplicar la Convención Biológica de Diversidad (CBD)
- hay que estudiar y asesorarse bien para los casos en que aplicaría el "access & benefit-sharing"
- además se puede conseguir información importante en Kew Gardens, tal vez también tengan material (semillas)
- hay que colectar semillas y entregarlas, en las condiciones que estén, a bancos de germoplasma
- los lugares de colección deben registrarse (GPS)
- por otra parte considera importante revisar los IPGRI-Newsletters.
- Propone enviar un manuscrito para publicación sobre temas de domesticación, cultivo, censos y monitoreo, conservación in situ y ex situ y una propuesta de estrategia de conservación.
- Da el dato de la Biselen-Stiftung (www.eiselen-stiftung.de) quienes financian estadías de tesistas
- Un tesista podría trabajar en el mapeo
- Menciona como softwares para mapeo una de FAO, ArcView o Artemio. Ver en www.maproom.psu.edu/dcv (digital chart of the World layer)

El Dr. Parzies se toma el tiempo de mostrarme las instalaciones e invernaderos. Su permanencia en la Universidad de Hohenheim no está asegurada, ya que es asistente de un profesor quien está por jubilarse.

Entrega de material: avance en la Convention on Biological Diversity (sacado del Internet www.biodiv.org/world/map.aspx)

Dr. Gerd Weber
Pflanzenzüchtung und Biotechnologie
Universität Hohenheim
Stuttgart-Hohenheim, 10 de enero de 2007

En una entrevista el Dr. Weber presenta su área de trabajo. Están trabajando en los efectos farmacológicos de lúpulo. Se pretende incorporar un gen de la vid que corresponde a la síntesis del enzima resveratol, una flavona, con efectos anti-fúngicos y anti-virales.

En un proyecto de la EU están estudiando la biodiversidad del manzano.

También están trabajando en patrones de manzano para aumentar la resistencia a enfermedades bacteriales vía transgenia.

Otro trabajo es en conjunto con una universidad en costa Rica, estudiando Papaya. Hay un convenio para el ámbito de docencia, el que se pretende ampliar a Chile, Universidad de Talca.

Están también haciendo inducción de haploides en maíz. Cultivos de células, genética molecular, transferencia de genes.

Para el tema del mejoramiento de orquídeas da el dato de Dr. Carlina Constabel, Alemana, quien trabaja en Canadá con orquídeas de climas templadas. Propaga orquídeas terrestres in vitro para su posterior comercialización. Contacto: carolina.constabel@planteck.com, fono +1-450-5896162.

Anexo 1:

Curso Conservación *in situ*, Universidad de Birmingham, Inglaterra, Handouts

SCHOOL OF BIOLOGICAL SCIENCES

CONSERVATION AND UTILISATION OF PLANT GENETIC RESOURCES

Introduction to *In Situ* Conservation
2006 / 2007 - Nigel Maxted

Publications

Given, D., 1995. Principles and practice of plant conservation. Chapman & Hall, London.

Iriondo, J., Maxted, N., *et al.* (2008). Genetic reserve management guidelines. Technical Bulletin Series. IPGRI, Rome.

Maunder, M., Clubb, C., Hankemer, C. and Groves, M., (2002). Tropical Plant Conservation: Perspective and Practice. Royal Botanic Gardens, Kew.

Maxted, N., Ford-Lloyd, B.V. & Hawkes, J.G., (1997). Plant genetic conservation: the *in situ* approach. Chapman & Hall. pp. 451.

Tuxill, J. and Nabhan, G., (1998). Plants and protected areas: a guide to *in situ* management. People and Plants Conservation Manual 3. Stanley Thornes Ltd.. Cheltenham.

Definitions

Article 2 of the Convention on Biological Diversity

> "*In situ conservation* means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties."

6.1.3 **Site Size, Number, Distribution and Design** Sites should be large enough to contain at least (1,000-)5,000-10,000 individuals of each target species to prevent natural or anthropogenic catastrophes causing severe genetic drift or population inviability. Sites should be selected to maximise environmental heterogeneity. Each reserve site should be surrounded by a buffer zone of the same vegetation type, where experiments on management regimes might be conducted and visits by the public allowed, under supervision.

6.1.4 **Taxon and Reserve Sustainability** Establishing and managing an *in situ* genetic reserve is resource expensive and therefore both the taxon and reserve must be sustainable over an extended period of time or the investment will be forfeit.

6.1.5 **Formulation of the Management Plan** The reserve site will have been selected because it contains abundant and hopefully genetically diverse populations of the target taxon. Therefore, the first step in formulating the management plan is to observe the biotic and abiotic qualities and interactions at the site. Once these ecological dynamics within the reserve are known and understood, a management plan that incorporates these points, at least as they relate to the target taxon, can be proposed.

6.2 Reserve Management and Monitoring

6.2.1 **Initiation of Reserve Management Plan** It is unlikely that any management plan will be wholly appropriate when first applied; it will require detailed monitoring of target and associated taxa and experimentation with the management plan before a more stable plan can be used. The plan may encompass several management regimes (a range of grazing practices, tree-felling, burning etc.) within the reserve.

6.2.2 **Reserve Monitoring** Each site should be monitored systematically at a set time interval and the results fed back in an iterative manner to enhance the evolving management regimes. The monitoring will take the form of measures of taxon number, diversity and density as measured in permanent transects, quadrats etc.

6.3 Reserve Utilisation

6.3.1 **Traditional, General and Professional Utilisation** Humans should conserve because they wish to utilise and it is necessary to make an explicit link between the material conserved and that currently or potentially utilised *ex situ* by humankind. There are three basic user communities: traditional, general and professional.

6.3.2 **Linkage to *Ex Situ* Conservation, Duplication, Research and Education** There is a need to form links with *ex situ* conserved material to ensure utilisation but also as a form of safety duplication. The reserve forms a natural platform for ecological and genetic research, as well as providing educational opportunities

A Methodology for Genetic Reserve Conservation

Phase 1 **Reserve Planning and Establishment**

Site Assessments

↓

Assessment of Local Socio-economic and Political Factors

↓

Reserve Design

↓

Taxon and Reserve Sustainability

↓

Formulation of the Management Plan

Phase 2 **Reserve Management and Monitoring**

Initiation of Reserve Management Plan

↓

Reserve Monitoring

↓

Community Inter-relationships

Phase 3 **Reserve Utilisation**

Traditional, General and Professional Utilisation

↓

Linkage to *Ex Situ* Conservation, Research, Duplication and Education

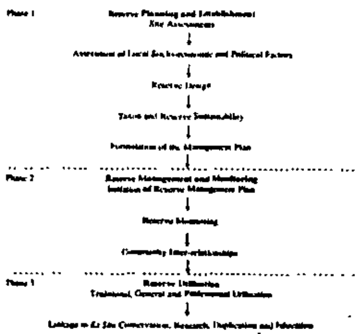
Definitions

- *Genetic Reserve Conservation* - the location, management and monitoring of genetic diversity in natural wild populations within defined areas designated for active, long-term conservation.
- *On-Farm Conservation* - the sustainable management of genetic diversity of locally developed traditional crop varieties with associated wild and weedy species or forms by farmers within traditional agricultural, horticultural or agri-silvicultural cultivation systems.
- *Home Gardens* - The sustainable management of genetic diversity of locally developed, traditional crop varieties by householders within domestic cultivation systems.

Active / Passive

- A distinction can be made between
  - 'active'
  - 'passive'
- *in situ* conservation

Genetic Reserve Conservation



Selection of Target Taxa

- Which species need to be protected
- Which need conservation in a genetic reserves
- Ideally there should be more than one chosen species in each reserve.

Project Commission

- Clear, concise conservation statement establishing
  - Which species
  - Why these species
  - Where in general terms the species are to be conserved

Ecogeographic Survey / Preliminary Survey Mission

- Obtain basic information for the planning of effective conservation.
- Survey the distribution of taxonomic and genetic diversity, ecological requirements and the reproductive biology of the chosen species over its entire geographic range.
- Where little ecogeographic data are available a preliminary course grid survey mission to collate the necessary background biological data on the species may be required.

Taxon and Reserve Sustainability

- Expensive so must be sustainable
- Taxon suitable?
- Site suitable?

IUCN (1993) Definition of a viable population

- Maintains its genetic diversity
- Maintains its potential for evolutionary adaptation
- Minimum risk of extinction

Formulation of the Management Plan

- Site selected because has abundant and hopefully genetically diverse populations of the target taxon.
- Observe the biotic and abiotic qualities and interactions at the site
- Once these ecological dynamics within the reserve are known and understood, a management plan that incorporates these points, at least as they relate to the target taxon, can be proposed.

Initiation of Reserve Management Plan

- Experimental introduction
- Revision based on monitoring of target and associated taxa
- Plan may encompass several management regimes (a range of grazing practices, tree-felling, burning etc.) within the reserve.

Reserve Monitoring

- Monitored systematically
  - Set time interval
  - Feed back loop to site management regimes.
- Monitoring involves measures of taxon number, diversity and density as measured in permanent transects, quadrats etc.

Traditional, General and Professional Utilisation

- Make an explicit link between the material conserved and that currently or potentially utilised *ex situ* by humankind
- Three basic user communities:
  - Traditional
  - General
  - Professional

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Nigel Maxted and Mària Scholten

Session Objectives

- Meet targets / goals of CBD, IT, GSPC, EPCS and CBD 2010 target
- Example of UK National Landrace Inventory
- Methodology for creation of National Landrace Inventory
- European Landrace Inventory

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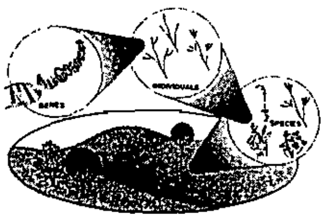
What is biodiversity

Diversity
- Genes
- Species
- Ecosystems



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Threats to Biodiversity

- Global wealth of biodiversity:
  - 250-300,000 plant species (WCMC, 2005)
- Plant diversity is being eroded by the careless actions of humans
  - Extinction
  - Genetic erosion
  - Genetic pollution
- Immediate causes
  - Environmental disturbance or change, loss
  - Over-exploitation
  - Competition from exotic species
  - Etc.

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Threat to plants

	Number of described species	Number of species evaluated in 2006	Number of threatened species in 2006	Number threatened in 2006, as % of species described	Number threatened in 2006, as % of species evaluated**
Plants					
Mosses	15,000	93	80	0.53%	86%
Ferns and allies	13,025	212	139	1%	66%
Gymnosperms	980	908	306	31%	34%
Dicotyledons	199,350	9,538	7,086	4%	74%
Monocotyledons	59,300	1,150	779	1%	68%
Subtotal	287,655	11,901	8,390	3%	70%

www.redlist.org

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But the most severe threat is to …

- LANDRACES
- Why?
  - We have no idea how many land-races of traditional seed-saved varieties exist
  - Landrace maintainers are almost always older and their number is dwindling each year
  - Farmers are by definition commercial they will grow what yields the highest economic return, they are not conservationists
  - Seed companies, breeders and government agencies are actively promoting modern cultivars
  - In most countries no agency has direct responsibility for their conservation
  - No country has an inventory of its extant landraces
- Unless action is taken immediately their loss will continue and complete extinction is the only possible conclusion.

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UK Landrace Database Structure

Field — *Number of records: 67*

- Crop name
- Genus/species/subspecies/citation
- Accepted name
- UK use
- Location
- Number of farmers
- Estimated area

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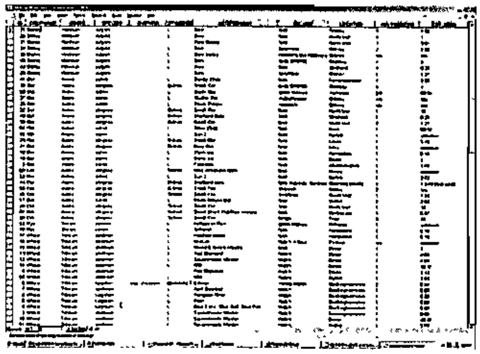
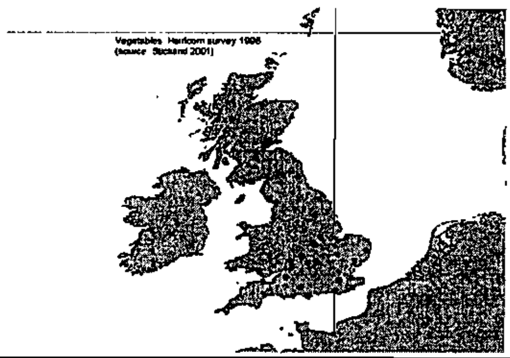
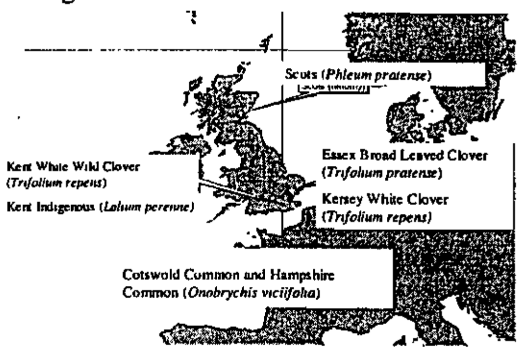
UK Landrace Database



Vegetable Heirloom Vars.



Forage Landraces



Cereal cultivars maintained as landraces

VARIETIES	USERS	USE	REGIME	AREA GROWN
Spelt	n/a	milling	organic	100 hectares
Maris Widgeon	80 - 110	thatch, milling	many organic	80-90 tonnes / yr
Emmer	2	museum	n/a	
Rampton Rivet	1	demo	n/a	
Plumage Archer	1	brewing	organic	100 acres
Sheriff wheat	1	religious	conventional	1/3 acre
several	10	multiple	Biodynamic	350 - 400 acres
SQM	7	thatch	low-nitrogen	546 acres
Rampton Rivet	3	thatch	low-nitrogen	25.3 acres
April Bearded	2	thatch	low-nitrogen	25 acres
Blue Cone	1	thatch	low-nitrogen	20 acres
Little Joss	1	thatch	low-nitrogen	5 acres
Rivet	1	thatch	low-nitrogen	20 acres

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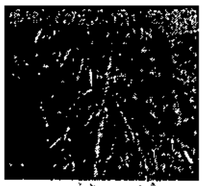
Scottish landraces

- small, bristle, sandy, little or grey oat
  diploid oat (*Avena strigosa* Schreb.)
  widely cultivated until 19th century



- Bere barley 6-rowed barley
  Widely cultivated until 19th century
  past uses. human food and whisky
  no diagnostics, no ecogeographic study

National landrace inventory methodology

1. Definition of landraces
2. What constitutes landrace diversity?
   a. Nomenclatural
   b. Real genetic diversity
3. Scope of inventory = which crops?
   a. Major field crops
   b. Forages
   c. Fruit
   d. Medicinal species
   e. Wild harvested species?
4. Scale of cultivation = what level of cultivation?
   a. Commercial alone
   b. Single farmer
   c. Home garden?

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Land race definitions

- Concept clarification: what are UK land races?
  - Historical Origin
  - Heterogeneity
  - Local adaptation
  - Distinct identity
  - Lack of formal crop improvement
  - Traditional farming systems
  - Farmer seed saving
- Working definition: "a landrace is a dynamic population(s) of a cultivated plant that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems" Camacho Villa *et al.* (2006)

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National landrace inventory methodology

1. Definition of landraces
2. What constitutes landrace diversity?
   a. Nomenclatural
   b. Real genetic diversity
3. Scope of inventory = which crops?
   a. Major field crops
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   c. Fruit
   d. Medicinal species
   e. Wild harvested species?
4. Scale of cultivation = what level of cultivation?
   a. Commercial alone
   b. Single farmer
   c. Home garden?

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National landrace inventory methodology

4. Collation of landrace diversity
- *Ex situ duplication* – origin of landraces conserved in gene banks, field gene banks, botanic gardens, etc
- *Expert advice* – gene banks, national testing centres, research institutes, agricultural extension divisions, farmers' NGOs, agricultural statisticians and other professionals
- *Commercial companies* - companies involved in seed production, brewing, milling, etc.
- *Scientific literature* – including reviews of historical literature, research reports, papers and articles.
- *'Grey literature' archival materials* – gene banks, research institutes and seed companies
- *Internet searches*
- *Official documents* - agricultural statistics, the EU Common Catalogues for vegetable and agricultural varieties (EU 2003a and b) and UK National List 2003 (DEFRA and PVRO 2003).
- *Farmer interviews* - farmers were approached indirectly through advertisements, articles in farmers' magazines and local newspapers, and directly via personal contacts. Questionnaires used by mail or email and interviews conducted by phone or in person.

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National landrace inventory methodology

5. Collate available information into web enabled database (e.g. http://grfa.org.uk/)
6. Match *in situ* landrace diversity against *ex situ* conserved landrace diversity
7. Stimulate use of landraces (breeding, niche promotion, identify perverse incentives, positive incentives, etc.)

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European Funded Projects

- EGRISI (European Genetic Resources *In Situ* Inventory) to be submitted under EC 870/2004 call 2
  - *To inventory European crop wild relatives (CWR) and crop landrace (LR) in situ resources and make the information available via a decentralised, permanent and widely accessible web-based information system*
- ONFARMSAFE (On-farm safeguard of plant genetic resources) submitted under EC 870/2004 call 2
  - *To sustain and promote on-farm conservation of LRs through use, where their current and potential value is greatest in Europe.*
- AEGRO (An Integrated European In situ Management Workplan: Implementing Genetic Reserves and On Farm Concepts) submitted under EC 870/2004 call 2
  - *To demonstrate through case studies the practical implementation of genetic reserves and on-farm projects to best conserve CWR and landrace diversity in Europe*

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SCHOOL OF BIOLOGICAL SCIENCES

CONSERVATION AND UTILISATION OF PLANT GENETIC RESOURCES

RESERVE DESIGN
2006 / 2007 - Nigel Maxted

Publications

Batisse M. (1986). Developing and focussing the biosphere reserve concept. Nature and Resources, 22, 1-10.

Cox G.W. (1993). Conservation Ecology. W.C.. Brown, Publishers, Dubugue, Iowa.

Given D.R. (1994). Principles and Practice of Plant Conservation. Chapman & Hall, London.

Iriondo, J.M., Dulloo, E. & Maxted, N. (2007). Genetic Reserves Management Guidelines. IPGRI Technical Bulletin 12. IPGRI. Rome.

Maxted, N., Ford-Lloyd, B.V. & Hawkes, J.G., (1997). Plant genetic conservation: the *in situ* approach. Chapman & Hall. pp. 451.

Shafer C.L. (1990). Nature Reserves, Island Theory and Conservation Practice. Smithsonian Press, Washington and London.

Soulé, M.E. and Simberloff, D. (1986). What do genetics and ecology tell us about the design of nature reserves? Conservation Biology 35: 19-40.

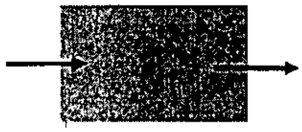
Spellerberg, F.B. Goldsmith & M.G. Morris., (1991). The scientific management of temperate communities for conservation. The British Ecological Society by Blackwell Scientific Publications, Oxford.

Reserve Size

- Size is often dictated by the relative concentration of people and the suitability of the land for human exploitation.
- Greenland National Park - 7000,000 Km2 of frozen land mass Bako National Park - Malaysia set on nutrient-deficient soils
- Largest 15 reserves in USA all on agriculturally marginal areas
- Unlikely to be a natural correlation between marginal agricultural land and the distribution of species worthy of conservation

Reserve Size

Size is commonly related to theories of Island Biogeography and relative rates of colonization and extinction per unit area



colonization = extinction per unit area

SLOSS debate

- Single Large Or Several Small
- For example is it better to have on large reserve of 15,000 ha or a network of five each of 3,000 ha?
- Large reserves - advantages and disadvantages
- Network of smaller reserves - advantages and disadvantages

Relative advantages of Single Large and Several Small Reserves

Reserve Size	Advantages	Disadvantages
Single Large	more ecogeographically diverse minimal edge effect easier to maintain species and population diversity maintain physical integrity of ecosystem (e.g watersheds, drainage system) suited for low-density species (e.g. forest trees)	Impossible to cover all genetic diversity of widely distributed species
Several Small	site each reserve in a distinct environment conservation value of multiple small reserves can be greater than the sum of its individual components animals often naturally found in dense but restricted stands Usually sited near urban areas so good for public awareness	Usually sited near urban areas so need more effective buffering Require more intensive management & monitoring Impossible to include real habitat diversity More susceptible to human or natural trauma Too small or too isolated a population less likely to remain unviable

Optimal Number and Size

- Depends on the characteristics of the target species i.e. breeding system, natural distribution, etc.
- Ideal - A number of reserves, located in different segments of the distribution area of the target species
- Size is frequently not the question!

Population and Reserve Size

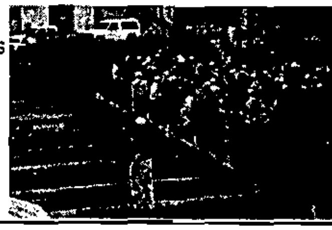
- The answer is what number of individuals form a viable population (i.e. effective population size - EPS)
- Shafer (1990) maintains that the minimum population size (MPS) for any given habitat is defined as the smallest population having a 99% chance of remaining extant for 100 years
- But what number? - No accurate answer

Political and Economic Factors Affecting Reserve Design

- Reserves rarely located on the basis of biological expedience
- Often on public land with conflicting or multiple uses of the land
- Idealized reserve design is pragmatically applied, allowing complementary use as an agricultural, industrial or recreational resource. So build into design
- Relative cost and ease of establishing reserves will affect the selection of reserve sites and their design

Reserve Utilisation

- Four distinct categories of user's may utilise the reserve:
  - local indigenous people
  - general public
  - reserve visitors
  - scientists



Local Indigenous People

- Design must take account of local communities, local farmers, land-owners and other members of the local population which may utilise the proposed reserve site should be considered
- Consultations and agreements (hunter-gatherer community, shifting cultivation and wild plant 'harvesting')
- Meffe and Carroll (1994) Guanacaste National Park in Costa Rica - "biocultural restoration"
- Reserve staff should be recruited locally and the whole community should be encouraged to take pride in local conservation work

General Public

- Population at large, whether local, national or international and its support may be essential to the long-term political and financial viability of the reserve
- Increase public awareness (support of conservation issues

Reserve Visitors

- Ecotourists
- Income for local people
- Design reserve to meet visitors requirements,
  - visitors centres
  - natural trails
  - lecture hall
  - reserve information packs etc.

Scientific Community

- Research platform for conservationists and other biologists
- Characterisation and initial evaluation of the target taxon - link to utilisation

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UNIVERSITY OF BIRMINGHAM

CONSERVATION AND UTILISATION OF PLANT GENETIC RESOURCES

RESERVE DESIGN ASSESSMENT - Nigel Maxted

DATE – 18th December 2006

Helpful Publications

Cox G.W. (1993). Conservation Ecology. W.C.. Brown, Publishers, Dubugue, Iowa.

Given D.R. (1994). Principles and Practice of Plant Conservation. Chapman & Hall, London.

Hawkes, J.G., Maxted, N. & Zohary, D., (1997). Reserve design. In: *Plant genetic conservation: the* in situ *approach* (ed. Maxted, N., Ford-Lloyd, B.V. & Hawkes, J.G.), pp. 210-230. Chapman & Hall, London.

Shafer C.L. (1990). Nature Reserves, Island Theory and Conservation Practice. Smithsonian Press, Washington and London.

Spellerberg, F.B. Goldsmith & M.G. Morris., (1991). The scientific management of temperate communities for conservation. The British Ecological Society by Blackwell Scientific Publications, Oxford.

The Assignment
We have been asked by the regional government of the Midlands to design a genetic reserve for a local endemic plant species, *Swarbii plantanus* Hawkes. Using the principles and concepts from your lecture on 'Genetic Reserves Design', with help from some of the above references, design a genetic reserve for the annual herb. Details of all the known localities are shown on the accompanying map.

Work individually.

1. Produce a 'best' scheme that incorporates one or more core areas surrounded by a buffer zone.
2. Produce a backup scheme in case the main scheme should prove politically unacceptable.
3. Draw the boundaries of your reserve(s) on the maps provided.
4. Explain and justify your two schemes.
5. Devise a timescale for the implementation of your conservation project for *S. plantanus*.
6. Devise a research agenda that will support the conservation of this plant *in situ* in the Midlands and comment on any implications that you feel appropriate for complementary conservation of *S. plantanus*.

Some interesting facts about the Midlands
- The indigenous people of the region live in three small villages. The inhabitants of the villages of Selly Oak and Bournville belong to the same ethnic group, while the inhabitants of the third village Harbourne have their own distinct language and culture.
- Access to Selly Oak and Bournville from the main road is via a rough track suitable only for four-wheel drive vehicles. The rough track to Harbourne is not suitable for vehicles of any kind.

- Village cultivation only occurs in the area around each village marked with a red dashed line.
- Other traditional uses of the land (eg: cattle grazing, fishing, fuel-wood gathering) take place to a distance of approximately 10 km from each village centre.
- *S. plantanus* is an insect-pollinated, annual herb that is used for medicinal purposes by the inhabitants of Selly Oak and Bournville, but not Harbourne. Seeds are dispersed via the guts of wild animals. Other than this very little is known of its ecology or physiology.

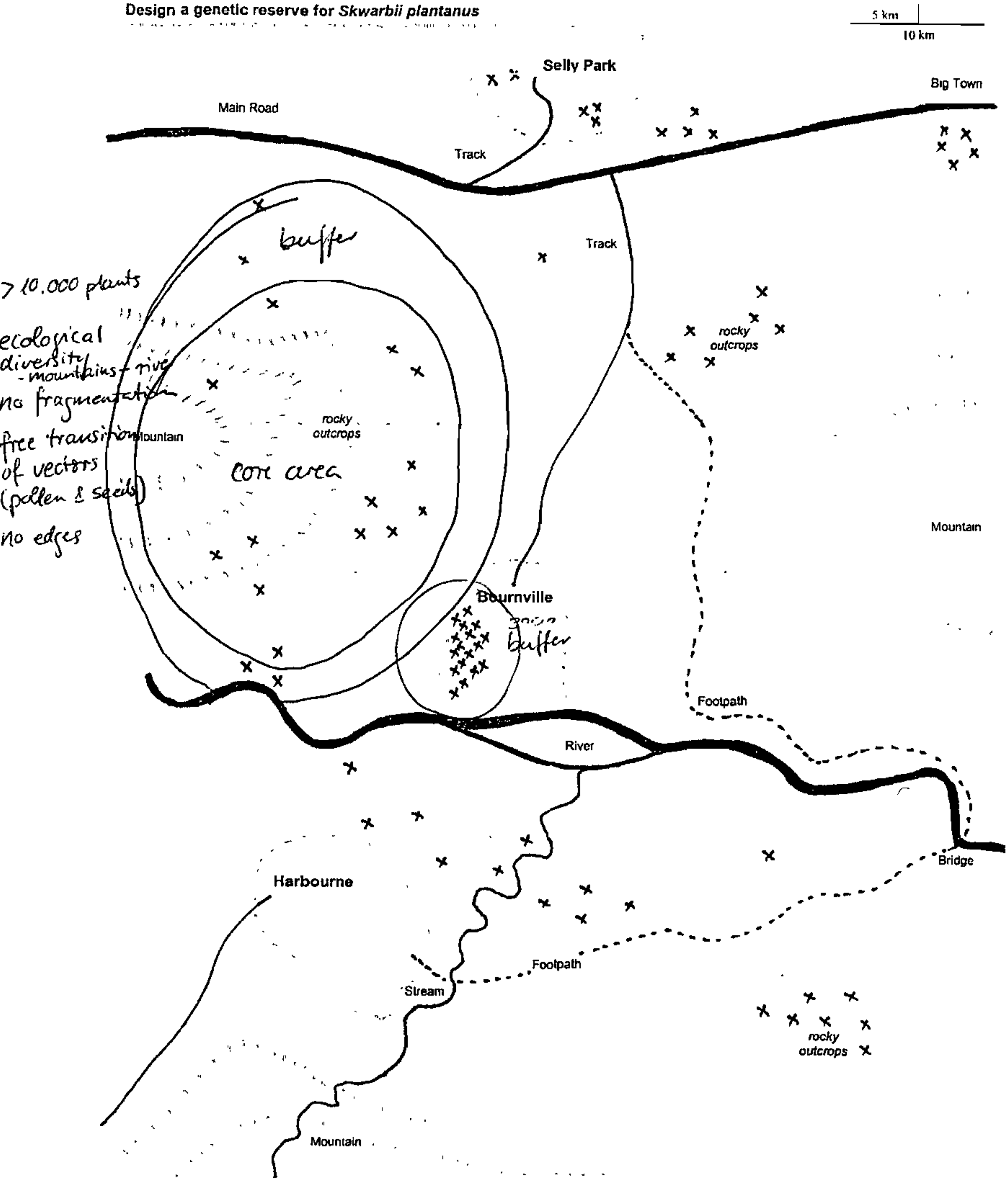
Reserve requirements

- The 'Minimum Viable Population' of *S. plantanus* is estimated to be about 10,000 individuals.
- For cost reasons it is hoped that the core area will not exceed 40 km^2.

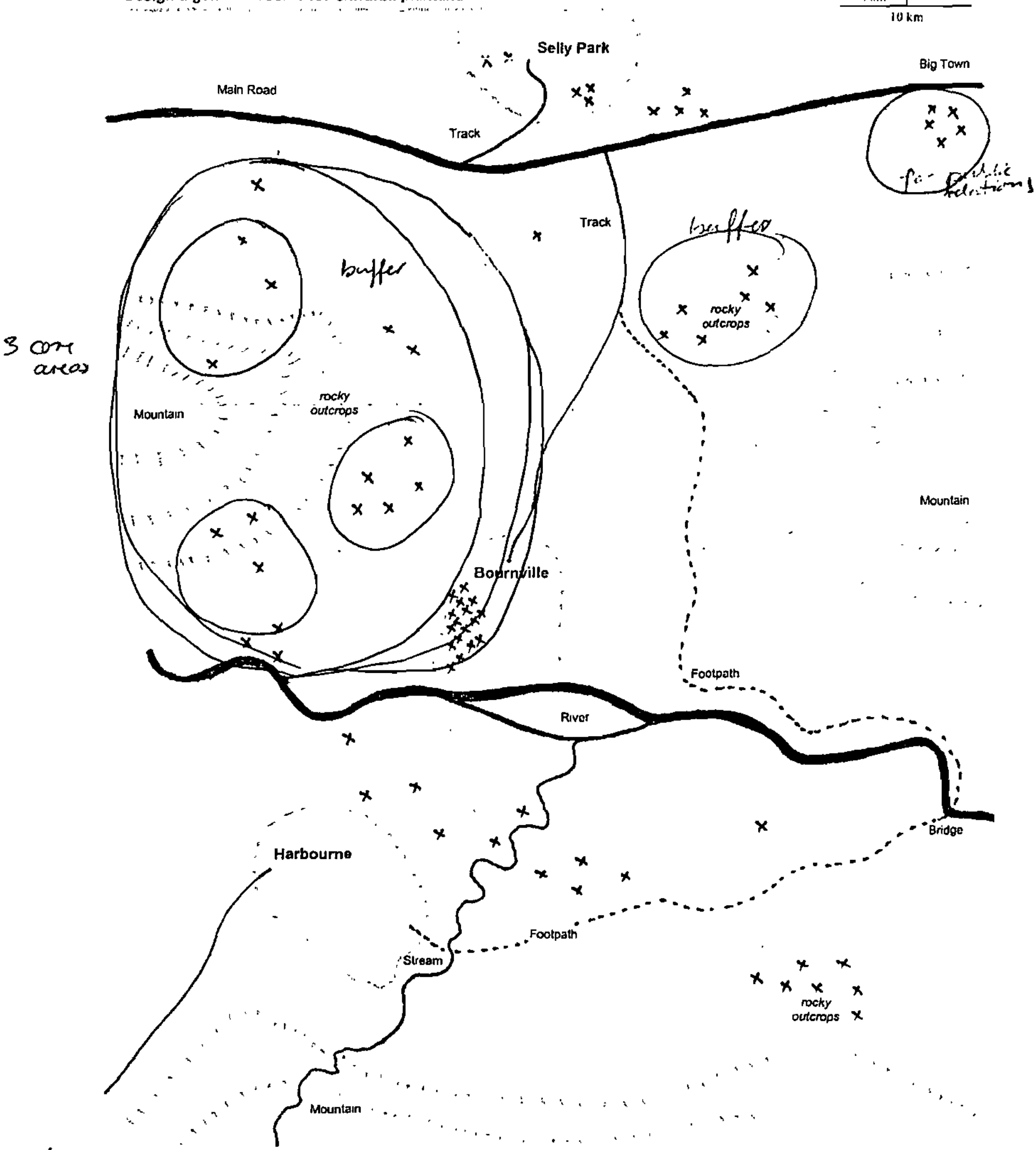
Key to the map

Green cross	X	*S. plantanus* population (approximately 1,000 individuals)
Red dash	------------	Village boundary
Red lines	||||||||||||	Elevation contours (200m)
Black thick line	▬▬▬	Main road
Black thin line	———	Rough car track
Black dotted line	....	Footpath
Blue line	▬▬▬	River and stream

Design a genetic reserve for *Skwarbii plantanus*



Design a genetic reserve for *Skwarbii plantanus*



> 10,000 plants
ecological diversity
core areas nearby
connected for seed and pollen vectors
- round

SCHOOL OF BIOSCIENCES

CONSERVATION AND UTILISATION OF PLANT GENETIC RESOURCES

RESERVE MANAGEMENT & MONITORING
2006 / 2007 - Nigel Maxted

Publications

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The IUCN Protected Area Management Categories

IUCN – The World Conservation Union has developed a definition and a series of categories of protected areas: as outlined below[1].

Category Ia: ***area managed mainly for science or wilderness protection*** – an area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

Category Ib: ***area managed mainly for wilderness protection*** – large area of unmodified or slightly modified land and/or sea, retaining its natural characteristics and influence, without permanent or significant habitation, which is protected and managed to preserve its natural condition.

Category II: ***area managed mainly for ecosystem protection and recreation*** – natural area of land and/or sea designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III: ***area managed mainly for conservation of specific natural features*** – area containing specific natural or natural/cultural feature(s) of outstanding or unique value because of their inherent rarity, representativeness or aesthetic qualities or cultural significance.

Category IV: ***area managed mainly for conservation through management intervention*** – area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats to meet the requirements of specific species.

Category V: ***area managed mainly for landscape/seascape conservation or recreation*** – area of land, with coast or sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the area's protection, maintenance and evolution.

Category VI: ***area managed mainly for the sustainable use of natural resources*** – area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while also providing a sustainable flow of natural products and services to meet community needs.

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[1] IUCN Commission on National Parks and Protected Areas with the World Conservation Monitoring Centre (1995); *Guidelines for Protected Area Management Categories*, IUCN, Gland, Switzerland

Anthropogenic Change

- Changes due to human activity are usually more dramatic, having permanent effects
  - e.g. In Mauritius 200 of 685 species of native plants are endangered (IUCN and WWF, 1994), 53 of the most threatened plants are known from 10 individuals or fewer, 13 of these are down to a single individual
- Human activity may create habitats, e.g. agriculture land, roadsides is the favoured habitat of the relatives of several important crops.
- Jain (1975) no major food crops or their progenitors are associated with climax vegetation

Why manage a site?

- Management areas are frequently too small to support all of the species they might once held, intervention management is necessary to maintain populations at viable levels.
- Protected areas are often too small to contain levels of disturbance that generate resource diversity. Management frequently must simulate those disturbances.
- Protected areas are often so fragmented and isolated that natural migration is unable to balance local extinctions. Under these conditions, managers may have to translocate individuals between management areas.
- Protected areas are often surrounded by hostile anthropogenic environments that produce invasive species (weeds, diseases and generalist predators) and degrading processes (siltation and pollution). Management must minimise or remove such influences.
- Protected areas may be under pressure for development, for release of their natural resources for human use, or for use as agricultural lands to feed rapidly increasing and desperately poor human populations.

Genetic Reserve Management Plan

1. *Preamble*: conservation objectives, site ownership and management responsibility, reasons for location of reserve, evaluation of populations of the target taxon, reserve sustainability, factors influencing management (legal, constraints of tenure and access).
2. *Conservation context*: place reserve within broader national conservation strategy for the responsible conservation agency and target taxon, externalities (e.g. climate change, political considerations), obligations to local people (e.g. allowing sustainable harvesting), present conservation activities (*ex situ* and *in situ*), general threat of genetic erosion.
3. *Site abiotic description*. location (latitude, longitude, altitude), map coverage, photographs (including aerial), detailed physical description (geology, geomorphology, climate, hydrology, soils)
4. *Site biotic description*: general biotic description of the vegetation, flora, fauna of the site, focusing on the species that directly interact with the target taxa (keystone species, pollinators, seed dispersers, herbivores, symbionts, predators, diseases, etc.).

Genetic Reserve Management Plan

5. *Site anthropogenenic description*: affects of local human population (both within reserve and around it), land use and land tenure (and history of both), cultural significance, public interest (including educational and recreational potential), bibliography and register of scientific research.
6. *General taxon description*: taxonomy (classification, delimitation, description, iconography, identification aids), wider distribution, habitat preferences, phenology, breeding system, means of reproduction (sexual or vegetative) and regeneration ecology, genotypic and phenotypic variation, local name(s) and uses.
7. *Site specific taxon description*: taxa included, distribution, abundance, demography, habitat preference, breeding system, minimum viable population size, and genetic structure and diversity of the target taxon within the site, autecology within the reserve, synecology with associated fauna and flora (particularly pollinators and dispersal agents), specific threats to population(s) e.g. (potential for gene flow between CWR and domesticate).

Genetic Reserve Management Plan

8. *Site management policy*: site objectives, control of human intervention, allowable sustainable harvesting by local people and general genetic resource exploitation, educational use, application of material transfer agreements.
9. *Taxon and site population research recommendations*: taxon and reserve description, auto- and synecology, genetic diversity analysis, breeding system, pollination, characterisation and evaluation.
10. *Prescription (management interventions)*: details (timing, frequency, duration etc) of management interventions, population mapping, impact assessment of target taxon prescriptions on other taxa at the site. Staffing requirements and budget, project register.
11. *Monitoring and Feedback (evaluation of interventions)*: demographic, ecological and genetic monitoring plan (including methodology, schedule, etc.), monitoring data analysis and trend recognition Feedback loops resulting from management and monitoring of the site in the context of site itself and the regional, national and international context.

Management Interventions

- Grazing Control
- Burning
- Erosion Control
- Invasive species control
- Nutrient Control
- Disturbance
- Assisted Propagation
- Habitat Restoration
- Cultural Change
- Research and training

Monitoring Regime

- Need to sample at the taxonomic and population levels
- Which taxa to monitor?
  - Target taxon
  - Closely related species
  - Keystone species.
- Where to sample?
  - Random
  - Systematic
  - Stratified random.

Monitoring Regime

- **How to assess abundance?**
  - Density, frequency or cover
    - Density is the number of individuals per unit area.
    - Cover is the percentage of the ground occupied by a perpendicular projection (shadow at noon) of the aerial parts of the species.
    - Frequency (which may be root or shoot frequency) is the proportion of samples (quadrats) within which the target species occurs.
- Cover values estimated using the Braun-Blanquet scale or Domin scales

Monitoring Regime

The Braun-Blanquet and Domin scales of vegetation Cover:

Value	Braun-Blanquet	Domin
0	< 1% cover	1 individual
1	1–5% cover	1–2 individuals
2	6–25% cover	< 1%
3	26–50% cover	1–4%
4	51–75% cover	4–10%
5	76–100% cover	11–25%
6		25–33%
7		34-50%
8		51-75%
9		76-90%
10		76-90%

Monitoring Regime

- **How to sample?**
  - Plot methods (quadrats)
  - Intercept (transect) methods.
- Quadrats are square or rectangular, permanent or ephemeral.

Monitoring Regime

Monitoring Regime

- **How much to sample?**
  - Quadrats should be small enough to be searched easily and permit sufficient replicates in the time and with the resources available, but large enough to accommodate whole plants of the target species
  - Rule of thumb (Goldsmith, 1991) most species in the vegetation should have a frequency of 20-70% in the quadrats sampled and if several are present in all quadrats, then quadrat size is probably too large.
- The Recommended Quadrat Size and Shape for Different Plant Habits (from Clark, 1986).

Target species	Plot size (m^2)	Ratio of sides
Herb	0.5-1.0	1.2
Shrub	50-100	1:5 or 1:10
Tree	200-1000	1:5 or 1:10

Genetic Management Outside Protected Areas

- Suitable for plants found outside of climax communities
- E.G. roadsides, field margins, orchards and even fields managed using traditional agro-silvicultural practices
- Increased threat: road widening, scrubbing out of hedgerows, introduction of herbicides
- Require management agreement / legislation

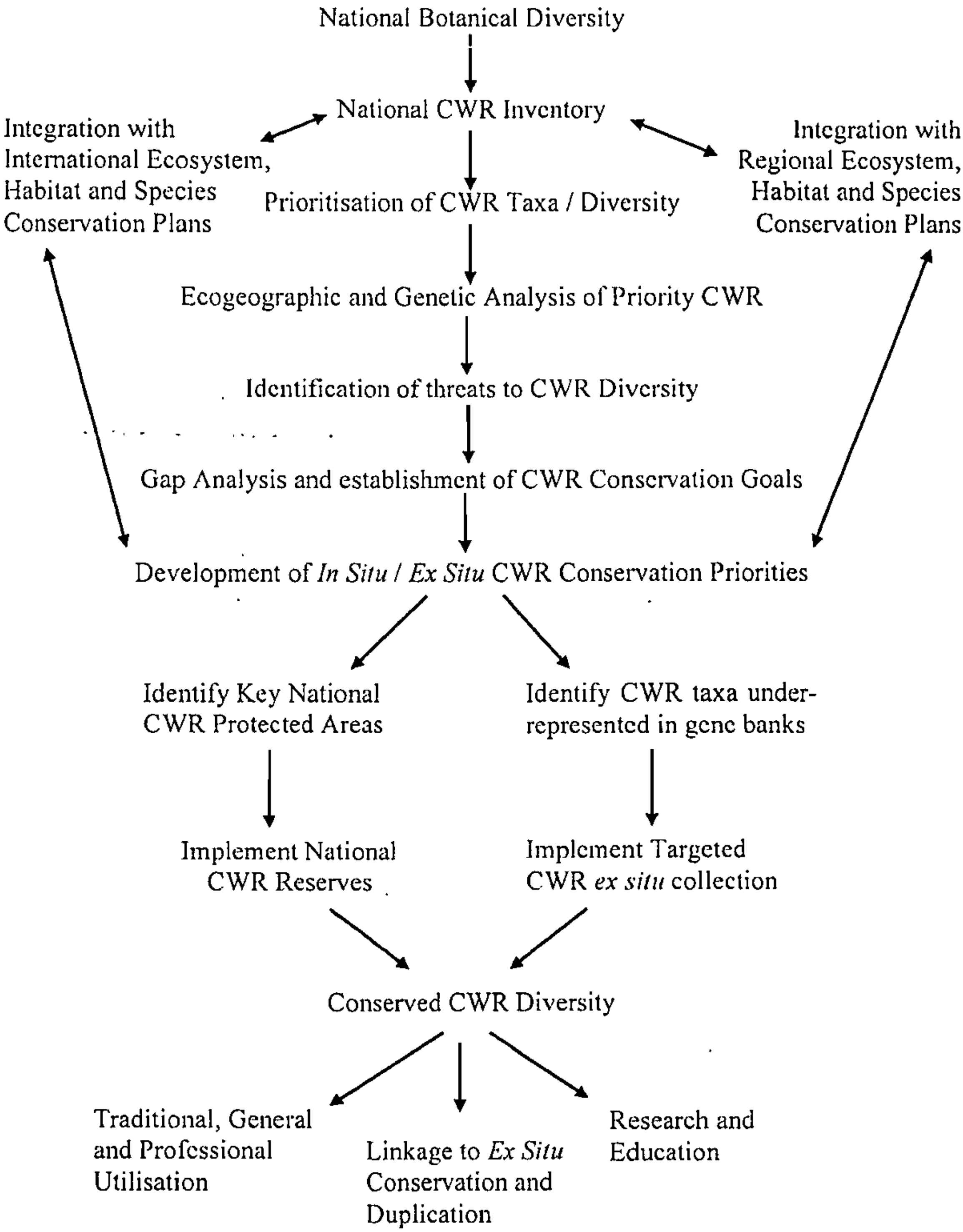
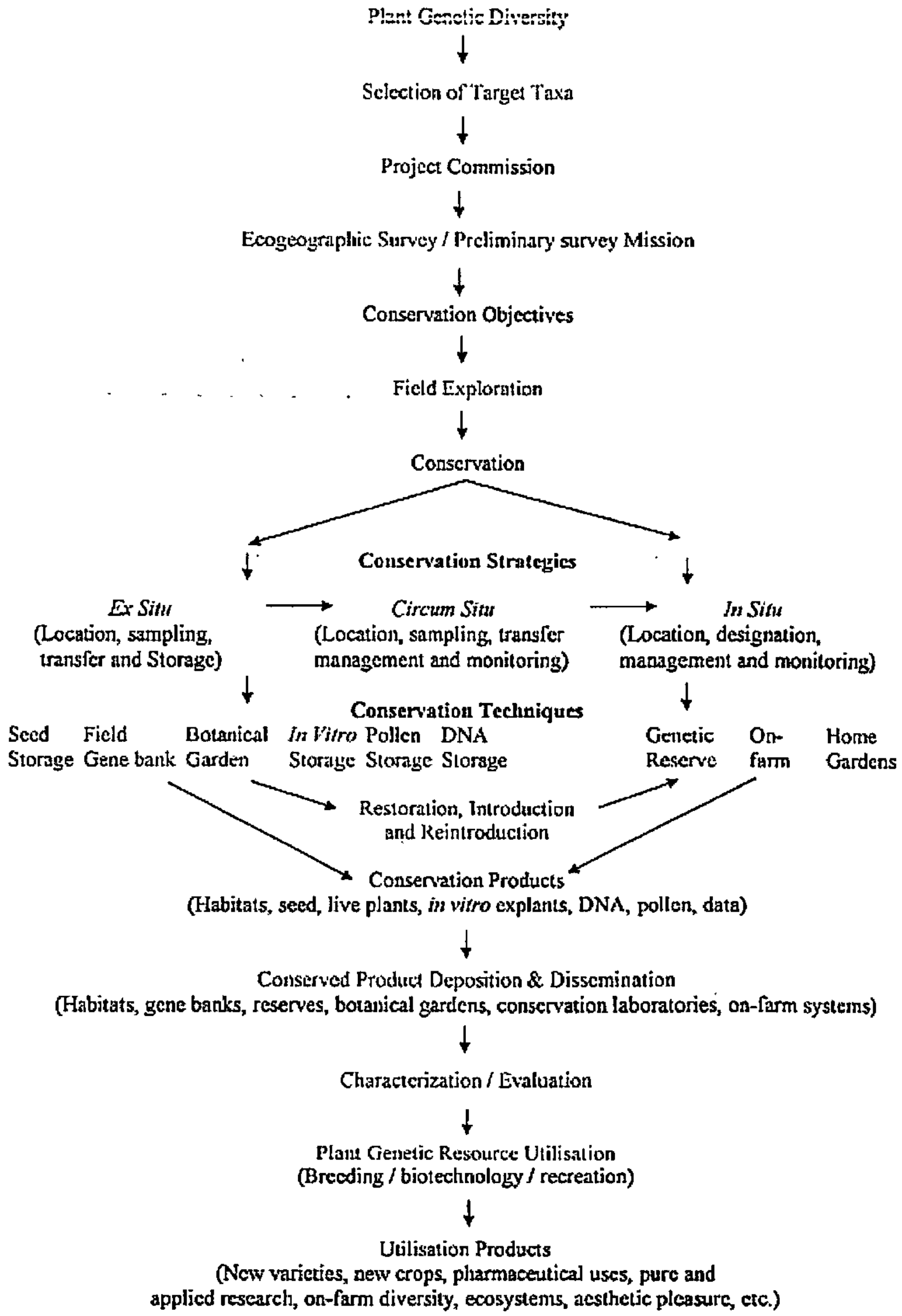

National Botanical Diversity
National CWR Inventory
Integration with International Ecosystem, Habitat and Species Conservation Plans
Integration with Regional Ecosystem, Habitat and Species Conservation Plans
Prioritisation of CWR Taxa / Diversity
Ecogeographic and Genetic Analysis of Priority CWR
Identification of threats to CWR Diversity
Gap Analysis and establishment of CWR Conservation Goals
Development of *In Situ* / *Ex Situ* CWR Conservation Priorities
Identify Key National CWR Protected Areas
Identify CWR taxa under-represented in gene banks
Implement National CWR Reserves
Implement Targeted CWR *ex situ* collection
Conserved CWR Diversity
Traditional, General and Professional Utilisation
Linkage to *Ex Situ* Conservation and Duplication
Research and Education

Figure 2. Proposed Model of Plant Genetic Conservation.



Geographic Information Systems (GIS)

Joana Magos Brehm
Ali Shehadeh

CUPGR 2006-2007
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The University of Birmingham

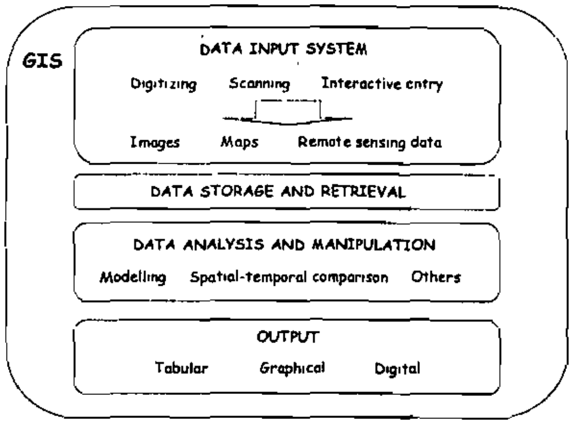
Overview

- Definition and major components
- Types of queries a GIS can answer
- How it works?
- Spatial features and attributes
- Data representation formats
- Coordinate systems
- Map projections
- What can be used for?
- The use of GIS in conservation
- Before starting a project in GIS
- Examples of software
- DIVA-GIS
- ArcGIS

What are GIS?

"GIS are integrated systems of computer hardware and software for the analysis and display of spatially distributed data"

Johnston (1998)



Types of queries a GIS can answer

Location:
WHAT exists here - what is at a particular location?
"What type of land use is at 41.95N, -8.25W?"

Condition:
WHERE are specific conditions
"Where does it rain 3000 mm per year ?"

Trends:
WHAT HAS CHANGED (over time)
"How far has the population of a certain species receded in the past 20 years?"

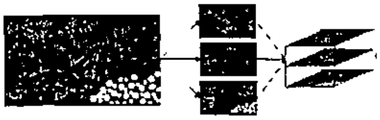
Types of queries a GIS can answer

Patterns:
HOW are patterns related
"How does soil type influence the distribution of a particular species?"

Modelling:
WHAT IF...?
"What would happen to a certain habitat if the climate warmed by 2 degrees?"

How it works?

- Data are stored in layers of information
- Each layer = different types of information (soil type, rainfall, etc..)
- Layers combine to produce a map (when the spatial reference system is common)



SPATIAL ANALYSIS

Spatial modeling...

All phenomena in our environment cannot be observed at one time.

Create a simplified representations of reality - model

A model is a way of describing something that cannot be directly observed

Spatial modeling...

Data modeling

Map overlay

Geostatistics

SPATIAL ANALYSIS

Cartographic modeling

Topological modeling

Geocoding

Others .

Spatial features and attributes

Two basic types of data area associated with GIS:

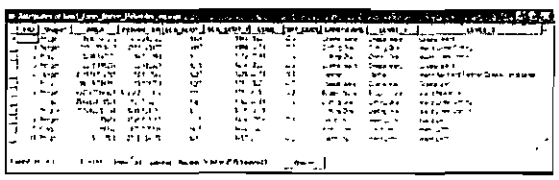
1. Spatial data: "where is it?"
2. Attribute data: "what is it ?"

Spatial features

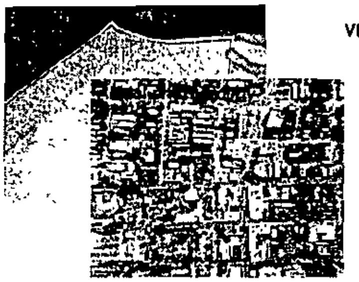
- Stored as x and y coordinates (= 2 columns of data)
- Gives information on the location and shape of features and between geographical features e.g. proximity

Attribute data

- Descriptors of spatial data (nature and qualities of features)
- Stored in tabular format (tables) and linked to the spatial data by a common identifier
- Numbers or text (e.g. 2, 3; marsh; high/low)



Data representation formats



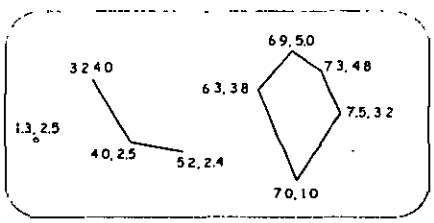
VECTOR FORMAT

Data representation formats

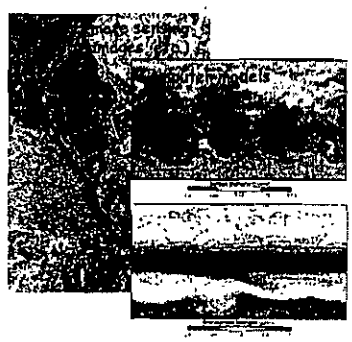
VECTOR FILES: based on features and have x and y coordinates, portrays features as points, lines and polygons

Data representation formats

VECTOR FILES



Data representation formats



RASTER FORMAT

Data representation formats

RASTER FILES: portrays features as a matrix of grid cells, one value per grid square

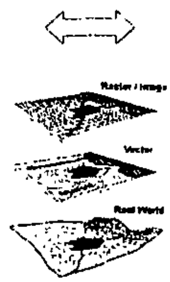
Vector *versus* Raster

VECTOR

Advantages
- Compact data structure for homogenous areas
- Efficient encoding of topology
- Better suited for map output

Disadvantages
- More complex data structure
- Cannot store image data (continuously varying).

Example: shapefiles (consists of at least three files. shp, shx, .dbf), CAD files



RASTER

Advantages
- Simple data structure
- Overlay operations are straight forward
- High spatial variability is efficiently represented
- Only raster can easily store image data (e.g photos)

Disadvantages
- Data structure is not compact
- Map output can appear 'blocky'.

Example: jpg, .tif (image), geotiff (georeferenced)

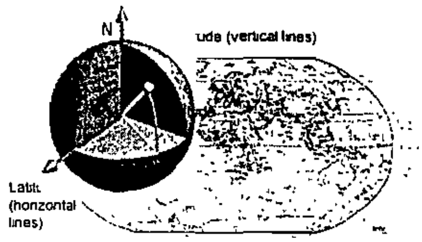
Coordinate systems

A reference system that uses a 3-dimensional spherical surface to determine locations on the Earth

Geographic: use latitude and longitude coordinates (only along the equator the distance represented by one degree of longitude approximate the distance represented by one degree of latitude)

Projected. use a mathematical conversion to transform 3-dimensional latitude and longitude coordinates to a 2-dimensional surface

Geographic coordinate systems

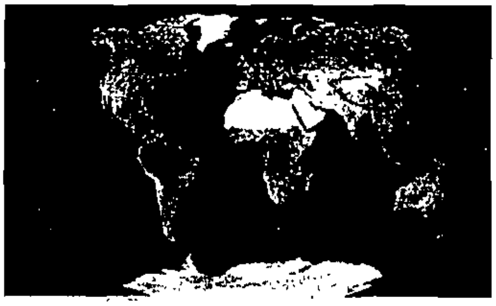


Map projections

A projection is a mathematical means of representing the 3-dimensional curved surface of the Earth, to a 2-dimensional medium

- Multiple types of projections which serve different purposes.
- Designed to preserve different properties of the curved surface.
- Any projection creates some degree of distortion (areas, distances, directions, combination of these).

Map projections



What can be used for?

- Scientific research
- Resources management
- Sustainable development
- Conservation planning
- Environmental impact assessment
- Urban planning
- Cartography
- Route planning
- Public health
- Crime mapping
- National defense
- Transportation, etc.

The use of GIS in conservation

- Measure habitat distribution;
- Map and predict species distribution;
- Speculate about *why* some certain species occur in a particular habitat and not elsewhere;
- Study ecological processes (e g determination of how micro-topography affects the flowering success of different species);
- Evaluating the impact of human constructions on rare plant populations

The use of GIS in PGR conservation

- Ecogeographic survey (e.g map species distribution, GAP analysis);
- Field exploration (development of field aids, information on the best time to undertake field work);
- Design, management and monitoring *in situ* genetic reserves (analysing species richness, frequency, distribution and abundance of endangered species).

The use of GIS in PGR conservation

- Germplasm regeneration and evaluation (e g climate data and distribution maps for pests, diseases, pollinators, and CWR can be overlapped in order to identify potential sites for regeneration; to determine the suitability of different sites for the evaluation of specific traits);
- Use of genetic resources (help to improve the quality of the location data associated with collections; help to identify interesting germplasm and reveal the genetic structure of the material being held in Genebanks).

Before starting a project in GIS...

- Keep it simple: start with simple data and software
- Read documentation. good manuals and online help available
- Use existing data
- Plan ahead: a GIS requires multiple steps which should be formulated in advance
- Keep good records
- Check results: determine of the results obtained from a GIS procedure are logical before continuing
- Consult with experts

Software – some examples

GENERAL

- ArcGIS
- ARC/INFO
- CARIS
- GENASYS
- IDRISI
- GEOMEDIA
- MAPINFO

GENETIC RESOURCES

- DIVA
- Flora Map

OTHERS:

- Biomapper

DIVA-GIS

- Designed to be used for spatial analysis of data associated with genetic resources collection and it can be used in developing strategies for future collecting and *in situ* activities
- Free from http //www.diva-gis org/

DIVA-GIS

Spatial analysis:

- assign coordinates;
- check for errors;
- analyse point distribution and produce maps;
- display the number of observations, the number of distinct classes of observations for an array of grid cells;

DIVA-GIS

Spatial analysis (cont.).

- calculate several diversity indices (Margalef, Mehhinick, Shannon, Simpson, Brillouin);
- predict potential species distribution given the climate of the locations where it was observed,
- identify sets of grid cells that are complementary to each other (that captures a maximum amount of diversity in few cells as possible);
- calculate statistics parameters for numerical variables.

Using ArcGIS, a tool

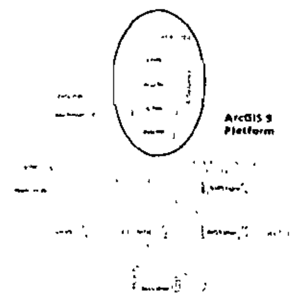
ArcGIS definition

"ArcGIS is a scalable system of software for geographic data for every organization from an individual to a globally distributed network of people"

Environmental Systems Research Institute (ESRI)

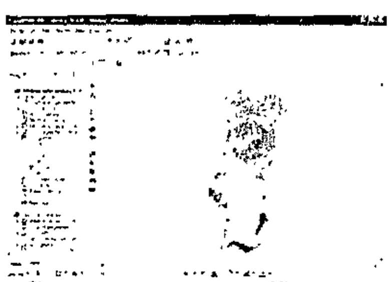
ArcGIS

- ArcCatalog
- ArcMap
- ArcToolbox
- ArcScene
- ArcGlobe



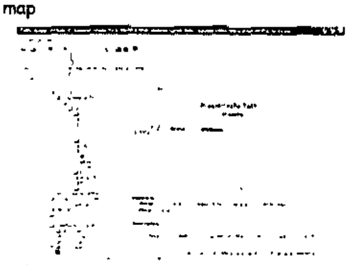
ArcMap

- Creates, displays, query and edit maps
- Perform many spatial analysis tasks

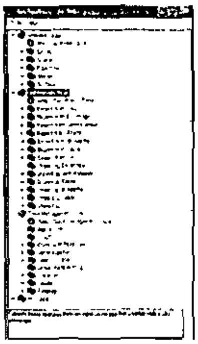


ArcCatalog

- Access and manage geographic data
- Data can be copied, moved, deleted, and viewed before it is added to the map
- Metadata can either be read or created
- New shapefiles can be created



ArcToolbox

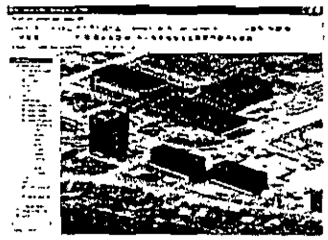


Geoprocessing operations:

- import/export
- format conversion
- statistics
- spatial and 3D analyst tool etc....

ArcScene

- View multiple layers of 3D data on a 2D surface data
- Create and analyse 3D surfaces
- Animation



ArcGlobe

- Highly interactive 3D visualization, analysis application for working with large GIS datasets
- Same basic functionalities as ArcMap

Extensions

- Spatial Analyst: advanced spatial modelling and analysis tools
- 3D Analyst: visualize and analyse surface data
- Network Analyst: network-based spatial analysis, routing, travel directions, closest facility and service area analysis
- Geostatistical Analyst: spatial data exploration and optimal surface generation
- And many more

Geographic Information Systems (GIS)

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CUPGR 2006-2007
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GEOGRAPHIC INFORMATION SYSTEMS

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Examples of application of GIS

Balram, S.; Dragićević, S. and Meredith, T. (2004). A collaborative GIS method for integrating local and technical knowledge in establishing biodiversity conservation priorities. *Biodiversity and Conservation*, 13: 1195–1208.

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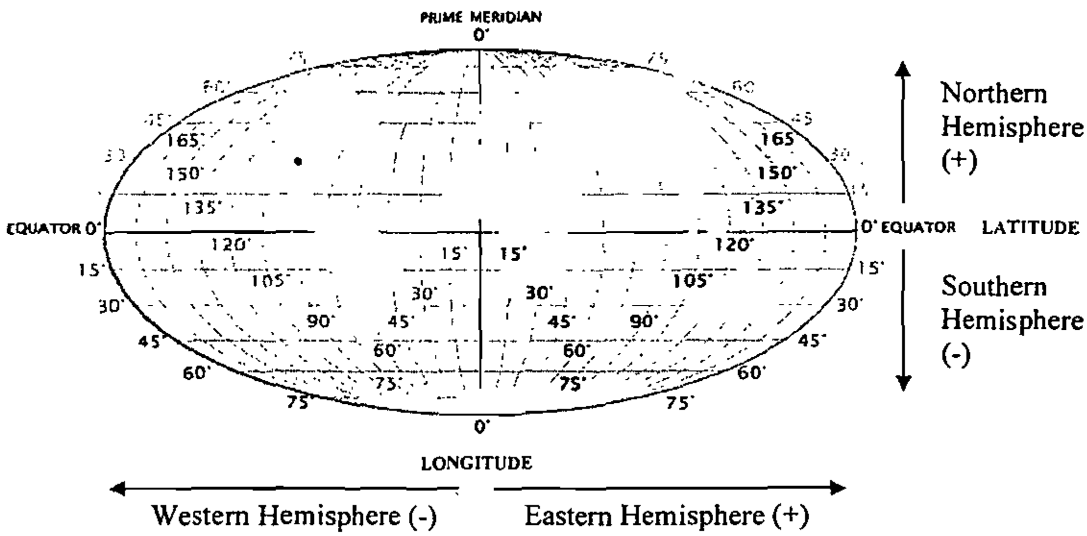
ARCGIS PRACTICAL SESSION

I. BEFORE STARTING - PREPARING THE DATA (SOME TIPS)

The data you want to plot in a map (e.g species distribution) should be in Access or dbf.

You can use several different types of coordinates however these should be coherent, that is to say that if you have a map in a particular coordinate system, your data should be in the same system. The most common is to use latitudes and longitudes. If your data is in latitudes and longitudes make sure they are in the correct format (decimal coordinates).



To convert Degrees, Minutes, and Seconds to Decimal Degrees you can find several websites that will do it for you (e.g. http://www.geology.enr.state.nc.us/gis/latlon.html). Alternatively you can follow the following procedure:

For example, if you have a value of 41°38'7.836'' (41 degrees, 38 minutes and 7.836 seconds) and want to convert to decimal degrees:

- 41 degrees = 41 degrees
- 38 minutes = 38 x 1/60 = 0.63333 degrees
- 7.836 seconds = 7.836 x 1/3600 = 0.00218 degrees

So 41°38'7.836''= 41 + 0.63333 + 0.00218 = 41.63551 degrees keyboard shortcut. Some keyboard shortcuts are listed in the menus. Others depend on the graphical user interface (GUI) system you are working with. The contents of the menu bar change according to what is in the active window.

The Standard toolbar

This bar located beneath the Main Menu toolbar in the ArcMap window contains buttons giving you quick access to various controls such as Saving or Printing your project. Click on a button to choose it. The contents of the button bar change according to what is in the active window.

The Drawing toolbar

With the tools on this toolbar you can add graphics and text to a layout. Since graphics don't change size as you zoom in or out on data, wait to use this toolbar until you're satisfied with the display scale.

Extensions toolbars

When you activate particular extensions such as Geostatistical Analyst or Spatial Analyst (see section VI) their correspondent tools will be displayed here.

The Table of Contents

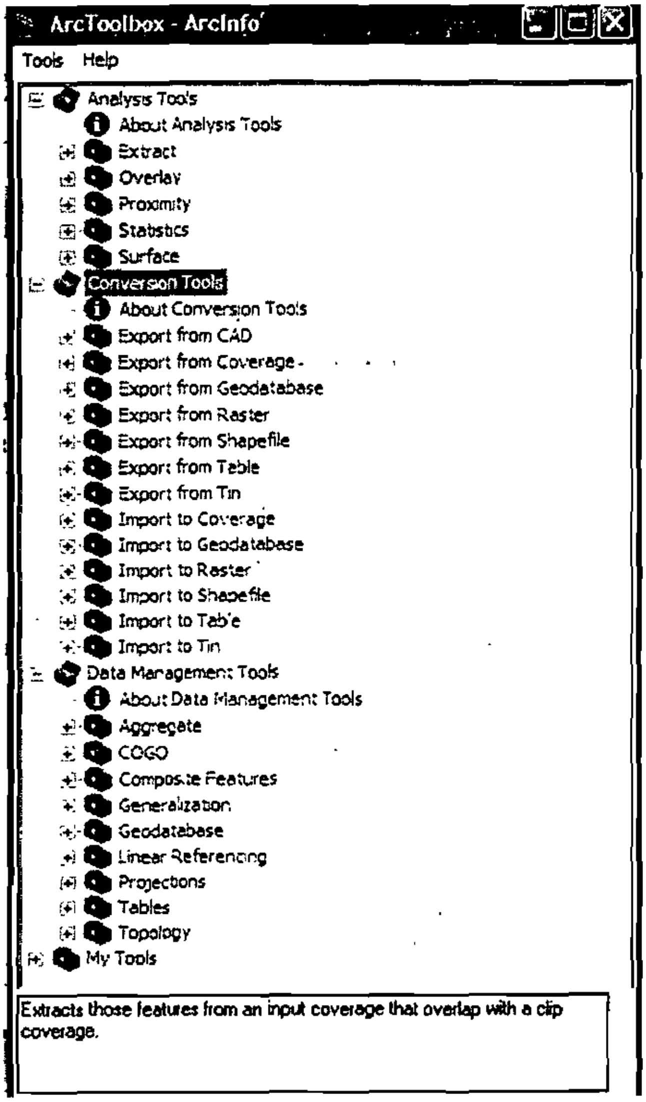
Each Project window has a Table of Contents that lists the themes in that project and shows what symbols and colours they are drawn with. You also use the Table of Contents to control how the view is drawn.

Tools toolbar

This bar contains various tools you can work with. You click on a tool to choose it. This will change the cursor to reflect the tool you have chosen. The tool remains selected until you choose another one.

ArcToolbox

Start > Programs > ArcGIS > ArcToolbox



which you name and save the project. If you select the name of an existing project, ArcMap asks if you want to replace it.

In ArcMap you can save the work you do on any project component by saving the project that contains it. When you resume work on the component, it will be in the same state it was in the last time you saved. You can save at any time during a session. When you save a project, you save the work you've done on all the components to which you've made changes. If you haven't saved the project, ArcMap will prompt you for a name. Also, if you close the project or quit ArcMap and you've made any changes, ArcMap will prompt you if you want to save the project.

Opening an existing project

When you open an ArcGIS project, you open one file that contains references to the geographic data and external tables as well as the maps, layouts, charts, scripts, and other components that make up the project.

1. Open ArcMap: Start > Programs > ArcGIS > ArcMap
2. Choose *An existing map* > *Browse for maps* (then you specify the name and location of the project you want to open) > *OK*

Renaming, copying, or deleting a project

As you work with a project file, you may want to assign it a different name, make backup copies, or delete unwanted projects. You can rename, copy or delete a project file by using your system's standard desktop editing technique or the appropriate operating system command.

Layers have a number of other properties that you can set to control their characteristics. For example, you can specify the range of scales at which the theme will be drawn on the data frame.
Each layer has its own legend displayed in the Table of Contents. A layer's legend controls how the layer is displayed in the data frame.

Specify coordinate system

Before you get started you should make sure the layers you are adding to your project are in the same coordinate system.

1. Open the ArcCatalog (as above or if you have ArcMap already opened you can access the ArcCatalog by clicking on )
2. Browse and right click on the layer file you want to specify the coordinate system (the file should have a *.shp* extension, not a *.lyr* extension) > *Properties*
3. Under the *Data type* tab click on *Geometry*
4. In the lower box, click on the dotted button next to *Spatial Reference*
5. Choose *Select* on the next screen and choose the Coordinate System you want.

Note: Any programs using the files you are changing (e.g. ArcMap) must be closed before doing this.

Exercise 1.

1. Open a new empty map in ArcMap.
2. Open ArcCatalog and make sure that the following layers are under the same coordinate system (Go to *Projected Coordinates* > *National Grids* > look for the *Lisboa Hayford Gauss IGeoE* system and select it): portugal.shp protected_areas.shp, , pret.shp, rivers.shp., temp.shp.

Add data layers to your project

Add layers to the data frame for each spatial data source you want to display (precipitation, soil type, etc.). You can add as many layers as you want. A layer usually is related to a shapefile.

1. If you want to add shapefiles: click the *Add Data* button > specify the location and name of the layer you want to add > *Add*.

Tip: To add several shapefiles to a view at once, hold down SHIFT and click on them in the list of files.

2. If you want to add x and y coordinate files (such as plant distribution locations): click the *Tools* button under the Main Menu toolbar > *Add XY data...* > browse a .dbf file or a table from an Access database > specify the X field and the Y field as the coordinates fields in your table and plot them onto your shapefile map.

Note: this type of file is not a shapefile, therefore in order to be able to query it and easily use it is advisable if you convert it into a shapefile first (see *Saving the selected features to a shapefile*).

Change layer's properties and display

You can change a layer's properties such as a theme's properties you can control characteristics such as the layer's name, which features in the data source will be represented in the layer, at which scales the layer will be drawn, etc. Layer properties can be set and changed at any time.

1. To change the layer's name: right click on the layer name > *Properties* > choose *General* tab and type the name you want.
2. To specify which colours and symbols themes will be drawn with: double click on the layer's legend and can then choose the *Fill colour*, the *outline colour* and *width* among other things.

To create and manage new group layers

An ArcGIS project can contain any number of data frames and layers.

Within your project:

1. Click *Insert* from the Main Menu toolbar > *Data Frame*
2. To rename it: right click and choose *Properties* > under the *General* tab, type the name you want > *OK*
3. To activate this new Data frame: right click and choose *Activate*, you will then be able to see the layers
4. To delete a Data frame: right click and choose *Remove*.

Note: If your data is in decimal degrees and you set the Map units to decimal degrees but you choose not to set a projection, ArcMap will draw the view by simply treating the longitude-latitude coordinates as unprojected spherical coordinates.

A map's projection can only be set if the map units of the spatial data it contains (or will contain) are decimal degrees (i.e., degrees of longitude-latitude expressed as a decimal rather than in degrees, minutes and seconds). This is because data in decimal degrees is in a spherical coordinate system and so is, by definition, unprojected. This data can therefore be drawn in any projection in ArcMap. The map projection used by a data frame is set in the Data View Properties dialog box.

When your spatial data is not in decimal degrees, and you are using data from a variety of different data sources on the same view, you should make sure that all these data sources are currently stored in the same map projection. If you draw data sources that are currently stored in different map projections on the same view you may get errors and inaccurate results.

Adjusting symbology

You can change the appearance of shapefiles:

1. Double clicking the layer in the Table of Contents will bring up the properties of that file.
2. Click on the *Symbology* tab
3. Click on *Categories* > *Unique values* > choose the *Value Field* you want > *Add All Values*
4. This will bring up a list of all the values that the field you choose comprises and how many instances of each there are.
5. If you double click the symbol of each of these values you can then change it to different symbols and/or colours.

Note: You can also choose a colour scheme.

If you decide you would like these not merely displayed differently, but as separate files, you will need to carry out queries (below)

Identifying features on a data frame

Each layer in a particular data frame has an attribute table about the geographic features it contains. A layer's attribute table contains one record for each feature in the layer.

V. SELECTING FEATURES AND WORKING WITH QUERIES

By default a theme represents all the features of a particular feature class in the data source are based on. However it is useful to be able to restrict a theme to represent only a subset of the features in a particular feature class. Selecting features on a data frame enables you to find specific geographic features that interest you or meet certain important criteria, and to work with specific geographic features in a variety of ways to find out more about them. By defining a feature selection you can control exactly which features from a layer's data source are represented in the data frame. Features are selected based on the attribute values in the layer's attribute table.

For example, you might have a layer (e.g. temperature map) that contains different temperatures classes for your study area but you want to create a new layer that only represents some of the classes.

Features highlight on the view when they are selected will remain highlighted until a different selection is made, or until they are deselected. By default, selected feature highlight in bright blue. You can choose the colour in which features are highlighted when they are selected:

1. Right click on the layer > *Properties* > *Selection* > *with this colour* and choose the colour you want.

When you save your project ArcGIS remembers which layers were active and which features were selected, so they'll be ready for use when you next open the project.

Before you can select features from a layer, you have to click on it in the layer's Table of Contents to make it active.

Selecting features with the mouse

1. In the Table of Contents select the layer you want to select attributes from, by clicking it.
2. Use the *Select Features* button  in order to select the features you want directly in the map by pointing at them or by dragging a selection box over them (these features will be automatically selected in the Attribute Table).

Notes: Features that fall partly or wholly inside the box you define will be selected. Features will be selected from all of the currently active themes.

Selecting features using a query

Select by Attributes: you can either select features according to their attribute values:

1. Right click on the layer name > *Properties* > *Definition Query* > *Query Builder* > and then make the query you want > *OK.*

Select by Location: or select features according to their location:

2. Go to *Selection* in the Main Menu toolbar > *Select by Attributes* > and make the query > *OK.*

Or select features according to their location:

3. Go to *Selection* in the Main Menu toolbar > *Select by Location* > *I want to select features from* > then you choose the layer > *that* > *intersect* (e.g.) > you choose the *features in another layer* > *Apply.*

Zooming to the selected features

1. Click the Selection button in the Main Menu toolbar
2. Choose Zoom to Selected Features to zoom to the extent of the features you have selected in the active theme(s). In this way you'll be able to focus in on the features you selected.

Saving the selected features to a shapefile

Once you have the selected features:

1. Right click on the layer where the features were selected from
2. Choose *Data* > *Export data*
3. Make sure you choose the option of exporting the *Selected features*
4. Rename the file > *OK*

This option creates a new shapefile that just contains the currently selected features from the theme. You are prompted to see if you want to add this new shapefile to your view. In this way you can make the set of features you have selected a 'permanent' part of your view. Another reason you might save your selected features to a new shapefile in this way is so that someone else can use this set of features in their work.

VI. CALCULATIONS AND CHARTS

Performing field calculations

It is possible to perform field calculations for Area, Perimeter and X-Y co-ordinates (for point files).

For calculating Area:

1. Open the Attribute Table as explained above;
2. Click on the *Options* button > *Add Field*
3. Call your field 'Area' and the field type should be 'Double'
4. Once the field has been created, right click on the *Field* heading and choose *Calculate Values*
5. In the dialogue box, check the *Advanced* box, then type the following in the box:

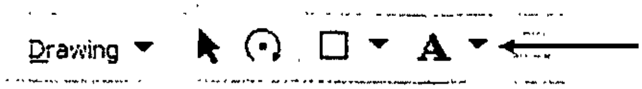
```
Dim dblArea as double
Dim pArea as IArea
Set pArea = [shape]
dblArea = pArea.area
```

6. Type the variable 'dblArea' in the box directly under the area field name and click *OK*.

For calculating perimeter the code is:

```
Dim dblPerimeter as double
Dim pCurve as ICurve
Set pCurve = [shape]
dblPerimeter = pCurve.Length
```

...with 'dblPerimeter' in the lower text box

2. Click 

and choose the label button  and choose your labelling options such as *Place label at position clicked.* So from then on whenever you click a label will be displayed.

How to save the map as a picture?

1. Go to *File* in the Main Menu toolbar > *Export Map...* > name the map and choose the format (TIFF is a larger file but will give you better resolution, JPEG is a smaller file but will give you worse resolution).

Exercise 5.

1. Make a layout of the distribution of *Dianthus cintranus* subps. *barbatus* and the protected areas layer. Do not forget to display a title, legend, north arrow and a scale.

2. Also display the labels for those protected areas which *completely contain Dianthus cintranus* subsp. *barbatus* populations (you will have to *Select by*

Enabling extensions

Spatial analysis operations are available when you use the Spatial Analyst extension.

1. In ArcMap go to *Tools* > *Extensions* and make sure the extensions *Geostatistical Analyst* and *Spatial Analyst* are checked.
2. Go to *View* > *Toolbars* and check the toolbar of the extension you wish to use.
3. Alternatively you can right click on the toolbar to bring up this list.

Preparing data for analysis

Sometimes your data set is not in the condition you need for a project. The Geoprocessing Wizard allows you to reduce the extent of a theme (when you have too much detail), to combine features in one layer that are alike, to combine features in one or more layers, to use one layer's data in another layer

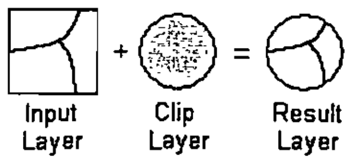
How to reduce the extent of a layer?

1. To clip one layer based on another

This process creates a new layer by using a polygon layer (or selected polygons in that layer) as a cookie cutter on a point, line, or polygon layer. The output layer will only contain data from the layer you're clipping – the layer used as a cookie cutter is only used to define the clipping boundary. You might use the boundary of your study area to clip a layer of roads or customers that extends over a much larger area.

About Clip

This operation uses a clip layer like a cookie cutter on your input layer. The input layer's attributes are not altered.



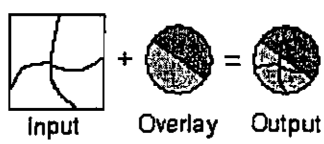
Go to *Tools* in the Main Menu toolbar > *Geoprocessing Wizard* > choose *Clip one layer based on another* > *Next* > Select the input layer to clip > Select a polygon clip layer > give a name to this new layer you are creating.

2. Intersect two layers

This process is similar to clipping a layer, except it preserves only those features falling within the spatial extent common to both layers. The features of the input layers are intersected or sliced by the

About Intersect

This operation cuts an input layer with the features from an overlay layer to produce an output layer with features that have attribute data from both layers.

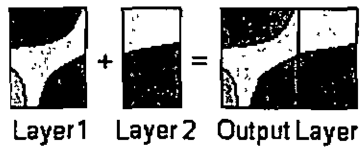


2. Merge layers together

Using merge is similar to union – a new layer is created from multiple layers but their features are not intersected. Merge allows you to combine the features from two or more layers of the same geometric type. When you merge layers, you specify which layer has the same fields you want the new layer to have. If the other layer you're merging have more fields than the layer you have specified, fields won't be in the new layer's table. If the other layers don't have the same fields as the layer you've specified, empty cells will be added to the new layer's table.

About Merge

This operation appends the features of two or more layers into a single layer. Attributes will be retained if they have the same name.



Go to *Tools* in the Main Menu toolbar > *Geoprocessing Wizard* > choose *Merge layers together* > *Next* > Select at least two layers to merge > give a name to this new layer you are creating.

To use one layer's data in another layer – assign data by location

Assigning data by location uses a spatial relationship to join data from one layer to another layer. Use Assign data by location when you want to use a spatial relationship to join data from the attribute table of one layer to the attribute table of another layer. Depending on the type of data you have, the join will be point-to-point or point-to-line, polygon-to-point, polygon-to-line, polygon-to-polygon, line-to-line.

1. Point-to-point, point-to-line

If you're assigning data from a point layer to another point layer OR you're assigning data from a point layer to a line layer.

2. Polygon-to-point, polygon-to-line, polygon-to-polygon

If you're assigning data from a polygon layer to a point, line, or polygon layer, the data will be joined to the point, line, or polygon that is contained by each of the polygons.

2. Line-to-line

Exercise 6.

1. Try to dissolve, merge, clip, intersect and union using the temperature layer and rainfall layer (this last one you will have to add) with the layers you have available and compare the results.
2. Extract temperature and total precipitation data for *Dianthus cintranus* subsp. *barbatus* and *Allium schmitzii* by using the GeoProcessing Wizard and open the Attribute Table to see the results.
3. Use the *Vicia bithynica* layer to create a 3 buffer rings at 2Km intervals which merge using the Buffer Wizard

USEFUL SITES

GIS Guide to Good Practice (particularly section 3, 4, and 5):
http://ads.ahds.ac.uk/project/goodguides/gis/

ESRI downloads and help forums: http://support.esri.com/

European Environment Agency:
http://dataservice.eea.europa.eu/dataservice/available.asp?type=Themes&refid=F163CB2B-35EE-486E-AC4A-2F8A8B97BF3C

USEFUL REFERENCES

Ormsby, T.; Napoleon, E.; Burke, R.; Groessl, C. and Feaster, L. (2001). Getting to know ArcGIS desktop. Basics of ArcView, ArcEditor, and ArcInfo. ESRI Press, Redlands, California.

Definition of Landraces

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Developing methodologies for on-farm conservation of plant genetic diversity in Malawi

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Introduction

- Publications
- The need for a clear definition of landraces
- Current problems with the definition of landraces
- Working definition of landraces (Experiences from Malawi)

Publications

- **Camacho Villa, T.C., Maxted, N., Scholten, M.A. and Ford-Lloyd, B.V., (2005).** Defining & identifying crop landraces. *Plant Genetic Resource: Characterization and Utilization*, 3(3): 373-384
- **Bellon M. R. and Brush S. 1994.** Keepers of maize in Chiapas, Mexico. Economic Botany 48:196-209
- **Cleveland D.A., Soleri D, Smith S.E. 2000.** A biological framework for understanding farmers plant breeding. Economic Botany 54 (3) pp 377-394

Publications Cont.

- **Hawkins, R.P. 1983**. The diversity of crop plants. Harvard University Press, Cambridge, MA, page 102A Note on Kersey White Clover. Journal of NIAB 11: 226 –227
- **Harlan J.R. 1975**. Our vanishing genetic resources. Science 188, Pp 618-621
- **Zeven, A.C., 1998a**. Landraces: A review of definitions and classifications. Euphytica 104: 127-139

Need for a clear definition of landraces

- Clarity over what constitutes a landrace in the legal sense may have particular importance with a view to issues of intellectual property rights (WTO), farmers' rights and access & benefit sharing (CBD).
- Landrace inventory: pre-requite to both *ex situ* and *in situ* (on-farm) conservation.

Current problems with definition of landraces

- Several terms have been associated with the concept of a landrace such as:
  - Primitive cultivar
  - Primitive variety
  - Primitive form,
  - Local variety (Malawi, SADC),
  - Farmer variety (CBD, SADC),
  - Traditional variety (Africa),
  - Folk variety

Current problems with definition of landraces

- All have been used as synonyms for the term landrace but there are inconsistencies over the application of each term. Examples:
  - Cleveland *et al.* (2000) indicated that farmers' varieties are composed of **landraces**, **locally adapted varieties** and **progeny** from crosses between landraces and modern varieties

Current problems with definition of landraces

  - Bellon and Brush (1994) consider that a landrace is constituted by several farmers' varieties.
  - Other terms associated with landraces include "ecotypes", heritage varieties, selection and conservation varieties
  - Zeven (1998) in a review of landrace definitions concluded that as a landrace has a complex and indefinable nature, an all embracing definition cannot be given.
- While there is no one term universally accepted, folk variety, local variety, traditional variety and farmers' variety are more frequently used than others

Working definition of landraces

- Attempts to define landraces
  - Harlan (1975) defined a landrace as populations that have evolved in subsistence agricultural societies as a result of millennia long, artificial human selection pressures, mediated through human migration, seed exchange as well as natural selection.

Working definition of landraces

  - Harlan (1975)also believed that landraces have three basic characteristics:
    - Variability of genotypes
    - Distinct
    - Adapted to local conditions
  - Hawkes (1983) extended the term by adding the association with marginal environments, lack of direct competition with highly bred cultivars.

Working definition of landraces

- Accepted working definition of landraces
  - Camacho Villa *et al.* (2005) in their review of the landrace definition came up with six characteristics associated with a landrace and on the basis of these provided the following working definition:

  "A landrace is a dynamic population of a cultivated plant species that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems"

Working definition of landraces

- Experiences from Malawi that support the current accepted definition of landraces
  - Farmers are able to give:
    - Historical origin of sorghum and cowpea landraces
    - Describe distinguishing features of each farmers variety
    - Given names to various landraces to reflect some characteristics of landraces. Examples from sorghum landraces:
    - Thengalamanga (Tall)
    - Gonkho (Tall, head with goose's neck)
    - Katswabanda (very hard seeds that can break mortar when pounding)
    - Kawawadzuwa (shiny seeds)

Exercise

1. With reference to plant genetic diversity conservation, comment on the products of the following proposal:

- Farmers will only keep landraces that are useful to them. In order to improve the attractiveness of those landraces not in use, value-adding through participatory breeding should be encouraged

Methodology for On-Farm Conservation

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13-Dec-06

Introduction

1. The need for on-farm conservation methodology
2. The problem of developing on-farm conservation methodology
3. **The generalised methodology framework**
4. Publications

13-Dec-06

Publications

- **Maxted, N., Guarino,L., Myer, L & Chiwona, E.A., (2002).** Towards a methodology for on-farm conservation of plant genetic resources. Genetic Resources and Crop Evolution 49: 31-46.
- **Maxted, N., Ford-Lloyd, B.V. & Hawkes, J.G., (1997).** Plant genetic conservation: the *in situ* approach. Chapman & Hall, London. pp. 451.
- **Laliberté, B., Maggioni, L., Maxted, N. & Negri, V., (Eds.). 2000**. ECP/GR *In situ* and On-farm Conservation Network. Report of a joint meeting of a Task Force on Wild Species Conservation in Genetic Reserves and a Task Force on On-farm Conservation and Management, 18-20 May 2000, Isola Polvese, Italy. International Plant Genetic Resources Institute, Rome, Italy. ISBN 92-9043-457-0.
- **United Nations Conference on Environment & Development 1992**. Biodiversity Conservation, UNCED, Geneva

13-Dec-06

The need for on-farm conservation Methodology

"Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity."

CBD Article 8

13-Dec-06

The problem in developing on-farm conservation methodology

- Difficult to develop a generalised methodology because of complex sociological / political / environmental / agricultural factors
- Many descriptive studies but limited methodological advances
- Farmer is the one to take the role of conservation

13-Dec-06

The problem of developing on-farm conservation methodology

- Are farmers interested in conservation?

13-Dec-06

Generalised Methodology Framework for On Farm Conservation

- Simple methodologies are particularly useful for those conservationists working in centres of diversity where:
  - Genetic erosion is often rife,
  - Conservation finances are severely limited and
  - Appropriately trained personnel are relatively few.

13-Dec-06

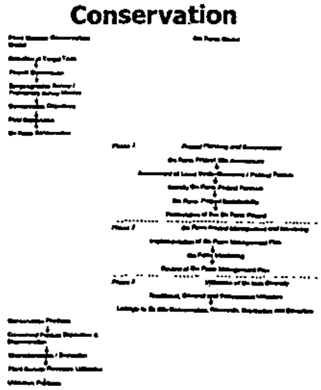
Generalised Methodology Framework for On Farm Conservation

A Model Within A Model

- On-farm model fits within the plant genetic conservation model
- Before on-farm model must select target taxon, undertake ecogeographic survey, establish conservation objectives
- After on-farm model must consider complementary conservation and use

13-Dec-06

Generalised Methodology for On Farm Conservation



13-Dec-06

Phase 1 - Project Planning and Establishment
1.1 On Farm Project Site Assessment

- Select sites, communities and farmers
- "The objective of an on-farm project is to ensure that the maximum possible range of genetic diversity of the target crop continues to be managed by farmers within their farming systems in a given region."
- Ecogeography should help

13-Dec-06

1.1 On Farm Project Site Assessment

- Site characteristics:
  - high levels of genetic diversity at the site (s)
  - interest the user community in the specific genetic diversity found at or believed to be found at the site
  - imminent threat of genetic erosion
  - presence of wild and weedy relatives of the target crop
  - local communities have a tradition of experimentation with, and manipulation of, genetic diversity
  - complementarity of sub-sites
  - sustainability and cost

13-Dec-06

1.1 On Farm Project Site Assessment

- The advantage of using existing agricultural development units to base on-farm projects would be that:
  - They are already mapped and well studied
  - They already have a extension worker / farmer / community interaction structure in place, which could be easily used to coordinate on-farm activities
  - They are relatively small units and so manageable in terms of an effective conservation project
  - They are already used for the collection of *ex situ* germplasm, farmers are already aware of the genetic resource of which they are custodians.

13-Dec-06

Assessment of Local Socio-economic and Political Factors

- Farmer Level
- Community-level social research
- Micro/macro-level anthropological analysis

13-Dec-06

1.2 On-Farm Project Sustainability

- Sustainable in terms of conservation of diversity
  - No agricultural, civil or industrial development projects (?)
  - Continuing market for produce
  - Farmers are keen and represent the community as a whole
  - Policies/legislation

13-Dec-06

1.3 Identify On-Farm Project Partners

They are likely to include:

1. Farm ers - These will commonly be the small land holders who already grow the targeted traditional landraces, who understand the impdance of conservation and are willing to be involved in the project.
2. Agricultural extension workers - Their role may well be critical in identifying potential farmers to be involved in the project, helping implement the project, as well as bridging anyperceived gap between the professional and non-profession partners in the project.
3. Non governmental organisations - There are many existing NGO's of various kinds operating in rural communites and farmers are used to interacting with them, therefore their assistane may prove beneficial.
4. Community leaders - All rural communities have some form of organised local leadership, so if the on-farm project is to succeed it must involve these local authorities.

13-Dec-06

1.3 Identify On-Farm Project Partners

- Selection of farmers:
  - *who currently maintain large quantities of diversity*, the overall goal is to conserve the maximum genetic diversity, so farmers who already have high levels of diversity and an appreciation of this diversity will be an obvious choice for inclusion in the project.
  - *who are older and more experienced*, there is likely to be a correlation between the length of time a farmer has been farming and the percentage of traditional land races grown, because they simply have been farming for longer and so will have been exposed to older land races for longer. Also older farmers are often more conservative and so wish to maintain traditional land races and agricultural practices. The project may encourage the passing of traditional knowledge to the younger farmers.
  - *who are younger*, if the project is to be sustainable over a long time period then younger farmers will also need to be selected. This may also be important in terms of awareness building of the importance of conserving traditional land races among the younger community of farmers. The project may also encourage the passing of more contemporary knowledge to the older farmers in the project.

13-Dec-06

1.3 Identify On-Farm Project Partners

- Selection of farmers (cont.):
  - *who are relatively wealthy*, this group of farmers may wish to continue growing landraces as a hobby or for sentimental reasons, because their economic position may not be so critically tied to the economic return from their farm produce.
  - *who are relatively poor*, this group of farmers may not have the economic resources to change from landraces to HYV's or to increase the level of inputs (e.g. fertilisers, herbicides, etc.) to the system.
  - *from different ethnic groups*, because certain landraces may be associated with certain ethnic groups.
  - *of different gender*, because the cultivation and maintenance of certain landraces may be correlated with the gender of the farmer.
  - *who are chiefs*, they may wish to continue growing landraces because they are the major custodians of traditional values within the village. There may always be pragmatic reasons for selecting the chiefs or headmen among those included in the project because of their key role within the village, they act as a model or leader showing the importance of land race conservation for the other farmers.

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1.3 Identify On-Farm Project Partners

- Must not be decisive or disruptive
- Community shares benefits
- Involve "gatekeepers"
- Participatory rural approaches

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1.4 Formulation of Project Activities

- Understand why farmers grow landraces, how they choose which seed to save for sowing next season and when they choose to introduce new material
  - Farmer decision making
  - It is not a closed system ('super'-dynamic)
- Micro/macro-level economics
  - Micro = off-farm income / economic aspiration
  - Macro = governmental / regional / international policies

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1.4 Formulation of Project Activities. Cont.

- Agricultural questions that will need to be addressed include:
  - what material is used for planting ('pure' land races ormixtures of primitive land racesor even mixtures with HYVs)?
  - where and when is the crop planted?
  - what area (size) is planted?
  - what planting and cultivation regime is used?
  - when and how is the crop harvested?
  - how is the crop threshed and stored until it is used?
  - how is the crop used?
  - how is the target crop integrated into the overall agriculturalregime?
  - what changes to the system might the farmer wish tointroduce?

13-Dec-06 what are the constraints the farmer faces when trying to achieve his or her objectives?

1.4 Formulation of Project Activities Cont.

- Non-agricultural questions that will need to be addressed include:
  - Are young people migrating to urban centres?
  - Is the local infrastructure, such as rads, being improved?
  - How close to the on-farm conservation site are development projects?
  - Is civil strife and the associated arrival of food aid likely?
- Positive sign of protection:
  - Are farm holdings fragmented?
  - Are farmers encouraged to maintain landraces?
  - Is marginal land being increasingly cultivated?
  - Is the site economically isolated, creating market distortions ad competitive advantage?
  - Are there cultural values and preferenes associated with individual landraces or diversity?

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Design Interventions

- If the farming system is sufficiently robust there may be no need for intervention, so just describe and monitor
- But if interventions may be necessary
- Each site is likely to be unique so need to design interventions to suit the site, these may include:
  - raising public awareness of the wider conservation importance of maintaining locally adapted land races.
  - education of the local community inthe benefits of using locally adapted land races (Qualset *et al.*, 1997).
  - creating new, preferential markets for traditional landraces either at the local, regional or national level, where farmers are paid a premium by the consumer becaue traditional landraces are seen as being 'better'. May require active promotion or marketing of the traditional land race material. These markets may always be niche markets but if publicised appropriately they could be sustainabe.

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Design Interventions

- locally based breeding programmes can improve the landraces (e.g. in terms of yield, quality, disease resistance, etc.) so they can better compete with HYV's (Ceccarelli *et al.*, 1996; Eryzaguirre and Iwanaga, 1996; Sthapit *et al.*, 1996).
- agro-ecotourism may not be as large a draw asnature based ecotourism, but cultivation of traditional land races may form a component of traditional farm structure which are becoming of increaing importance.
- halting subsidies (perverse incentives- McNeely, 1988) for HYV's.
- introduction of incentives that promote genetic, social, economic, cultural and political stability.
- direct payment of subsidies (not market related) to farmes growing locally adapted land races
- indirect subsidies may also be given to communities with continue growing locally adapted land races, such a providing extra local services e.g. the building of better roads to help get this niche crop to market.

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Design Interventions

- access to landraces that have been lost from the region
- changes in agricultural practice to a more sustainable model
- monitoring of any changes in genetic, social, economic, cultural and political factors at a local and national level.
- introduction of community seed banks to assist farmer-based conservation.
- establishment of farmer's networks to promote seed exchange.

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Phase 2 – On-Farm Project Management and Monitoring

2.1 Implementation of On-Farm Management Plan

1. statement of the rationale for the on-farm project within overall conservation strategy for the target gene pool
2. results of the ecogeographic survey and exploratory ethnobotanical/diversity survey, including a list of specific potential sites for implementation of the project
3. specific target crop (e.g. taxonomy, phenology, habitat preference, breeding system, minimum population size)
4. morphometric and genetic description of the landraces present at the site (e.g. mapping of landrace distribution and density within the site, details of farmers management practices, relationship with other crops in the cultivation system, genetic diversity)

2.1 Implementation of On-Farm Management Plan

5. results of the preliminary socio-economic survey of the potential sites, including a list of possible project partners both in the proposed project sites and beyond
6. preliminary assessment of the reasons why management of landraces is currently taking place at the proposed project site (s) and discussion of the any potential threats to the *status quo*
7. conservation management prescription, a set of proposed interventions aimed at overcoming the potential causes of genetic erosion identified above that can be implemented if required,

2.1 Implementation of On-Farm Management Plan

8. training and research agendas
9. strategy for monitoring (relative to a known baseline) both the potential cause of genetic erosion and the effects of the proposed interventions on genetic diversity
10. strategy for use of conserved genetic diversity by different groups
11. budget, manpower, local, national and international conservation agency involvement, and local and national political involvement

2.2 On-Farm Monitoring

- On-farm is 'super'-dynamic, so there is a lot of change in genetic diversity
- Trying to identify significant decline in diversity
- Will depend on crop, local situation and resources available
  - Regular, standardised sampling
  - Morphological
  - Molecular

2.2 On-Farm Monitoring

- Criteria for selecting samples:
  - How will samples be taken?
  - When during the crop cycle will samples be taken?
  - How frequently will samples be taken? Every year, every other year?
  - What characters will be assessed?
  - How will the data be analysed?

2.3 Review of On-Farm Management Plan

- Compare data over time series
- Identify changes, bearing in mind change is natural and dealing with 'super'-dynamic system
- Review and revise management

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Phase 3 – Diversity utilisation

- 3.1 Traditional, general and professional utilisation
  - Similar to genetic reserve, though obviously of more interest to farmers
- 3.2 Linkage to *ex situ* conservation and duplication
  - Very important as the system is 'super'-dynamic

13-Dec-06

Traditional, General and Professional Utilisation

- Humans should conserve because they wish to utilise and it is necessary to make an explicit link between the material conserved and that currently or potentially utilised *ex situ* by humankind. There are three basic user communities: traditional, general and professional.

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Linkage to *Ex Situ* Conservation, Research and Education

- There is a need to form links with *ex situ* conserved material to ensure utilisation but also as a form of safety duplication. The on-farm site forms a "natural" platform for ecological and genetic research, as well as providing educational opportunities to educational (primary, secondary, higher tertiary) institutions and the general public.

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Conclusions

- The Model in Perspective
  - Model may not suit all crops / situations
  - Farmers need not wholly under the control of conservationists
- Ethics: Meeting needs and distributing benefits
  - Farmer priority is to feed family not be a conservationist
- On-farm conservation and agricultural development
  - Need to be pragmatic!

13-Dec-06

Generalised Methodology Framework for On-farm Conservation of Plant Genetic Diversity

Selection of Target Crop species

Project Commissioning

Survey of on-farm maintenance

Development of Conservation Objectives

On-farm Conservation

Phase 1: **Project Planning and Establishment**

- Identification of Project site(s)
- Project sustainability
- Identification of project partners
- Formulation of project activities

Phase 2: **Project Management and Monitoring**

- Implementation of project activities
- Monitoring
- Review of project activities

Phase 3: **Diversity Utilization**

Traditional, General and Professional Utilization

Linking to *Ex Situ* Conservation, Research, Duplication and Education

Conservation Products

- Product Deposition & Dissemination
- Characterisation/Evaluation
- Plant genetic Resources Utilisation

Figure 1: **Proposed methodology for on-farm conservation of plant genetic diversity**

Source: Maxted *et al.* (2002).

International Board for Plant Genetic Resources

and the

European Association for Research on Plant Breeding
(Eucarpia)

CROP GENETIC RESOURCES
FIELD COLLECTION MANUAL

For Seed Crops, Root and Tuber Crops, Tree Fruit Crops and related wild species

J.G. Hawkes
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1980

CONTENTS

1. PREFACE.

This field collecting manual has been written as a general guide for people involved in collecting genetic resources materials of seed crops, root and tuber crops and tree fruit crops, as well as the wild species related to them. It is based on an earlier version for seed crops only, commissioned by FAO, to which acknowledgement is hereby made.

The International Board for Plant Genetic Resources (IBPGR) and the European Association for Research on Plant Breeding (Eucarpia) have sponsored the present booklet in the hope that it will be of value to Germ Plasm Exploration Missions in all parts of the world.
The author wishes to acknowledge the helpful comments and advice of Eucarpia Gene Bank Committee members and of colleagues in FAO, Indonesia, India and South America, as well as colleagues in Birmingham and former students (especially Dr. Rena Farias, Dr. Ayla Sencer and Mr. R. Denton), all of whom read earlier drafts of this booklet.
Finally, special thanks are due to Sir Otto Frankel (Australia), Miss Erna Bennett (FAO) and Dr. J.T. Williams (FAO/IBPGR) for much help and advice, based on wide experience.

The writer will be happy to receive suggestions for improvement of the text if new editions are published and will try to provide further advice on collecting and general expedition techniques. Advice can also be obtained by writing to the Crop Ecology and Genetic Resources Unit, FAO, which also provides the Secretariat of the International Board for Plant Genetic Resources), at Via delle Terme di Caracalla, 00100 Rome, Italy.

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2. INTRODUCTION.

It is now universally agreed that a catastrophic loss of diversity in our crop plants has been taking place during the last few decades, and that this process of genetic erosion is likely to continue at an even greater speed in the future. Plant breeders need this genetic diversity as a basis for the creation of new higher yielding, better adapted and more disease resistant varieties to help solve the world problems of hunger and malnutrition.

Over the whole world a concerted effort has recently been taking place to collect, preserve and exploit this genetic diversity before it disappears for ever. Breeders need not only genetic resources of major field crops but those of the so-called minor crops also, since to the people who grow them they may be of a very great importance indeed. We also need living stores of fruit and forest tree materials and the related wild species of all such cultivated plants.

Carefully designed plans for collecting and storage of genetic resources materials, with established regional and crop priorities, are currently being agreed to. Many people are becoming involved in exploration activities, and it is thus becoming necessary to provide guidance and help in the correct methods to be used.

There are many misconceptions about the methods of germplasm collecting. It is *not* just a matter of going into the field, taking a few seeds from a plant or two and taking a note of the country where it was found. Our knowledge of the taxonomy, population genetics and breeding objectives of cultivated plants shows very clearly that exploration for genetic resources purposes is a discipline in its own right, which is far removed also from ordinary botanical collecting. In general terms, the botanical collector is looking for uniformity and trueness to type; the genetic resources collector is looking for diversity, and is using methods devised to capture maximum diversity for the minimum amount of material collected.

Sampling methods differ according to whether one is collecting annual

seed crops, vegetatively propagated crops or fruit and timber crops. In this manual all three main methods of sampling are described, and as much detail as possible is given on how to plan and equip an expedition.

When planning a field exploration mission it is as well to bear in mind the methods by which the material is going to be conserved, since it is of little use to make collections when no facilities for conservation can deal with them. Shipping and quarantine problems must also be borne in mind at an early planning stage.

Details of collecting and travelling are bound to differ according to the nature of the material collected, the climatic and other conditions of the country in which the expedition is taking place and the personalities and past experience of the expedition team members.

What follows, therefore, is not a description of unchangeable laws but a series of general recommendations. It is hoped that the collectors will follow these as closely as possible, making minor changes and adjustments where necessary, particularly in relation to individual crops.

The parts to be followed most closely are those dealing with sampling techniques and the need for adequate field records which can be used in computerised documentation systems. On the other hand, general expedition planning and the types of equipment and methods of transport can be adjusted within wider limits to fit into local conditions and requirements.

To sum up genetic resources collecting requirements in a few words.

1) The collector must have a good knowledge of the crop(s) he will be collecting.
2) He must have a good knowledge of the country or the region where he will be travelling.
3) He must try to collect as much as genetic diversity as possible by using the recommended methods of sampling.
4) He must make adequate records in the field at the time he is making his collections.

3. PLANNING A GENETIC RESOURCES EXPEDITION.

3.1. *REGION AND CROPS.*

As much time as possible should be allowed for expedition planning. From six months to one year or even longer are advisable. Sometimes three months or less can be enough, depending on whether the collecting team has already been to the region in question and can therefore return with a minimum of further planning.

Choosing a region for exploration depends on.

1. expectation of genetic variability,
2. crop priorities for genetic resources conservation,
3. regional priorities,
4. past exploration activities.

The fact that extensive collections have been made in the past and have provided useful germplasm for breeding programmes, does not mean that no more collections are needed, since the existing ones may not necessarily contain adequate amount of genetic diversity.

Frequently these past collections, 1. may have been collected by breeders for a limited purpose, 2. may not have been population samples, 3. may not have been conserved properly for long-term conservation, 4. may have suffered from genetic erosion or drift since they were collected, 5. may have been collected from easily accessible areas, ignoring remote or even fairly accessible sites, 6. may have been lost by neglect, fungal and pest attacks, etc.

The main purpose of the exploration may well be to collect wild species and primitive cultivars. These are in general not particularly well represented in some of the larger collections; even some so-called "world collections" may not include more than a few samples of related wild and weed species.

It is sometimes necessary to collect only one crop on an expedition, as for instance when there is an immediate threat to indigenous land races of a crop because of their replacement by improved cultivars.

Very often, however, several related species are all grown together (wheats) or groups of even unrelated species occur in the same rotation (wheat, barley, lentils, etc.). When this is so, an attempt should be made to collect this wider range of crops since it will probably be very expensive and not very cost effective to send several expeditions to the same region, each for its own particular crop.
In some instances, multiple crop collecting may not be practical. This could be so for cottons and *Quinoa* in the Andes, where each crop occurs in a complete distinct altitudinal and agro-ecological zone. So, careful decisions must be made in the planning stage, and collecting priorities must always be kept firmly in view. Of course, some flexibility must be allowed in the field if interesting material is found, even though it may not have been on the list of crops to be collected when the expedition was planned.
The planning of collecting expeditions on a national basis should incorporate the regulations set out by the particular country involved. In all expedition planning to other countries it is of the greatest importance to enlist the enthousiastic support of the host country and to ensure that governmental officials, agricultural scientists and extension officers are fully aware of the importance of the exploration, conservation and efficient utilisation of their national plant genetic resources.
A government permit to collect plants may be required, and if the plants are to be exported to another country, clearance from the appropriate section of the Ministry of Agriculture (Plant Health, Quarantine, etc.) may be necessary. Information on how to get these permits, who to contact, etc. varies from country to country. The relevant Embassy, the FAO Unit of Crop Ecology and Genetic Resources, or the IBPGR should be contacted for advice.
Full reports on the expedition results and OFFERS OF SUB-SAMPLES OF ALL COLLECTIONS SHOULD BE MADE AVAILABLE TO THE AUTHORITIES OF THE HOST COUNTRY. Reciprocal exchange of materials and data covering their

subsequent evaluation studies should be arranged where possible, on a continuing basis after the close of the expedition. The attention of government officials should be drawn to areas where further collecting should be carried out.
A final word is necessary here on nature conservation. Germplasm collecting should not violate the principles of nature protection. Thus, if the wild species to be collected seems to be very rare and in danger of extinction, care should be taken not to collect so many samples of seeds, bulbs, tubers or voucher specimens that none is left for natural regeneration.

3.2 THE COLLECTING TEAM.

This should be kept small for efficiency. From two to three person is ideal. Larger teams can be split up into groups of two or three people, each allocated to a particular area and reporting back to th team leader at regular intervals.
The team leader should preferably be a botanist, a breeder or an agronomist. At least some members of the expedition team should be familiar with the morphology, ecology and breeding needs of the crop to be collected as well as their wild relatives. The team should als have some knowledge of the region to be visited, whether from person experience, from the accounts of others who have been there before, by reading all the available literature. At least three months' intensive study is desirable. Knowledge of the diseases and pests of the crops collected in the region is also of considerable advantage. Briefing sessions for all team members should be arranged before the expedition so that all should start with a thorough knowledge of the crop(s) to be collected, the vegetation and the climate, the agricul systems and the history and results of past collecting in the region Whenever possible, the team should include a specialist on the regio to be visited, such as an extension officer who works in the area or who is conversant with local conditions and languages, as well as

its crops and people. Often a driver, guide or interpreter may be hired for each particular place or region when special needs arise.

3.3 ROUTE.

Preplanning the route is essential, and the availability of maps such as contour maps 1:1,000,000, 1:500,000 (or larger scale if possible) and road maps, is most important. Regional soil types and climatic maps as well as vegetation maps are most useful, but generally are difficult to find or do not exist. In many regions, the maps are unreliable and allowance should be made for this where known. Good road maps, even without contours, are quite useful and are better than nothing.
At an early planning stage a provisional route should be drawn up. Local contacts should be made by correspondence, especially to field staff in more remote areas, to advise on the feasibility of following certain routes. Government permission is often required to enter certain areas, and this must be sought well in advance by writing to officials at as high a level as possible.

3.4 TIMING OF THE EXPEDITION.

Correct timing will make it possible 1. to collect the largest amount of genetic diversity in the period available, 2. to be in the various areas when the crop is maturing, 3. to collect from many distinct places within each region, 4. to cover local variations in soil, climate, altitude, varying agricultural practices, etc., 5. to look for weedy forms in and around the field borders, 6. to search for related wild species.
In general, when planning the expedition, allowance in timing can be made for climatic and seasonal differences associated with broad geographic factors, viz. latitude, longitude, altitude, within the agro-ecological region to be sampled. It is most important to ask for advice on maturity and harvest times from local agriculturalists who

will have intimate knowledge of crop production and statistics on regularity of yield, etc.
There will inevitably be certain areas where primitive or locally selected cultivars flower early, or late, despite the maturity times known for the general region. In such cases it may be necessary to allow sufficient time for two visits by the team, or to arrange for a second collection to be made by local agronomists or extension workers after the team has left the region.
The period when seeds or vegetative storage organs are ripe is relatively short. Thus it is useful to have all the collecting techniques well rehearsed during the expedition planning, so as to collect as many samples as possible in the field during the time available.

3.5 EQUIPMENT.

This will vary according to the materials to be collected, climate, local conditions, mode of travel, etc. The items listed below constitu an optimal list for an ideal collecting mission, but even if certain items are not available good collections can still be made:

3.5.1 Collecting equipment.

1. Strong cotton bags, size and type depending on crop, with draw strings or tapes if possible. Sometimes strong paper bags will be satisfactory, especially for tuber materials.
2. Polythene or parchment bags for fruits, e.g. berries, capsules, etc. to be "cleaned" later.
3. Large bags, sacks or boxes in which to put the samples.
4. Strong paper seed packets of various sizes.
5. Sieve for cleaning seeds taken from berries, etc.
6. Strong knife or secateurs for making budwood cuttings, collecting vegetative organs, etc. Even though seeds, roots or tubers are to be collected it may be necessary to collect or examine other parts of the plants.

7. Small pocket notebooks, for taking notes IN THE FIELD and for listing photographs taken.
8. Collectors' field notebooks (see Section 11, page 34)
9. Larger notebook (say 15 x 20 cm) for keeping diary of impressions, notes, etc. - to be written up each evening from the notes made in the field. This will then comprise a "journey log".
10. Rubber bands, paper clips or string for closing bags.
11. Tag labels for specimens, e.g. for particular cereal spikes, panicles, ears.
12. Several pocket knives and pairs of scissors.
13. Napsacks and rucksacks for carrying collecting equipment, notebooks, etc.
14. Insecticide and/or fungicide dusts. It will be essential to make sure that these do not reduce the viability of the samples.

3.5.2 Scientific equipment.

1. Small portable altimeter to read up to 5,000 m. (15,000 ft.).
2. Field compass.
3. Cameras, one for black and white and one for colour. 35 mm single lens reflex with pentaprism or view-finder, close-up lenses, ultraviolet filter, green or yellow filters, flash apparatus, tripod, etc.
4. A plentiful supply of films.
5. Large piece of cloth (black velvet is ideal) for use as backcloth when photographing individual plants in the field. (Note: take care to expose for plant, not for backcloth!).
6. Lightmeter, if not already incorporated into camera.
7. Pocket lenses (x 10 and x 15 or x 20 are useful magnifications).

3.5.3 Additional equipment (when considered desirable).

1. Scalpels, dissecting needles, dissecting scissors.
2. Binoculars, especially for reconnaissance trip.
3. pH kit - colorimetric type.

4. Polaroid camera.
5. Polythene or glass specimen tubes for root tips, anthers, flowers, etc.
6. Bottles of formalin, alcohol, or acetic acid for preserving required parts of plants.
7. Silica gel for seed drying, together with airtight specimen tubes. On the whole, seed drying is best done later, after returning to home base.
8. Presses in which voucher specimens can be dried. These are regarded as essential by some collectors.
9. Absorbent paper, felt or plastic foam sheets for pressing specimens.
10. Newspaper or 'flimsies' for individual specimens.
11. Corrugated cards or aluminium sheets to put between drying paper in the press and thus allow for adequate ventilation.
12. Drying stove and stand. (A slow-burning paraffin stove is ideal).
13. A small battery tape recorder for dictating field notes, etc., may be a useful addition or alternative to 3.5.1, 9 above.

3.5.4 Transport.

This depends on the type of expedition and number of participants. If the expedition is in very isolated areas (across deserts, etc.) then it may be better to have two small vehicles in the field then one. Advice should be taken from local residents and past collectors.

1. Land Rover, jeep, etc. where possible with four-wheel drive, high/low gear change and winch. It must be completely covered in and lockable to prevent theft of contents. Long wheel base, heavy duty tyres and heavy springs are desirable. For very narrow twisting mountain roads a short, narrow jeep is recommended.
2. Roof rack with waterproof cover and ropes.
3. Good set of spare parts and tools.
4. Two spare tyres, pump and pressure gauge.
5. Puncture repair kit with plenty of patches.

6. Heavy duty jack and tyre levers.
7. Spare petrol cans and large funnel, as well as a length of plastic tubing.
8. Chain or nylon rope.
9. Shovel and pick.

It should be stressed here that in many regions, perhaps in most, collecting has already been done along the roads. Therefore, plans should be made to visit remoter places which are accessible only on horseback, muleback and camelback, or on foot. Local porters may be necessary in some places. MANY OF THESE REMOTER REGIONS STILL CONTAIN VALUABLE GENETIC RESOURCES WHICH HAVE DISAPPEARED FROM THE MORE EASILY ACCESSIBLE PLACES.

3.5.5 Camping equipment, cooking stoves and fuel.

Most collecting will be made in areas which do not have hotels or overnight accommodation. Camping equipment is therefore essential, but in planning the route the accessibility of towns and villages for accommodation and for buying food and other essential supplies should be noted.

1. Light-weight tents to take one or two people each (with fly sheet and mosquito netting), also sealed-in groundsheet.
2. Sleeping bags with sheet bags.
3. Small camp beds, air matresses or damp-proof foam matresses.
4. Cooking equipment and stoves.
5. Set of aluminium cutlery.
6. Plastic cups, mugs, plates, etc.
7. Water container(s).
8. Electric torches and adequate supply of batteries.
9. Lamp (battery or gas).
10. A small table and chairs may be useful if space permits.

3.5.6 Clothing.

Clothing should be suited to the region and should be lightweight

wherever possible. Wash n'wear/drip dry clothes are especially useful.

1. Field shirts and trousers.
2. Sweaters, several of various thickness.
3. Waterproof jacket with hood.
4. Sun hat and sun glasses.
5. Waterproof trousers.
6. Strong leather boots, leather shoes or rubber-soled canvas shoes according to what is thought to be most appropriate.
   Note: Jackets and shirts should have plenty of pockets.

3.5.7. Medical supplies.

The type of supplies depends on local advice on the problems likely to be encountered, and the common sense of the team members on whether to sample foods and drinks which are totally unfamiliar.

1. Insecticide sprays.
2. Insect repellent creams.
3. Antibiotic tablets against stomach and intestinal infections (take several types).
4. Antacid tablets against minor stomach upsets.
5. Antimalarial tablets, when necessary.
6. Antihistamine cream.
7. Bandages.
8. Band-aid, Elastoplast, etc.
9. Paracetamol, asprin or other form of pain killer.
10. Oil of cloves for toothache.
11. Water purifying tablets or portable water purifier.
12. Snake bite serum, where thought to be necessary.

Previous injections against smallpox, typhus, yellow fever, tetanus, cholera, etc, will have to be taken according to the health laws and regulations of the particular country to be visited.

4. COLLECTING SEED CROPS.

4.1. GENERALIZED SAMPLING STRATEGY.

4.1.1 Field collections (Cultivated and wild materials).

The overall sampling strategy depends on the kind of species and especially its breeding system, amount of gene flow between populations etc. However, this is often not known in advance. Therefore, one should try to cover the whole region by taking random population samples at wide intervals (= "coarse grid sampling"). The size of these intervals depends on the amount of environmental diversity. Thus, if an area seems to be fairly uniform in climate, soil type, vegetation, farming practices, crop cultivars and altitude the intervals can be quite large (20-50 kms, or even more, perhaps). However, if these factors are changing quickly (especially altitude) , then frequent samplings should be made (sometimes every km or less, or every 100 m increase of altitude). It is difficult to be precise here, but the collector should take advice from local people and should observe the general changes in vegetation, farming practices, tribal boundaries, etc. before making his decisions.

Sometimes, if time permits, a two-stage collecting can be done. First a "coarse grid" sampling should be carried out; and this should be followed in a later year by:

1. more intensive sampling in specific areas depending on the records of past evaluation of material collected previously. This two-stage collecting is essential when searching for defined genotypes, e.g. those showing high drought resistance, disease resistance, etc.
2. special sampling of disjunct populations, peripheral populations and those occupying geographically remote and often peculiar or distinct ecological niches.
3. wherever possible the wild population should be sampled at least twice in different years, because climatic changes from year to year may change the frequency of certain biotypes in the population.

4.1.2 Collections from farmers' stores, markets, shops, etc.

It may not always be possible to take field samples over a whole region adequately, even using a coarse grid, through lack of time. In any case it is often advisable to investigate and collect from farmer storage bins, from local shops and markets, or through the good offices of local officials. Much useful information may be gathered i this way, and collections may be made more easily. In region-oriented multiple-crop expeditions, the farmers' stores are particularly important to ensure that all crops from the rotation are collected. When sampling from shops and markets it is important to ascertain how much mixing has occurred - especially if the seed is being sold for consumption rather than as seed for sowing. Many market seed stalls offer mixtures matched to consumer demand, e.g. grain legumes with a particular cotyledon colour when split, rice caryopses translucent or not, coloured or not; and these may represent selected seed lots with mixtures of genotypes different from those sown by the farmer. Whenev possible the region from which the seed was obtained should always be ascertained.

4.1.3 Collections from orchard and kitchen gardens, etc.

It is very important to make collections from orchard and kitchen gardens ("door yard" gardens, etc.), since the genetic diversity of t crops in these is often very high, and has hardly suffered from genet erosion, whilst the diversity of the field crops nearby may have disappeared completely.

The number of species in these gardens is often very high (50 to 100 more) though the numbers of individuals may be rather low. Therefore, the population sample may need to be taken from several adjacent gard or even a complete village rather than a single garden. The collector will gain experience of these situations, particularly when sampling vegetable and medicinal crops and will be able to make useful decisic based on concepts of population sampling rather than individual plant sampling (see also Sections 5 and 6, pp. 19 and 22, for root and tuber

crops and fruit tree crops, respectively).

4.2 SAMPLING SITE.

This is an area in which a population sample is collected. For each sample there will be a single collection number with its set of recordings of locality and habitat data (see Section 8 - Documentation).

4.2.1 Size of sampling site.

1. For an annual crop this will be the farmer's field.
2. For a weed species the same concept applies as in 1.
3. For a wild species this must be determined in relation to the variation observed in the population, the size of the colony and environmental factors. Areas sampled may vary from as small as 5 x 5 to as large as 50 x 50 m according to the colony size and the density of individuals.

Some collectors advise that a widespread population, whether cultivated or wild, should be divided into subpopulations, each of which will then require a different collection number and set of locality and habitat records. In some cases these data may be even required for individual plants, as with very sparsely occuring wild species. However, others advise against this, since then the natural plant community with its characteristics features is lost.

4.2.2 Selection of sampling site.

This depends on 1. environmental diversity, 2. the pattern of distribution and densities of individuals in the populations (especially in wild and weedy forms), 3. observation of rare variants in the populations. The more variability that is seen between sites, the closer will be the sites to be sampled.

4.3 NUMBER OF PLANTS AND SEEDS PER PLANT IN EACH SAMPLE.

Random sampling is strongly recommended. This is often spoken of as "non-selective" sampling. Sampling error is minimal when a large sample

is taken, but if the variation in each population is high large samples may be needed.

The general strategy is to obtain a RANDOM SAMPLE by taking heads, say every three paces along a number of transects through the crop. Continue UNTIL NOT LESS THAN FIFTY and NOT MORE THAN ONE HUNDRED HEADS are collected. Take about 50 seeds per head, thus ensuring that a total of from 2,500 to 5,000 seeds are included in each sample (see Table 1 and footnote). If the plant species in question produces small pods with limited numbers of seeds in them, standardise by taking five or more ripe pods from each of three adjacent plants every three paces so as to make up the total of 50 seeds. If the species produces inflorescences, spikes, etc with very large numbers of seeds (such as sorghums and millets with 2000-4000 or more grains), only parts of each head need sampling, so as to provide the 50 seeds required. When sampling maize it is advisable to take one ear every 10 or 20 paces, according to the size of the field, separating the transects by about 5 to 10 rows. Non-random collections based on "race identification" can be made in addition, but should be given distinct collection numbers and should be kept separate from the random collections.

The sampling of crops with seeds in juicy berries or other types of soft fruits (tomatoes, peppers, *Cucurbita*, etc) is basically similar. If each berry contains about 50 seeds, about 50 to 100 of these should be collected at random and put together as a single sample, as for cereals, legumes etc. Fruits with fewer seeds should be sampled in larg numbers in order to make up the required number of 2,500 to 5,000 seeds per sample.

Where some populations seem to be extremely variable one can either a. make very much larger samples, or b. take several distinct samples from various parts. On the other hand in some instances it may not be possible to collect more than 100 to 1,000 seeds. Such small numbers should also be collected, or even less, if they are all that can be found. For extremely small seeds, such as clover (*Trifolium*) and poppy

(*Papaver*) very much larger samples should be collected, since samples of small size are very difficult to handle in practice.

Wherever possible, seeds should be collected from plants that are disease-free or undamaged by pests.

Not all the seeds in the head or fruits may be mature, and allowance may have to be made for conditions of low seed set or low seed viability. Where this is suspected a larger sample than usual would be advisable.

Additional NON-RANDOM (or "selective") samples may be added if the collector sees any particularly interesting variants, present in small numbers, which were not included in the sample by strictly RANDOM sampling. However, some authorities advise that non-random samples should not be mixed with random ones but should be kept seperate and given another collecting number.

Table 1. Suggested seed numbers per sample

Population type	Plants	Seeds from each	Total seeds per sample
Highly variable	100	50	5,000
Fairly uniform	50	50	2,500

NOTE: See Table 2 for storage requirements; it will be necessary to increase seed number per sample four times if multiplication cannot be undertaken.

4.4 SEED CLEANING AND TREATMENT.

4.4.1 Dry seed and grain crops.

For many seed and grain crops seed cleaning is left until the end of the expedition. The heads are simply placed in cloth or paper bags

which allow the circulation of air. This is true for many temperate crops as well as those from arid zones.

As far as possible the seed sample must be cleaned and sun dried. If the weather is wet during harvesting the seed must be dried quickly to prevent the growth of moulds. This should be done by means of artificial heat, but never exceed 40°C. The moister the conditions of harvest the slower the drying process and the lower the drying temperature should be. Great care must be taken during this process not to damage the seeds and so reduce the viability of the sample. In this connection the stove mentioned under Section 3.5.3, p. 10, may be useful.

In the short time between collection and processing in the laboratory, elaborate fungicide or insecticide treatments are usually not necessary beyond the light dusting treatment, AFTER DRYING, with an insecticide and/or fungicide. Note, however, that some Genetic Resources Centres prohibit pretreatment. Check which are the preferred compounds for the particular crop in question because some chemicals may affect seedling emergence. Never use these chemicals to treat seed with a high moisture content.

4.4.2 Crops where the seeds require extraction from fruits.

With several vegetables, such as tomatoes, peppers, pumpkins, gourds, squashes, aubergines, potatoes, etc, the seeds need to be extracted from the collected fruits. The number of fruits needed per population will depend on the number of seeds contained in each.

In these cases the fruits should be fully mature when collected. If this is not possible, the largest ones should be taken and kept in paper or cloth bags until they ripen.

The best way for seed extraction is to spread the seeds from the fruits onto newspaper or blotting paper, after firstly squeezing them into a sieve, washing, and draining off excess moisture.

5. COLLECTING ROOT AND TUBER CROPS.

5.1 GENERAL CONSIDERATIONS.

In this section we shall deal with herbaceous crops that reproduce vegetatively by means of roots, tubers, bulbs, corms, etc. Root crops such as *Beta* which are biennials and reproduce by seed are dealt with under Section 4 (seed crops). Fruit trees, vines and long-lived perennials such as bananas will be discussed under Section 6 (Fruit and timber tree crops).

Many root and tuber crops, such as potatoes, and particularly the related wild species, reproduce by seed as well as vegetatively; again, for seed collection techniques in these crops reference should be made to Section 4.

There are many difficulties with root and tuber crops, of which the main ones are listed below:

a. They are slower to collect than seed crops because they need to be dug up.
b. They need to be collected at the right stage of maturity; if immature they will not store properly and if completely mature the above-ground stems will have died down and the tubers will be difficult to find. (This applies to the wild forms, chiefly; in a farmers field the furrows or "hills" can generally be seen clearly).
c. Material is more bulky and thus more awkward to store and transport.
d. Collections are difficult to keep alive during transport and storage.
e. The clonal "populations" in wild species may be quite widespread and consequently attempts at random sampling may merely result in the collecting of identical clonal materials rather than population samples.

Where sexual reproduction is very limited and the clones are highly sterile, as in sweet potatoes (*Ipomoea*) and other crops, the sampling of vegetatively propagated materials is essential, and cannot be

replaced by seed collecting.

Rather different situations occur with wild and cultivated materials, so their sampling will be discussed separately.

5.2 WILD MATERIALS.

So far as we know, the wild species exist as populations in the normal way, but each genotype may have propagated itself vegetatively over quite a large area. Careful observations should be made in the target areas of apparently similar phenotypes, and samples should not be made too close together. The following strategy is suggested:

a. Collect just a single propagule from each of 10-15 individuals (more if time allows) as a bulk sample. If the organs collected are very large (as with wild *Dioscorea* species) or very difficult to dig up, only a few can be collected (2-3 possibly).
b. The area of the target collecting site for this population sample could be about 100 x 100 m or less if the population is smaller.
c. Avoid collecting duplicates of the same clone.
d. Sample as many sites as possible, in preference to collecting a large number of individuals from few sites.
e. Choose sampling sites over as broad an environmental range as possible.
f. Supplement with seed samples where possible, and give these separate collection numbers, noting their connection with the tuber, etc. samples.
g. Make voucher specimens if time allows.

5.3 CULTIVATED MATERIALS.

These are vegetatively propagated clones. They are not populations, but small parts of what were once populations that have been very strongly selected by the farmers so that only a few varieties remain. Because they are not populations they must be sampled selectively (non-randomly), in complete contrast to seed collections.

The agreed methods for these are as follows:

a. Collect each distinct "variety" in a market or village. By "variety" we mean anything that can be distinguished by eye as a distinct "morphotype".
b. Repeat this process at 10-50 km intervals over an area; the distances depend on the distances between the main market towns or villages.
c. Collect a COMPLETE RANGE of morphotypes at EVERY collecting site, no matter whether they seem to be the same as those collected previously. Duplicates can be eliminated in the gene bank or introduction station afterwards by growing them and carefully observing all characters.
d. Supplement with seed collections where possible. Give the same collection numbers if the seeds come from the same plants as the vegetative samples. If they do not, or are "bulked samples" give separate collection numbers.

Experience with potatoes has shown that this method of collecting is likely to pick up a very large part of the genetic variation within a crop. Even with seed sampling methods we cannot be sure of obtaining every variant. This method for collecting vegetatively propagated crops may miss out some physiological variants but will certainly capture most of the rest: (For further information on this collecting method see Hawkes, 1975 in reference list on p. 26).

NOTE: STEMS (NOT ROOTS) of Cassava (*Manihot*) should be collected.

6. COLLECTING FRUIT AND TIMBER TREE CROPS.

6.1 GENERAL CONSIDERATIONS.

Sampling of fruit and timber tree germplasm is complicated by the following facts:

a. Most temperate and tropical fruit trees, many timber and nut tr[ees] and economic trees and shrubs such as *Hevea* rubber, coffee, and [...] possess seeds known as "recalcitrant". These cannot be stored under normal storage conditions and are sometimes very short-li[ved] indeed. Hence if seeds are collected they need to be sown withi[n] a few weeks. If this is not possible they should be kept within the fruits or packed in moist charcoal.
b. For the reasons given in a. above, the collection of woody cuttings ("budwood") is generally preferred.
c. Collecting strategy must be very closely related to storage, an[d] for this reason the number of seeds recommended for seed crops (Section 5) is far too large for tree crops. Seeds need to be sown directly, cuttings need to be grafted onto rootstocks or rooted by mist propagation or similar techniques, and every gen[o]type needs to be grown into a permanent bush or large tree.
d. Really reliable population sampling cannot be undertaken with "recalcitrant" species until research now in progress has solve[d] the problem of recalcitrant seed storage, or until research funds and facilities for meristem (tissue culture) banks have b[een] established.
e. Thus careful thought is needed as to the numbers of seeds or cuttings that can be established in the introduction station or fruit tree orchard before plans for collecting are completed.
f. In temperate forests each fruit, nut or timber tree species is reasonably frequent and can be sampled on an easily recognizabl[e] population basis. In tropical forests each fruit, nut or timber tree species is very sparsely scattered, and in many cases only

or 2 mature individuals are to be found every ten hectares. Sampling of these can only be done when trees are actually found, with no thoughts of population sampling at all.

With these limitations the following sampling strategies are suggested:

6.2 WILD MATERIALS.

a. Collect seeds from up to 10 or 15 individuals in some 10 hectares (or a smaller area if possible) and put all together as a single sample. If random collections can be made this will clearly be an advantage.
b. Take as many seeds as possible per sample. Where large, as with coconuts, only 10 or 15 seeds would be possible.*
c. If no seeds are available or no facilities are available to prevent the seeds dying, take budwood cuttings or suckers, one per tree, from 10 to 15 individuals in some 10 hectares (or a smaller area if possible).
d. Repeat at intervals, depending on climatic, altitude or soil differences.
e. Do not sample more than one tree in each clump or group, if such occurs, in case they are clonally propagated.
f. Make arrangements for quick despatch of seeds or cuttings to headquarters or introduction station for sowing or planting, if seeds are suspected of being 'recalcitrant'.

6.3 CULTIVATED MATERIALS.

a. Try to sample seeds or fruits wherever possible. If not, take budwood cuttings, suckers, etc.
b. If farmers or villagers indicate that trees are grown from seed, treat the whole village as a collecting site and make a random

* See, however, recommendations from Coconut Genetic Resources (IBPGR, 1978, where 100 seeds per population are recommended as optimal.

population sample from 10 to 15 (or more) individuals throughou[t] the village, as for seed crops, bulking together as one sample. Note: individual gardens often possess only 1 or 2 individuals, so for this reason the trees throughout the village are to be regarded as the population.

c. If seeds are not available and budwood cuttings can be made, sample as in b. but with cuttings in place of seeds.
d. If farmers or villagers indicate that trees are clonally propag[ated] from specially selected varieties collect each distinct variety in the village and keep each as a distinct sample (as for root and tuber crops; see p. 20).
e. Sample as many sites or villages as possible, scattered at intervals throughout the region.
f. Collected seeds or budwood should be kept cool and moist, the se[eds] retained if possible within the fruits or packed in moist charc[oal] and despatched to headquarters or an introduction station for immediate sowing or planting, if the seeds are suspected of bei[ng] 'recalcitrant'.

7. VOUCHER SPECIMENS.

Whenever possible or desirable, voucher herbarium specimens may be made. Specimens of the plants are important for several reasons. In the first place they facilitate identification and may be used for later taxonomic work. Secondly, they are useful for recording features of the particular seed accession, especially where there is much variation within the sample. In addition, the sample needs to be checked against the original voucher after regeneration to prevent admixture or error. Difficulties will be experienced when sampling populations having clearly visible morphological diversity, as to which "morphotype" to use as a voucher specimen. There are no set rules here, but in general it is advisable to take 3 or 4 voucher specimens to illustrate the range of diversity in the population and to note this carefully in the field note book (see p. 27 Section 20).

The voucher specimens are placed between drying papers and felt or foam sheets in presses at the time of collection. Each evening the felt or foam sheets should be changed or the press heated gently over a non-pressure paraffin stove until the specimens are thoroughly dried. If stove heating is carried out the sheets must be separated by cardboard or aluminium corrugates to allow for the passage of hot air from the stove, thus removing the moisture. The corrugations should be vertical and at right-angles to the long side of the press.

8. DOCUMENTATION.

Genetic resources operations include collection, storage, maintenance, utilisation and evaluation. At each stage it is necessary to observe and record data, which will later be stored, processed and retrieved. At the collecting stage data gathering is a very important part of the operation.

The absolute minimum of information is a. the title of the expedition, b. an identification of the plant, c. the collector and collection number, d. the date of collection, and e. a description of the collection site so that at any time this could be relocated. Also important are information on status (wild, weed, cultivated), frequency, provenance (field, farm store, market), soil type and various other data.

Scientists working with different crops require somewhat different collection data, e.g. those collecting maize are particularly interested in the ethnic group who grew the sample, those collecting sorghum the maturity group of the specimen, the processing and the opinions of the cultivator.

The descriptive terms used for the collection data are termed descriptors and these are graded if necessary by means of descriptor states. A certain number of collection record descriptors are common to all expeditions, viz:

1. Expedition and organisation (name, year, etc.). (Note: Descriptors 1, 2 and 3 can easily be printed on all collecting sheets before beginning the mission).
2. Country in which the expedition is made.
3. Team, collector's name.
4. Collector's number (A single sequence is strongly recommended for the whole expedition and any others in which the leader may be participating. The numbers can be stamped in sequence on to the collecting sheets before beginning the mission).
5. Date of collection (Day, month, year).

6. Photograph numbers of specimen, habitat, farm field, etc.
7. Latin name of genus, species, subspecies, etc (written in full).
8. Vernacular or cultivar name.
9. Precise locality (e.g. political division, province, department, etc. including compass direction and approximate distance from nearest village or geographical feature; distance in kilometers along road between two inhabited places).
10. Latitude (degrees and minutes).
11. Longitude (degrees and minutes).
12. Altitude (in meters above sea level).
13. Type of material (seeds; inflorescences, spikes, panicles, etc; vegetative storage organs, such as rhizomes, corms, roots, tubers; whole live plants; herbarium specimens).
14. Sample type (whether populations, pure lines or individuals sampled and whether by random, non-random or both methods).
15. Status (cultivated, weed, wild).
16. Source (from field, farmer's store, market, shop, garden, wild vegetation, etc.).
17. Original source of material if from market or store; or if obtained from other gene bank, where grown originally. Farmers may know the source of their material, also.
18. Frequency; a rough estimate of frequency of wild species.
19. Habitat (mostly relevant for wild species).
20. Descriptive notes, scoring of morphological features of interest for the particular crop or wild species; thus - plant height, branching, etc colour of stems, leaves, flowers, fruit. Amount of diversity in population and range shown in voucher specimens. NOTE: Tear-off labels at the bottom page with collector's NAME and NUMBER are to be placed with the collections (These can be printed and stamped on to the labels before beginning the mission - see notes to 1. and 4. above).

In addition the following specifications may be recorded:

21. Accession number of institution (where it differs from the collector's number).
22. Uses.
23. Cultural practices (irrigated, dry, etc.).
24. Approximate dates of sowing and harvesting (For instance, "Early April to mid July").
25. Soil observations (texture, stoniness, depth, drainage, approximate soil colour if thought desirable to record).
26. Soil pH (if thought desirable to record).
27. Land form observation (aspect, slope).
28. Topography (swamp, flood plain, level, undulating, hilly, hilly dissected, steeply dissected, mountainous, other - specify).
29. Plant community (natural vegetation; for wild species).
30. Other crops grown in surrounding fields or in the rotation.
31. Field observations of pest and pathogen reactions.
32. Name and address of Farmer (if thought desirable to record).
33. Taxonomic identification (when made subsequently in genebank).
34. Name of person making identification, and date.

The aim of the collector should be to gather enough information to ensure that it can be used in data recording procedures and thus provide intelligibility in genetic resources documentation.

For convenience in the field some form of collecting record book is needed. A specimen page (both sides) is shown at the back of the manual (pp. 34 and 35) A convenient page size is 17 x 25 cm and the pages can be bound in books of 100 sheets along the top margin with a spiral binder. The four pieces at the bottom should be perforated to tear off and put with the samples.

9. STORAGE.

Altough storage does not of course form part of the process of field collecting, all collectors should bear in mind the particular storage requirements of the plants they are collecting and the optimum amount of material required. Storage of vegetatively propagated materials can only be done for short periods, depending on the crops in question. Therefore this section is concerned with seed crops only.

Table 2 sets out the suggested optimum numbers of seeds per population sample for collection and storage. It will be noted that the numbers for collections are much lower than those recommended for storage. The extra numbers must thus be made up by one multiplication cycle. If this cannot be done, the collections must be increased by a factor of four. Special requirements for storage of vegetatively propagated and tree crops should be ascertained during the expedition planning stage.

Table 2. Suggested numbers of seeds per population sample for collection and storage[1]

Population type	For collection	For storage			
		Base collection	Duplicate of base collection	Active collection	Total for storage
Highly variable (hetero-geneous)	5,000 (100 plants, 50 seeds from each)	12,000	3,000	5,000	20,000
Fairly uniform (homo-geneous)	2,500 (50 plants, 50 seeds from each)	4,000	1,000	3,000	8,000

[1] Some gene bank managers would regard the numbers advocated for hetero-geneous populations as too high, 12,000 instead of 20,000 being considered as sufficient.

By *Base collections* we mean those that are to be kept under ideal storage conditions for really long periods (up to 50 or 100 years or even perhaps more in some instances).

Duplicate storage of base collections in another institute in another country or even continent is needed as insurance to prevent total loss.

By *Active collections* we mean those that are kept under less than idea storage for medium to short-term (5-20 years) and are used for regeneration, multiplication and distribution, evaluation and documen-tation. Breeders' working collections are regarded as outside the framework of the conservation of genetic resources, but they can provide important evaluation data.

Since the 2,500 to 5,000 seeds recommended for a single collection are less than the 8,000 to 20,000 reasonably required for conservation som multiplication is obviously needed. In practice, it may sometimes not be possible to collect more than 200 to 1000 seeds.

It is therefore well to keep in mind that the initial samples should b multiplied up at the main introduction centre or genetic resources cen to which they are first sent, with a minimum of natural or artificial selection. The only criterion is the maximum survival of the component of the population or the health and survival of the clonal material under vegetative propagation.

The single multiplication cycle will have the following additional advantages:

a. A primary description of morphological features can be made on the plant grown.
b. The seeds from these plants can be harvested under optimum con-ditions, which is not always possible under expedition conditions
c. Cleaning and drying can be carried out under good conditions.
d. Seeds can be put into long-term storage (Base collection) with th least possible delay after harvesting.

Thus the points made under b., c. and d. will ensure that the seeds ar in the best possible condition for long-term storage. The only apparen

disadvantage is that the material will probably not be grown under the same climatic conditions (isoclimatic conditions) to those where it was collected. However, provided there is no artificial selection and the plants are spaced sufficiently widely apart to prevent inter-plant competition there should be little loss of genetic integrity.

As a very rough guide the following weights of cleaned air-dried seed lots contain the seed numbers indicated in Table 3.

Table 3. Numbers of seeds and weights of certain crop species

Cultigens	Numbers			
	2,500	5,000	8,000	20,000
Groundnut (*Arachis*)	440g	875g	1,400g	3,500g
Soybean	215g	425g	680g	1,700g
Wheat, oats, barley, rye, rice	100g	200g	320g	800g
Sorghum	50g	100g	160g	400g
Onion	12g	25g	35g	85g
Brassica, jute (*Corchorus*)	9g	18g	28g	70g

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12. QUICK REFERENCE GUIDE FOR FIELD SAMPLING.

SEED CROPS

1. Collect from 50 to 100 plants, about 50 seeds from each, AT RANDOM and put all together as ONE SAMPLE. If uniform 50 plants are sufficient (total seeds about 50 x 50= 2500). If variable collect from 100 plants (total seeds about 100 x 50= 5000).
2. Add non-random or selective sample to random ones or as a separate collection.
3. Sample as many sites as possible in time available.
4. Choose sampling sites over as broad an environmental range as possible.
5. Take voucher specimens where necessary.
6. Fill up all descriptors in field note book for each collection.

ROOT AND TUBER CROPS

a. Wild materials

1. Collect a single propagule (tuber, root, etc.) from each of 10-15 individuals in an area of 100 x 100 m or less and put all together as ONE SAMPLE.
2.-6. as for seed crops.

b. Cultivated materials

1. Collect each distinct "variety" in a market or village. This is selective sampling and is correct for this kind of material.
2. Repeat the process at 10-50 km intervals, depending on distances between market towns or villages.
3. Collect EVERY variety at every village.
4. Sort out duplicates in the gene bank afterwards.
5. Supplement with seed collections if available.
6. and 7. as 5. and 6. for seed crops.

FRUIT AND TIMBER TREES

a. Wild materials

1. Collect seeds from 10 to 15 individuals in an area of up to 10

hectares (or smaller area if possible). Make random samples wherever there are enough individuals to make this possible.
2. If seeds not available take budwood cuttings on same sampling basis.
3. Repeat at intervals, depending on climate, altitude or soil differences.
4. Make arrangements for quick despatch to institute where material is to be sown, grafted or planted.
5. and 6. as for seed crops.

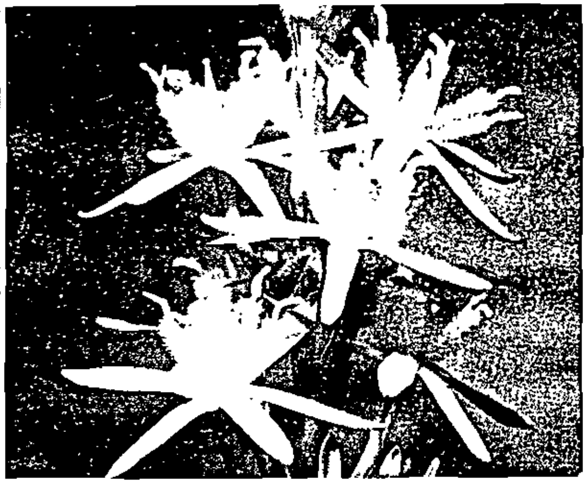
b. Cultivated materials.

1. If farmers indicate the trees are grown from seed, sample as for wild materials.
2. Whole village must be regarded as collecting site for the population.
3. Take seeds or budwood cuttings according to availability.
4. If farmers indicate that trees are clonally propagated collect each distinct variety in a village, as for cultivated root and tuber crops.
5. Sample as many villages and sites as possible.
6. Arrange for quick despatch to institute where material is to be sown, grafted or planted.
7. and 8. as 5. and 6. for seed crops.

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

HABITATS SERIES

Peatlands



Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Anexo 2:
IUCN Lista Roja, categorías y criterios

2001 Categories & Criteria (version 3.1)

I. INTRODUCTION

1. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk. However, while the Red List may focus attention on those taxa at the highest risk, it is not the sole means of setting priorities for conservation measures for their protection.

Extensive consultation and testing in the development of the system strongly suggest that it is robust across most organisms. However, it should be noted that although the system places species into the threatened categories with a high degree of consistency, the criteria do not take into account the life histories of every species. Hence, in certain individual cases, the risk of extinction may be under- or over-estimated.

2. Before 1994 the more subjective threatened species categories used in IUCN Red Data Books and Red Lists had been in place, with some modification, for almost 30 years. Although the need to revise the categories had long been recognized (Fitter and Fitter 1987), the current phase of development only began in 1989 following a request from the IUCN Species Survival Commission (SSC) Steering Committee to develop a more objective approach. The IUCN Council adopted the new Red List system in 1994.

The IUCN Red List Categories and Criteria have several specific aims:

- to provide a system that can be applied consistently by different people;
- to improve objectivity by providing users with clear guidance on how to evaluate different factors which affect the risk of extinction;
- to provide a system which will facilitate comparisons across widely different taxa;
- to give people using threatened species lists a better understanding of how individual species were classified.

3. Since their adoption by IUCN Council in 1994, the IUCN Red List Categories have become widely recognized internationally, and they are now used in a range of publications and listings produced by IUCN, as well as by numerous governmental and non-governmental organizations. Such broad and extensive use revealed the need for a number of improvements, and SSC was mandated by the 1996 World Conservation Congress (WCC Res. 1.4) to conduct a review of the system (IUCN 1996). This document presents the revisions accepted by the IUCN Council.

The proposals presented in this document result from a continuing process of drafting, consultation and validation. The production of a large number of draft proposals has led to some confusion, especially as each draft has been used for classifying some set of species for conservation purposes. To clarify matters, and to open the way for modifications as and when they become necessary, a system for version numbering has been adopted as follows:

Version 1.0: Mace and Lande (1991)
The first paper discussing a new basis for the categories, and presenting numerical criteria especially relevant for large vertebrates.

Version 2.0: Mace et al. (1992)
A major revision of Version 1.0, including numerical criteria appropriate to all organisms and introducing

the non-threatened categories.

Version 2.1: IUCN (1993)
Following an extensive consultation process within SSC, a number of changes were made to the details of
the criteria, and fuller explanation of basic principles was included. A more explicit structure clarified the significance of the non-threatened categories.

Version 2.2: Mace and Stuart (1994)
Following further comments received and additional validation exercises, some minor changes to the criteria were made. In addition, the Susceptible category present in Versions 2.0 and 2.1 was subsumed into the Vulnerable category. A precautionary application of the system was emphasised.

Version 2.3: IUCN (1994)
IUCN Council adopted this version, which incorporated changes as a result of comments from IUCN members, in December 1994. The initial version of this document was published without the necessary bibliographic details,such as date of publication and ISBN number, but these were included in the subsequent reprints in 1998 and 1999. This version was used for the 1996 IUCN Red List of Threatened
Animals (Baillie and Groombridge 1996), The World List of Threatened Trees (Oldfield et al 1998) and the 2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000).

Version 3.0: IUCN/SSC Criteria Review Working Group (1999)
Following comments received, a series of workshops were convened to look at the IUCN Red List Criteria
following which, changes were proposed affecting the criteria, the definitions of some key terms and the handling of uncertainty.

Version 3.1: IUCN (2001)
The IUCN Council adopted this latest version, which incorporated changes as a result of comments from
the IUCN and SSC memberships and from a final meeting of the Criteria Review Working Group, in February 2000.

All new assessments from January 2001 should use the latest adopted version and cite the year of publicatio and version number.

4. In the rest of this document, the proposed system is outlined in several sections. Section II, the Preamble, presents basic information about the context and structure of the system, and the procedures that are to be followed in applying the criteria to species. Section III provides definitions of key terms used. Section IV presents the categories, while Section V details the quantitative criteria used for classification within the threatened categories. Annex I provides guidance on how to deal with uncertainty when applying the criteria; Annex II suggests a standard format for citing the Red List Categories and Criteria; and Annex III outlines the documentation requirements for taxa to be included on IUCN's global Red Lists. It is important for the effectiv functioning of the system that all sections are read and understood to ensure that the definitions and rules are followed. (**Note**: Annexes I, II and III will be updated on a regular basis.)

II. PREAMBLE

The information in this section is intended to direct and facilitate the use and interpretation of the categories (Critically Endangered, Endangered, etc.), criteria (A to E), and subcriteria (1, 2, etc.; a, b, etc.; i, ii, etc.).

1. Taxonomic level and scope of the categorization process
The criteria can be applied to any taxonomic unit at or below the species level. In the following information, definitions and criteria the term 'taxon' is used for convenience, and may represent species or lower taxonomic levels, including forms that are not yet formally described. There is sufficient range among the different criteria to enable the appropriate listing of taxa from the complete taxonomic spectrum, with the exception of micro-organisms. The criteria may also be applied within any specified geographical or political area, although in such cases special notice should be taken of point 14. In presenting the results of applying the criteria, the taxonomic unit and area under consideration should be specified in accordance with the

documentation guidelines (see Annex 3). The categorization process should only be applied to wild populations inside their natural range, and to populations resulting from benign introductions. The latter are defined in the IUCN Guidelines for Re-introductions (IUCN 1998) as '...an attempt to establish a species, for the purpose of conservation, outside its recorded distribution, but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historic range'.

2. Nature of the categories
Extinction is a chance process. Thus, a listing in a higher extinction risk category 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.

All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together these categories are described as 'threatened'. The threatened categories form a part of the overall scheme. It will be possible to place all taxa into one of the categories (see Figure 1).

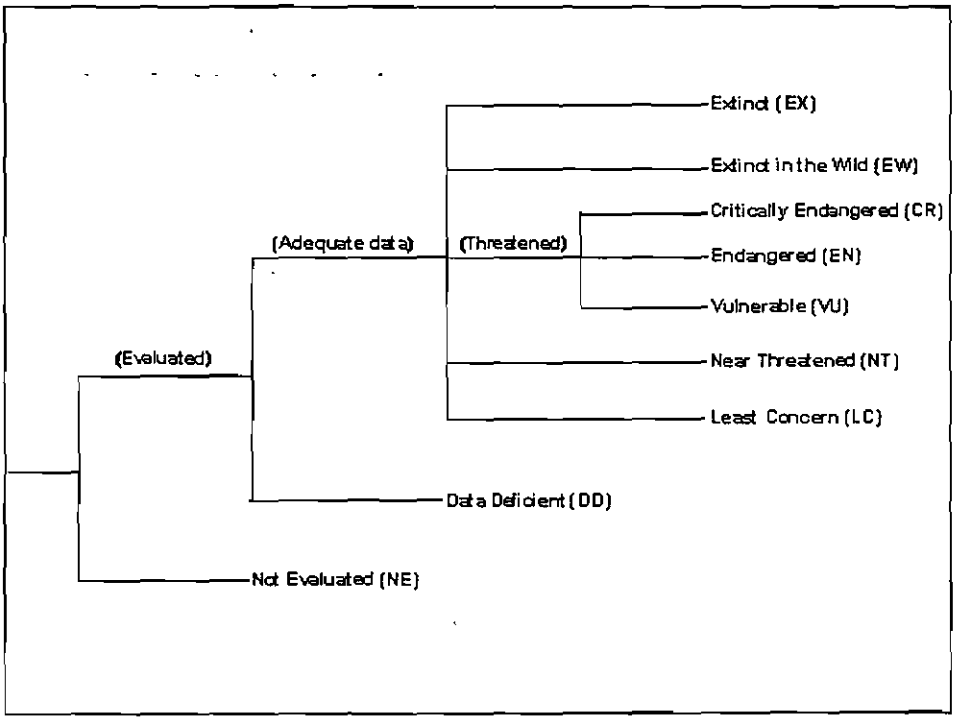


Figure 1. *Structure of the categories.*

3. Role of the different criteria
For listing as Critically Endangered, Endangered or Vulnerable there is a range of quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. Each taxon should be evaluated against all the criteria. Even though some criteria will be inappropriate for certain taxa (some taxa will never qualify under these however close to extinction they come), there should be criteria appropriate for assessing threat levels for any taxon. The relevant factor is whether any one criterion is met, not whether all are appropriate or all are met. Because it will never be clear in advance which criteria are appropriate for a particular taxon, each taxon should be evaluated against all the criteria, and all criteria met at the highest threat category must be listed.

4. Derivation of quantitative criteria
The different criteria (A-E) are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. The quantitative values presented in the various criteria associated with threatened categories were developed through wide consultation, and they are set at what are generally judged to be appropriate levels, even if no formal justification for these values exists. The levels for different criteria within categories were set independently but against a common standard. Broad consistency between them was sought.

5. Conservation actions in the listing process
The criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it. It is important to emphasise here that a taxon may require conservation action even if it is not listed as threatened. Conservation actions which may benefit the taxon are included as part of the documentation requirements (see Annex 3).

6. Data quality and the importance of inference and projection
The criteria are clearly quantitative in nature. However, the absence of high-quality data should not deter attempts at applying the criteria, as methods involving estimation, inference and projection are emphasised as being acceptable throughout. Inference and projection may be based on extrapolation of current or potential threats into the future (including their rate of change), or of factors related to population abundance or distribution (including dependence on other taxa), so long as these can reasonably be supported. Suspected or inferred patterns in the recent past, present or near future can be based on any of a series of related factors, and these factors should be specified as part of the documentation.

Taxa at risk from threats posed by future events of low probability but with severe consequences (catastrophes) should be identified by the criteria (e.g. small distributions, few locations). Some threats need to be identified particularly early, and appropriate actions taken, because their effects are irreversible or nearly so (e.g., pathogens, invasive organisms, hybridization).

7. Problems of scale
Classification based on the sizes of geographic ranges or the patterns of habitat occupancy is complicated by problems of spatial scale. The finer the scale at which the distributions or habitats of taxa are mapped, the smaller the area will be that they are found to occupy, and the less likely it will be that range estimates (at least for 'area of occupancy': see Definitions, point 10) exceed the thresholds specified in the criteria. Mapping at finer scales reveals more areas in which the taxon is unrecorded. Conversely, coarse-scale mapping reveals fewer unoccupied areas, resulting in range estimates that are more likely to exceed the thresholds for the threatened categories. The choice of scale at which range is estimated may thus, itself, influence the outcome of Red List assessments and could be a source of inconsistency and bias. It is impossible to provide any strict but general rules for mapping taxa or habitats; the most appropriate scale will depend on the taxon in question, and the origin and comprehensiveness of the distribution data.

8. Uncertainty
The data used to evaluate taxa against the criteria are often estimated with considerable uncertainty. Such uncertainty can arise from any one or all of the following three factors: natural variation, vagueness in the terms and definitions used, and measurement error. The way in which this uncertainty is handled can have a strong influence on the results of an evaluation. Details of methods recommended for handling uncertainty are included in Annex 1, and assessors are encouraged to read and follow these principles.

In general, when uncertainty leads to wide variation in the results of assessments, the range of possible outcomes should be specified. A single category must be chosen and the basis for the decision should be documented; it should be both precautionary and credible.

When data are very uncertain, the category of 'Data Deficient' may be assigned. However, in this case the assessor must provide documentation showing that this category has been assigned because data are inadequate to determine a threat category. It is important to recognize that taxa that are poorly known can often be assigned a threat category on the basis of background information concerning the deterioration of their habitat and/or other causal factors; therefore the liberal use of 'Data Deficient' is discouraged.

9. Implications of listing
Listing in the categories of Not Evaluated and Data Deficient indicates that no assessment of extinction risk has been made, though for different reasons. Until such time as an assessment is made, taxa listed in these categories should not be treated as if they were non-threatened. It may be appropriate (especially for Data Deficient forms) to give them the same degree of attention as threatened taxa, at least until their status can be assessed.

10. Documentation
All assessments should be documented. Threatened classifications should state the criteria and subcriteria that were met. No assessment can be accepted for the IUCN Red List as valid unless at least one criterion is given. If more than one criterion or subcriterion is met, then each should be listed. If a re-evaluation indicates that the documented criterion is no longer met, this should not result in automatic reassignment to a lower category of threat (downlisting). Instead, the taxon should be re-evaluated against all the criteria to clarify its

status. The factors responsible for qualifying the taxon against the criteria, especially where inference and projection are used, should be documented (see Annexes 2 and 3). The documentation requirements for other categories are also specified in Annex 3.

11. Threats and priorities

The category of threat is not necessarily sufficient to determine priorities for conservation action. The category of threat simply provides an assessment of the extinction risk under current circumstances, whereas a system for assessing priorities for action will include numerous other factors concerning conservation action such as costs, logistics, chances of success, and other biological characteristics of the subject.

12. Re-evaluation

Re-evaluation of taxa against the criteria should be carried out at appropriate intervals. This is especially important for taxa listed under Near Threatened, Data Deficient and for threatened taxa whose status is known or suspected to be deteriorating.

13. Transfer between categories

The following rules govern the movement of taxa between categories:

A. A taxon may be moved from a category of higher threat to a category of lower threat if none of the criteria of the higher category has been met for five years or more.

B. If the original classification Is found to have been erroneous, the taxon may be transferred to the appropriate category or removed from the threatened categories altogether, without delay (but see Point 10 above).

C. Transfer from categories of lower to higher risk should be made without delay.

14. Use at regional level

The IUCN Red List Categories and Criteria were designed for global taxon assessments. However, many people are interested in applying them to subsets of global data, especially at regional, national or local levels To do this it is important to refer to guidelines prepared by the IUCN/SSC Regional Applications Working Group (e.g., Gärdenfors et al. 2001). When applied at national or regional levels it must be recognized that a global category may not be the same as a national or regional category for a particular taxon. For example, taxa classified as Least Concern globally might be Critically Endangered within a particular region where numbers are very small or declining, perhaps only because they are at the margins of their global range. Conversely, taxa classified as Vulnerable on the basis of their global declines in numbers or range might be Least Concern within a particular region where their populations are stable. It is also important to note that taxa endemic to regions or nations will be assessed globally in any regional or national applications of the criteria, and in these cases great care must be taken to check that an assessment has not already been undertaken by a Red List Authority (RLA), and that the categorization is agreed with the relevant RLA (e.g., an SSC Specialist Group known to cover the taxon).

III. DEFINITIONS

1. Population and Population Size (Criteria A, C and D)

The term 'population' is used in a specific sense in the Red List Criteria that is different to its common biological usage. Population is here defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life forms, population size is measured as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

2. Subpopulations (Criteria B and C)

Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less).

3. Mature Individuals (Criteria A, B, C and D)

The number of mature individuals is the number of individuals known, estimated or inferred to be capable of reproduction. When estimating this quantity, the following points should be borne in mind:

- Mature individuals that will never produce new recruits should not be counted (e.g. densities are too low for fertilization).
- In the case of populations with biased adult or breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals, which take this into account.

- Where the population size fluctuates, use a lower estimate. In most cases this will be much less than the mean.
- Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g. corals).
- In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.
- Re-introduced individuals must have produced viable offspring before they are counted as mature individuals.

4. Generation (Criteria A, C and E)
Generation length is the average age of parents of the current cohort (i.e. newborn individuals in the population). Generation length therefore reflects the turnover rate of breeding individuals in a population. Generation length is greater than the age at first breeding and less than the age of the oldest breeding individual, except in taxa that breed only once. Where generation length varies under threat, the more natural, i.e. pre-disturbance, generation length should be used.

5. Reduction (Criterion A)
A reduction is a decline in the number of mature individuals of at least the amount (%) stated under the criterion over the time period (years) specified, although the decline need not be continuing. A reduction should not be interpreted as part of a fluctuation unless there is good evidence for this. The downward phase of a fluctuation will not normally count as a reduction.

6. Continuing decline (Criteria B and C)
A continuing decline is a recent, current or projected future decline (which may be smooth, irregular or sporadic) which is liable to continue unless remedial measures are taken. Fluctuations will not normally count as continuing declines, but an observed decline should not be considered as a fluctuation unless there is evidence for this.

7. Extreme fluctuations (Criteria B and C)
Extreme fluctuations can be said to occur in a number of taxa when population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e. a tenfold increase or decrease).

8. Severely fragmented (Criterion B)
The phrase 'severely fragmented' refers to the situation in which increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, witt a reduced probability of recolonization.

9. Extent of occurrence (Criteria A and B)
Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy (see Figure 2). This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat) (but see 'area of occupancy', point 10 below). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

10. Area of occupancy (Criteria A, B and D)
Area of occupancy is defined as the area within its 'extent of occurrence' (see point 9 above) which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. Ir some cases (e.g. irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data (see point 7 in the Preamble). To avoid inconsistencies and bias in assessments caused by estimating area of occupancy at different scales, it may be necessary to standardize estimates by applying a scale-correction factor. It is difficult to give strict guidance on how standardization should be done because different types of taxa have different scale-area relationships.

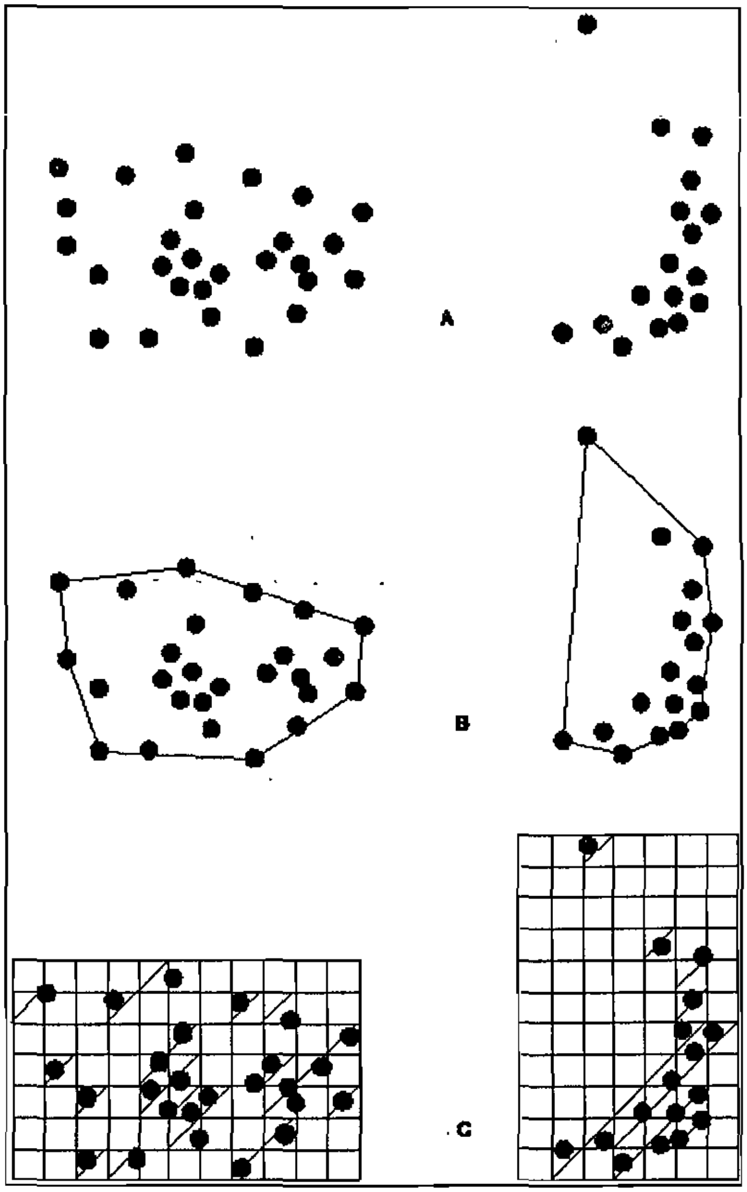


Figure 2. Two examples of the distinction between extent of occurrence and area of occupancy. (A) is the spatial distribution of known, inferred or projected sites of present occurrence. (B) shows one possible boundary to the extent of occurrence, which is the measured area within this boundary. (C) shows one measure of area of occupancy which can be achieved by the sum of the occupied grid squares.

11. Location (Criteria B and D)
The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by mor than one threatening event, location should be defined by considering the most serious plausible threat.

12. Quantitative analysis (Criterion E)
A quantitative analysis is defined here as any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options. Population viability analysis (PVA) is one such technique. Quantitative analyses should make full use of all relevant available data. In a situation in which there is limited information, such data as are available can be used to provide an estimate of extinction risk (for instance, estimating the impact of stochastic events on habitat). In presenting the results of quantitative analyses, the assumptions (which must be appropriate and defensible), the data used and the uncertainty in the data or quantitative model must be documented.

IV. THE CATEGORIES

A representation of the relationships between the categories is shown in Figure 1.

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 ris 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 threatene 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 thi 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.

Note: As in previous IUCN categories, the abbreviation of each category (in parenthesis) follows the English denominations when translated into other languages (see Annex 2).

V. THE CRITERIA FOR CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE

CRITICALLY ENDANGERED (CR)

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

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying any of (a) to (e) under A1.

3. A population size reduction of ≥ 80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 year: in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km², and estimates indicating at least two of a-c

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km², and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence
(ii) area of occupancy

(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at leas one of the following (a-b):

(a) Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 50 mature individuals, OR
(ii) at least 90% of mature individuals in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or thre generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

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

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥ 50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 50% over an 10

year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km², and estimates indicating at least two of a-c

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km², and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

C. Extreme fluctuations in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at leas one of the following (a-b):

(a) Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 250 mature individuals, OR
(ii) at least 95% of mature individuals in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

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

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥ 30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 30% over an 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may nc have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km², and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km², and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at leas one of the following (a-b):

(a) Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 1000 mature individuals, OR
(ii) all mature individuals are in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km²) or number of location (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Annex 1: Uncertainty

The Red List Criteria should be applied to a taxon based on the available evidence concerning its numbers, trend and distribution. In cases where there are evident threats to a taxon through, for example, deterioration of its only known habitat, a threatened listing may be justified, even though there may be little direct information on the biological status of the taxon itself. In all these instances there are uncertainties associatec with the available information and how it was obtained. These uncertainties may be categorized as natural variability, semantic uncertainty and measurement error (Akçakaya et al. 2000). This section provides guidance on how to recognize and deal with these uncertainties when using the criteria.

Natural variability results from the fact that species' life histories and the environments in which they live change over time and space. The effect of this variation on the criteria is limited, because each parameter refers to a specific time or spatial scale. Semantic uncertainty arises from vagueness in the definition of terms or lack of consistency in different assessors' usage of them. Despite attempts to make the definitions of the terms used in the criteria exact, in some cases this is not possible without the loss of generality. Measurement error is often the largest source of uncertainty; it arises from the lack of precise information about the parameters used in the criteria. This may be due to inaccuracies in estimating the values or a lack of knowledge. Measurement error may be reduced or eliminated by acquiring additional data. For further details see Akçakaya et al. (2000) and Burgman et al. (1999).

One of the simplest ways to represent uncertainty is to specify a best estimate and a range of plausible values. The best estimate itself might be a range, but in any case the best estimate should always be included in the range of plausible values. When data are very uncertain, the range for the best estimate might be the range of plausible values. There are various methods that can be used to establish the plausible range. It may be based on confidence intervals, the opinion of a single expert, or the consensus opinion of a group of experts. Whichever method is used should be stated and justified in the documentation.

When interpreting and using uncertain data, attitudes toward risk and uncertainty may play an important role. Attitudes have two components. First, assessors need to consider whether they will include the full range of plausible values in assessments, or whether they will exclude extreme values from consideration (known as dispute tolerance). An assessor with a low dispute tolerance would include all values, thereby increasing the uncertainty, whereas an assessor with a high dispute tolerance would exclude extremes, reducing the uncertainty. Second, assessors need to consider whether they have a precautionary or evidentiary attitude to risk (known as risk tolerance). A precautionary attitude will classify a taxon as threatened unless it is certain that it is not threatened, whereas an evidentiary attitude will classify a taxon as threatened only when there is strong evidence to support a threatened classification. Assessors should resist an evidentiary attitude and adopt a precautionary but realistic attitude to uncertainty when applying the criteria, for example, by using plausible lower bounds, rather than best estimates, in determining population size, especially if it is fluctuating. All attitudes should be explicitly documented.

An assessment using a point estimate (i.e. single numerical value) will lead to a single Red List Category. However, when a plausible range for each parameter is used to evaluate the criteria, a range of categories may be obtained, reflecting the uncertainties in the data. A single category, based on a specific attitude to uncertainty, should always be listed along with the criteria met, while the range of plausible categories should be indicated in the documentation (see Annex 3).

Where data are so uncertain that any category is plausible, the category of 'Data Deficient' should be assigned. However, it is important to recognize that this category indicates that the data are inadequate to determine the degree of threat faced by a taxon, not necessarily that the taxon is poorly known or indeed not threatened. Although Data Deficient is not a threatened category, it indicates a need to obtain more information on a taxon to determine the appropriate listing; moreover, it requires documentation with whatever available information there is.

Annex 2: Citation of the IUCN Red List Categories and Criteria

In order to promote the use of a standard format for citing the Red List Categories and Criteria the following forms of citation are recommended:

1). The Red List Category may be written out in full or abbreviated as follows (when translated into other languages, the abbreviations should follow the English denominations):

Extinct, EX
Extinct in the Wild, EW
Critically Endangered, CR
Endangered, EN
Vulnerable, VU
Near Threatened, NT
Least Concern, LC
Data Deficient, DD
Not Evaluated, NE

2). Under Section V (the criteria for Critically Endangered, Endangered and Vulnerable) there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the Category. Under the criteria A to C and D under Vulnerable, the first level of the hierarchy is indicated by the use of numbers (1-4) and if more than one is met, they are separated by means c the '+' symbol. The second level is indicated by the use of the lower-case alphabet characters (a-e). These ar listed without any punctuation. A third level of the hierarchy under Criteria B and C involves the use of lower case roman numerals (i-v). These are placed in parentheses (with no space between the preceding alphabet character and start of the parenthesis) and separated by the use of commas if more than one is listed. Where more than one criterion is met, they should be separated by semicolons. The following are examples of such usage:

EX
CR A1cd
VU A2c+3c
EN B1ac(i,ii,iii)
EN A2c; D
VU D1+2
CR A2c+3c; B1ab(iii)
CR D
VU D2
EN B2ab(i,ii,iii)
VU C2a(ii)
EN A1c; B1ab(iii); C2a(i)
EN B2b(iii)c(ii)
EN B1ab(i,ii,v)c(iii,iv)+2b(i)c(ii,v)
VU B1ab(iii)+2ab(iii)
EN A2abc+3bc+4abc; B1b(iii,iv,v)c(ii,iii,iv)+2b(iii,iv,v)c(ii,iii,iv)

Annex 3: Documentation Requirements for Taxa Included on the IUCN Red List

The following is the **minimum** set of information, which should accompany every assessment submitted for incorporation into the IUCN Red List of Threatened Species™:

- Scientific name including authority details
- English common name/s and any other widely used common names (specify the language of each name supplied)
- Red List Category and Criteria
- Countries of occurrence (including country subdivisions for large nations, e.g. states within the USA, and overseas territories, e.g. islands far from the mainland country)
- For marine species, the Fisheries Areas in which they occur should be recorded (see http://www.iucn.org/themes/ssc/sis/faomap.htm for the Fisheries Areas as delimited by FAO, the Food and Agriculture Organization of the United Nations)
- For inland water species, the names of the river systems, lakes, etc. to which they are confined
- A map showing the geographic distribution (extent of occurrence)
- A rationale for the listing (including any numerical data, inferences or uncertainty that relate to the criteria and their thresholds)
- Current population trends (increasing, decreasing, stable or unknown)
- Habitat preferences (using a modified version of the Global Land Cover Characterization (GLCC) classification which is available electronically from http://www.iucn.org/themes/ssc/sis/authority.htm or on request from redlist@ssc-uk.org)
- Major threats (indicating past, current and future threats using a standard classification which is available from the SSC web site or e-mail address as shown above)
- Conservation measures, (indicating both current and proposed measures using a standard classificatio which is available from the SSC web site or e-mail address as shown above)
- Information on any changes in the Red List status of the taxon, and why the status has changed
- Data sources (cited in full; including unpublished sources and personal communications)
- Name/s and contact details of the assessor/s
- Before inclusion on the IUCN Red List, all assessments will be evaluated by at least two members of a Red List Authority. The Red List Authority is appointed by the Chair of the IUCN Species Survival Commission and is usually a sub-group of a Specialist Group. The names of the evaluators will appear with each assessment.

In addition to the minimum documentation, the following information should also be supplied where appropriate:

- If a quantitative analysis is used for the assessment (i.e. Criterion E), the data, assumptions and structural equations (e.g., in the case of a Population Viability Analysis) should be included as part of the documentation.
- For Extinct or Extinct in the Wild taxa, extra documentation is required indicating the effective date of extinction, possible causes of the extinction and the details of surveys which have been conducted to search for the taxon.
- For taxa listed as Near Threatened, the rationale for listing should include a discussion of the criteria that are nearly met or the reasons for highlighting the taxon (e.g., they are dependent on ongoing conservation measures).
- For taxa listed as Data Deficient, the documentation should include what little information is available.

Assessments may be made using version 2.0 of the software package RAMAS® Red List (Akçakaya and Ferson 2001). This program assigns taxa to Red List Categories according to the rules of the IUCN Red List Criteria and has the advantage of being able to explicitly handle uncertainty in the data. The software capture most of the information required for the documentation above, but in some cases the information will be reported differently. The following points should be noted:

- If RAMAS® Red List is used to obtain a listing, this should be stated.
- Uncertain values should be entered into the program as a best estimate and a plausible range, or as a interval (see the RAMAS® Red List manual or help files for further details).
- The settings for attitude towards risk and uncertainty (i.e. dispute tolerance, risk tolerance and burden c proof) are all pre-set at a mid-point. If any of these settings are changed this should be documented an fully justified, especially if a less precautionary position is adopted.
- Depending on the uncertainties, the resulting classification can be a single category and/or a range of plausible categories. In such instances, the following approach should be adopted (the program will usually indicate this automatically in the Results window): -
  - If the range of plausible categories extends across two or more of the threatened categories (e.g Critically Endangered to Vulnerable) and no preferred category is indicated, the precautionary approac is to take the highest category shown, i.e. CR in the above example. In such cases, the range of plausible categories should be documented under the rationale including a note that a precautionary approach was followed in order to distinguish it from the situation in the next point. The following notation has been suggested e.g. CR* (CR-VU). -
  - If a range of plausible categories is given and a preferred category is indicated, the rationale should indicate the range of plausible categories met e.g. EN (CR-VU).
- The program specifies the criteria that contributed to the listing (see Status window). However, when data are uncertain, the listing criteria are approximate, and in some cases may not be determined at all In such cases, the assessors should use the Text results to determine or verify the criteria and sub-criteria met. Listing criteria derived in this way must be clearly indicated in the rationale (refer to the RAMAS® Red List Help menu for further guidance on this issue).
- If the preferred category is indicated as Least Concern, but the plausible range extends into the threatened categories, a listing of 'Near Threatened' (NT) should be used. The criteria, which triggerec the extension into the threatened range, should be recorded under the rationale.
- Any assessments made using this software must be submitted with the RAMAS® Red List input files (i.e. the *.RED files).

New global assessments or reassessments of taxa currently on the IUCN Red List, may be submitted t the IUCN/SSC Red List Programme Officer for incorporation (subject to peer review) in a future editior of the *IUCN Red List of Threatened Species™*. Submissions from within the SSC network should preferably be made using the Species Information Service (SIS) database. Other submissions may be submitted electronically; these should preferably be as files produced using RAMAS® Red List or any c the programs in Microsoft Office 97 (or earlier versions) e.g. Word, Excel or Access. Submissions should be sent to:

IUCN/SSC Red List Programme, IUCN/SSC UK Office, 219c Huntingdon Road, Cambridge, CB3 0DL . United Kingdom. Fax: +44-(0)1223-277845; Email: redlist@ssc-uk.org.

For further clarification or information about the IUCN Red List Criteria, documentation requirements (including the standards used) or submission of assessments, please contact the IUCN/SSC Red List Programme Officer at the address shown above.

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Anexo 3:

Revistas Crop Wild Relative 1 a 5 (título) y

Estudios de caso 1 a 5

European crop wild relative diversity
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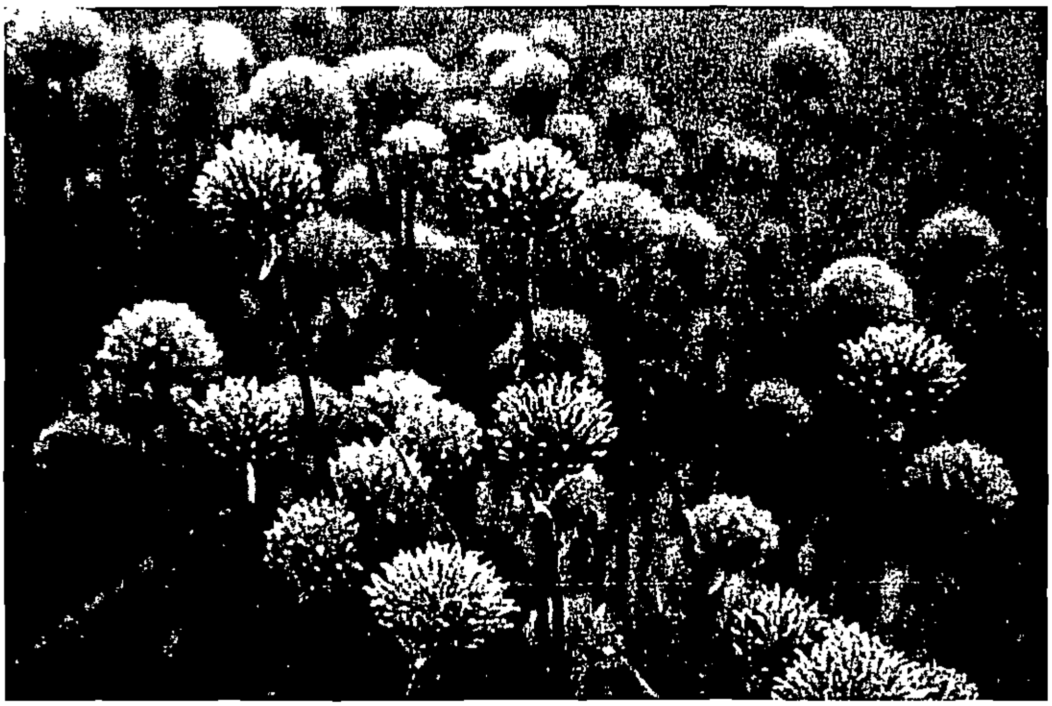
Issue 1 October 2003



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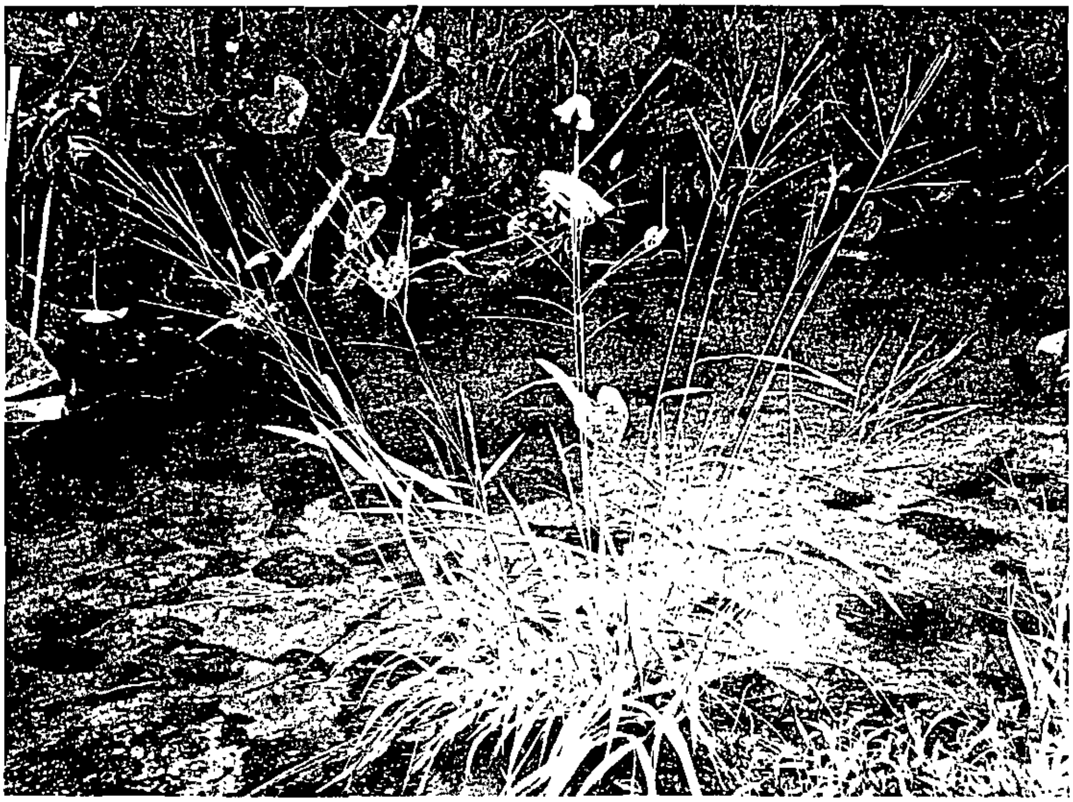

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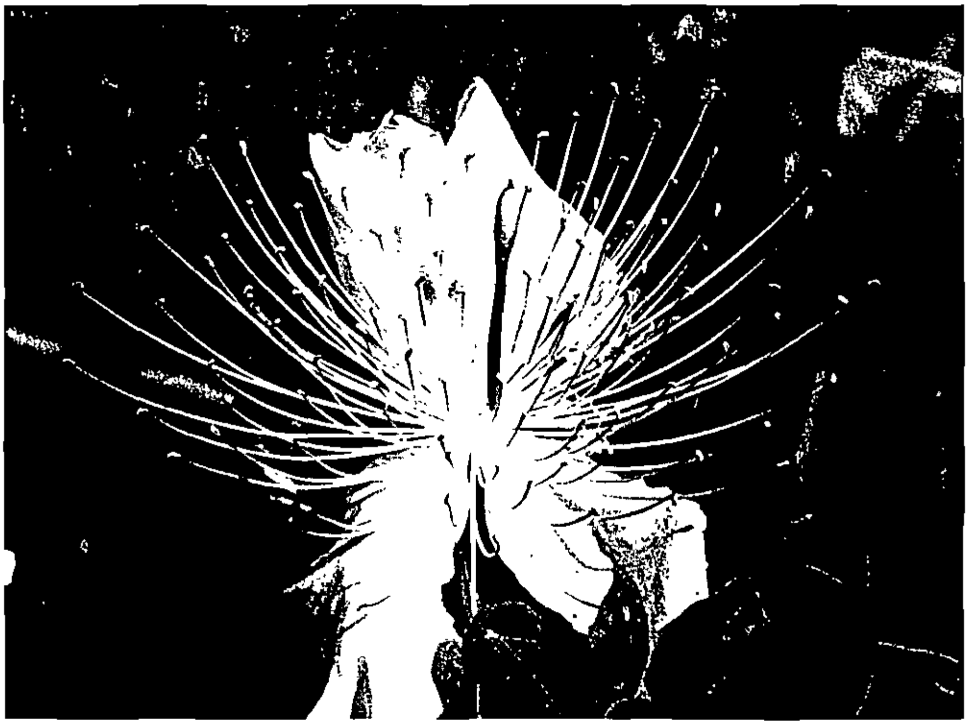

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Ecotypic exploration and characterization trials to promote conservation of *Arnica montana* L. in Northern Europe

Å. Asdal[1], J. Labokas[2], K. Olsson[3], J. Radušienė[2] and K.W. Bladh[4]

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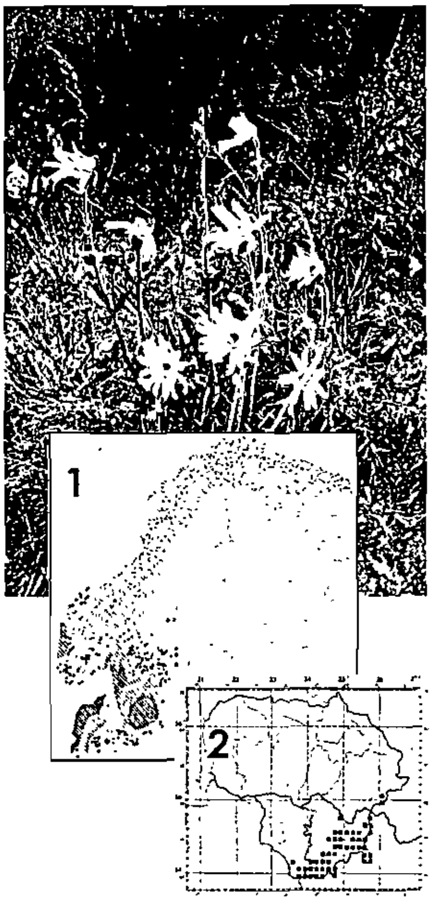
Photography K. Olsson and B. Galambosi   Maps J. Radušienė and Den Virtuella Floran, Naturhistoriska riksmuseet, Sweden



Taxonomy and biology

Arnica montana L. is divided into two subspecies; ssp. *montana* grows in Scandinavia and Central Europe, while ssp. *atlantica* is found in the south of France, Spain and Portugal. The geographical distribution of A. *montana* in the Nordic countries is shown in fig. 1. *Arnica* is common in the western part of Denmark and in the south-western part of Norway. It is also found in Southern Sweden, where it is richest in Småland, but due to loss of its habitat it has declined during the last decades. Lithuania is on the north-eastern border of the distribution in the Baltic region (Figure 2)

Ecotypic variation in Lithuania

In its main distribution area, Central and Western Europe, *Arnica montana* is a species of meadows, pastures and heaths, mainly in mountains. In Lithuania, on the north-eastern border of its distributional range, the species evolved into a lowland forest ecotype which occurs in light and dry pinewoods in the southern and south-eastern parts of the country. The former, mountain-meadow ecotype, occurs only in one location, occupying less than 1 hectare of wet grassland near Medininkai village in the Vilnius district. This ecotype develops more vigorously compared to the forest one. this ecotypic differentiation is not reported from the central area of its distribution and may be attributed to an increased ecological adaptability of the species as a consequence of its occurrence on the border of its distributional range.

Medicinal uses: historical and current

A. montana L. has been applied for centuries in folk medicine to treat swelling, soreness and bruising. Active components in *Arnica* are sesquiterpene lactones, helenalin and dihydrohelenalin and their short esters (Douglas et al., 2004). An estimated 50,000 kg of dried flowers are used annually in Europe. This is equivalent to 250,000-300,000 kg of fresh flowers. In addition, hundreds of kilos of dried roots are utilized each year (Lange, 1998). *Arnica* is mainly harvested from the wild. The main sources of *Arnica* for medicinal use are the Balkan countries, Spain and Switzerland. The demand for A. *montana* has remained consistently high in face of continuing declines in availability in the wild.

Promoting conservation: the SPIMED project in Sweden, Lithuania and Finland

Arnica montana L. is one out of eight target taxa of the Nordic Genebank project "Spice and medicinal plants in the Nordic and Baltic countries. Strategies for conservation of genetic resources" (SPIMED). The project makes initiatives and efforts to conserve medicinal- and aromatic plants in the Nordic and Baltic countries, formulates conservation recommendations and will be finalised this year. Cultivation trials will be recommended as means to avoid exploitation of vulnerable populations.

SPIMED included collecting. and characterisation of accessions of the target species and collections of plants with a broad diversity have been established. Descriptors for the vegetative and generative plant parts of the species have been developed and tested. Collections of Arnica have been established and compared in Sweden, Lithuania and Finland. The characterization work was carried out at Svalöv in Sweden, in Vilnius in Lithuania and at Mikkeli in Finland.

Threat: a problem of European scale

A. montana L. has greatly declined European-wide due to loss of habitats and over-harvesting. In the Nordic region, changes in agriculture are major factors for the reduction. In Norway loss of habitat is the main problem and *A. montana* is now on the Norwegian Red List with status DC (declining/care demanding). If the changes in agriculture persist, the distribution will be even more reduced (Asdal, 2005).

The species is regarded as critically endangered in Belgium, Bosnia, Croatia and Luxembourg; endangered in Belarus and the Netherlands; vulnerable in Estonia, Germany, Latvia, Lithuania, Portugal and Romania; and near threatened in Denmark and Norway (TRAFFIC Network, 2005).

European countries should develop general guidelines for sustainable collection of indigenous medicinal and aromatic plant species and promote their implementation (Lange, 1998). *A. montana* is an example of a threatened species for which specific guidelines for particular habitats and countries should be developed. Annual quotas of the amount of plant parts that may be harvested should be established.

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TRAFFIC Network http://www.traffic.org/

Lupinus hispanicus Boiss. & Reut. in the Iberian Peninsula: a crop wild relative traditionally harvested for fodder

J.M. Iriondo, L. De Hond and M. Parra

Universidad Politécnica de Madrid, Spain

The importance of *Lupinus hispanicus* as a CWR

Lupinus hispanicus, an annual herb, belongs to the group of 12 Old World *Lupinus* species found in the Mediterranean area. Due to their importance as nitrogen-fixing symbionts and their high protein content, economically, there has always been a growing interest and demand for lupins. *L. hispanicus* has been traditionally cultivated by farmers as sheep fodder and for soil improvement. In the last 10 years this plant has been included in breeding programmes of lupins as it is the closest wild relative

Taxonomy and biology

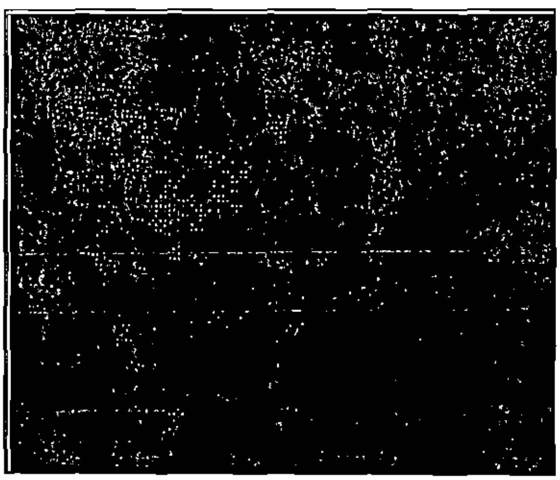
Family: Leguminosae

Scientific name: *Lupinus hispanicus* Boiss. & Reut. P.É. Boissier & G.F. Reuter 1842 Diagnoses plantarum novarum hispanicarum.

Common names: altramuz, alberjón, titones, haba de lobo, haba de lagarto (Spanish), favaca (Portuguese).

The genus *Lupinus* is commonly known as bluebonnets in English, due to its attractive flowers.

Biology: *L. hispanicus* is an annual autogamous plant with hermaphrodite flowers that bloom from April to August.



Ecogeographic features of *Lupinus hispanicus*

Geographical distribution: Spain and Portugal.
L. hispanicus is endemic to the Iberian Peninsula. It is found in the Central and mid-Western regions as show on the map.

Habitat: This species occurs on neutral and acidic soils (pH 5-6.5) with a silty to sandy texture. It grows at altitudes between 600-1600 m.

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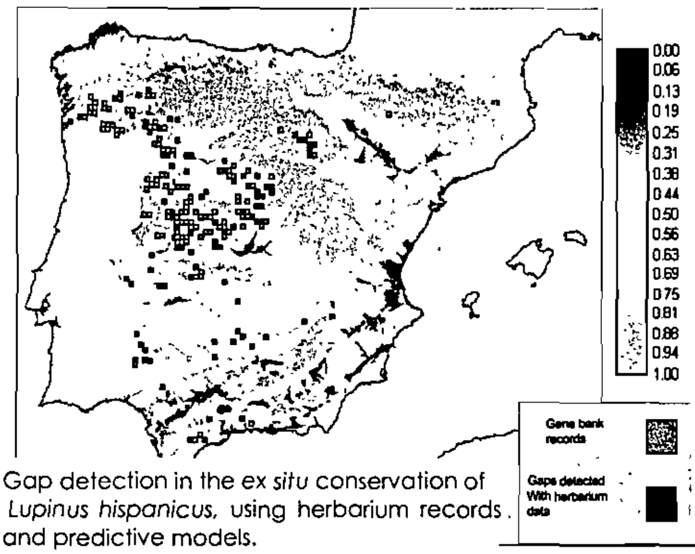
Threats

Major threats to *L. hispanicus* are habitat alteration and loss, changes in agricultural practices and genetic pollution.
The natural populations of *Lupinus hispanicus* occur in cereal fields, vineyards, olive orchards, road edges and shrubby land. Many populations are now in severe decline due to agricultural abandonment and human intervention (urbanization, road widening, etc). The photograph shows road widening in Casavieja, Spain, which partially destroyed a *L. hispanicus* population



Gap detection in the ex *situ* conservation of *Lupinus hispanicus*, using herbarium records and predictive models.

Conservation

In situ

Half of the known 174 *L. hispanicus* populations are located in the Natura Network of Sites of Community Interest. Predictive distribution models have been used to assess the overall occurrence of L. hispanicus in protected areas (shown on the left).

Ex situ

A large collection of *L. hispanicus* seeds is maintained in European and Australian national seed banks. GIS-based methodologies have been used to detect biases in collections and to identify additional collection sites to capture greater genetic diversity for ex situ collections.

The role of *L. hispanicus* in agriculture and sustainable development

- This crop wild relative was traditionally harvested by farmers for use as fodder. However, the high proportion of toxic, bitter alkaloids found in this species has limited its wider use.
- *Lupinus hispanicus* as a crop for sustainable development: As this species has nitrogen-fixing nodules on its roots, it assimilates nitrogren and fixes it in the soil, thereby reducing fertilizer requirements in subsequent crops. Thus, it has the potential to increase the efficiency of N use in arable rotations and in mixed arable livestock systems.
- Breeding qualities of *Lupinus hispanicus*: the species has a high oil content in seeds, and both the plant and its seeds have a 30-50% protein content. *Lupinus hispanicus* has a high tolerance to many pests and diseases, requiring fewer insecticides and fungicides than other high-protein crops such as soybean and peas. Other traits include cold tolerance and adaptation to poor soils.
- Experimental cultivation of *L. hispanicus* began in 1988 using seeds from natural populations to provide summer pastures for sheep and goats.

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Linum dolomiticum Borbás
a strictly protected wild relative of cultivated flax in Hungary

G. Vörösváry, L. Holly and L. Udvardy
Institute of Agrobotany, Hungary

Linum dolomiticum: a wild relative of cultivated flax

The dolomite flax (*Linum dolomiticum* Borbás) is a very rare, endemic, perennial flax species restricted to some habitats on dolomite rocks in Hungary. It is a relic species, the entire world population of approximately 1000 plants is living on a 10 ha area () about 32 km north-west of Budapest, near Pilisszentiván, a strictly protected area. It was declared a protected species in 1951.

Biology

It is a dwarf shrub (chamaephyton) with woody, branching stem ending in leaf rosettes. The flowering stems are usually 10–15 cm. The inflorescence has 2–6 yellow flowers. Sepals are 6–7 cm, narrowly lanceolate acuminate. Petals are 10–16 mm obovate or lanceolate. Capsules are globose with 10 seeds. It is closely related to *Linum elegans* Spruner ex Boiss. in the Balkan Peninsula. It has a chromosome number of 2n=28. It is pollinated by insects (entomogamy), but sometimes it is auto-gamous. Seeds are dispersed by animals (epizoochory).

Natural habitat of *Linum dolomiticum* in the Buda Hills

Taxonomy

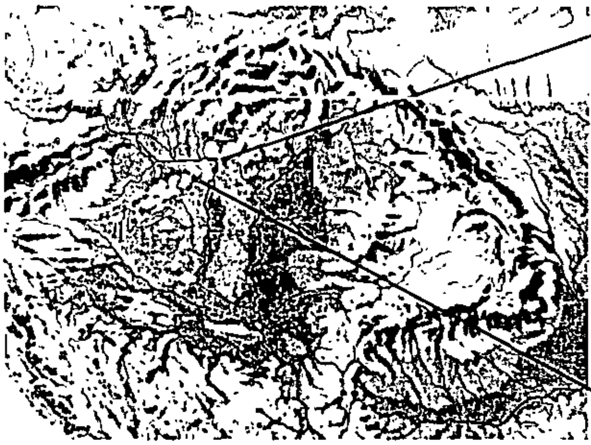
Sect. Syllinum Griseb. *Linum flavum* group

Taxon: *Linum dolomiticum* Borbás (1897)

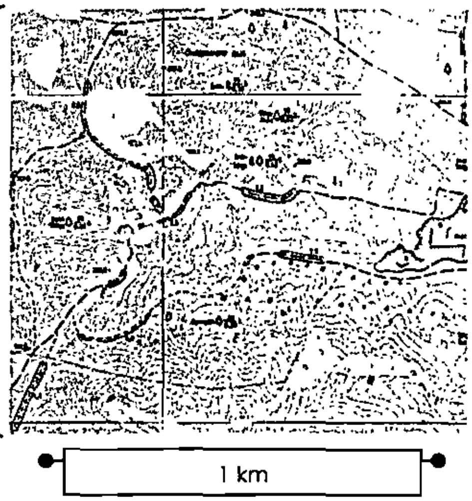
Forms: forma *dolomiticum* with petals 15-16 mm long and ovate and forma *parviflorum* Wagner with petals 10-12 mm long and lanceolate

Vernacular name: Dolomite flax (English), Pilisi len (Hungarian)

PGR Forum
European Crop Wild Relative Diversity Assessment and Conservation Forum



Distribution of *Linum dolomiticum* in the Carpathian Basin



Locations of the existing populations *of L. dolomiticum* in the Buda Hills

Distribution

An endemic and relic plant species of the Hungarian flora, it can be found only on one location (Kisszénás) in the entire world, in close proximity to the Buda Landscape Protection Area. The world population is living on a 10 hectare size habitat which is strictly protected.

Ecology

The Budapest part of the Buda Landscape Protection Area managed by Directorate of the Danube-Ipoly National Park is characterized by the richness of plant communities. The limestone and dolomite rock grasslands, covered only with a thin layer of ground, have the highest diversity, and are home to the most rare species. Endemic to the Carpathian basin are *Draba lasiocarpa* Rochel var. *demissorum* Borbás, *Phyteuma orbiculare* L., *Seseli leucospermum* Waldst. et Kit., *Dianthus plumarius* L. ssp. *regis-stephani* (Rapcs.) Baksay, *Centaurea sadleriana* Janka, or *Vincetoxicum pannonicum* (Borhidi) Holub. The latter can be found only in the Villányi Mountains and here. Facing north, on the cooler slopes grows *Sesleria sadleriana* Janka.

Threats

The most important threats to *L. dolomiticum* are disturbances and its small population size. At present, its level of threat is assessed as low.

In situ conservation

First steps to protect this endemic flax species were taken in 1934. This species is protected by Law № LIII. of 1996 on Nature Conservation and Act № 13/2001 of the Ministry of Environmental Protection. In addition it is listed in the Bern Convention 1979, CORINE Biotopes and the Habitats Directive (92/43/EEC) Appendix I. and European Diploma 1995 (The Szénás Hills strictly protected area).

Ex situ conservation

Three seed samples from three populations are conserved in the genebank collection at the Institute for Agrobotany, Tápiószele (Hungary).

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Avena strigosa (Schreb.) in North-Western Europe: a historical landrace without crop wild relatives?

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Photography M. Scholten Map adapted from Preston *et al.* 2002 New Atlas of the British and Irish Flora

A. strigosa has been used in the past in Scotland both for human consumption, as fodder for horses and cattle, and the straw for furniture and thatching. The photograph above shows one current use on the Outer Hebrides as feed for Highland cattle. On the Shetland Islands the straw is still used to make chairs. It is usually grown as a mixed stand (with rye) to safeguard a harvest in dry years. Traditionally it was stored outside the farm in stacks (below).

Avena strigosa: crop and crop wild relative

Avena strigosa, an annual cereal, is both a minor, neglected crop and a crop wild relative. It is a diploid oat.
As a crop it was domesticated in southern Europe, probably Spain and spread from there over Europe where it was cultivated before the more productive hexaploid oat (*Avena sativa*) made its entry.

A. strigosa does not form a seedbank, it requires continuous reintroduction. Hence, without the crop, there will be no crop wild relatives. This is currently the case in many European countries where cultivation has ceased, for example in a wide survey in Denmark, former stronghold of the crop, not one plant was discovered (Weibull, 2001).

The fate of not-native crop wild relatives: the example of the UK

Plants associated with arable and horticultural habitats have undergone the strongest decline compared with plants in other habitats in the UK. Many crop wild relatives associated with former crops only occur as rare casuals nowadays.
The plight of these plants, many of which not native to the UK, has recently been recognised by UK conservation authorities in the latest national Red Listing. "Archaeophytes", that is, not-native plants that have arrived in the UK before 1500, have been included in the National Red List 2005 and as a consequence will be candidates for Biodiversity Action Plans.

Current distribution of *Avena strigosa*, cultivated and in the wild

Historical geographical distribution includes Austria, Belorussia, Belgium, Corsica, Denmark, France, Finland, Germany, Hungary, Lithuania, Luxemburg, Norway, Portugal, Russia, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.

In Portugal its cultivation nowadays is restricted to small areas with light sandy soils. Current cultivation in Lithuania comprises four locations of small scale cultivation.

In the UK the remaining area of cultivation is mainly on the Outer Hebrides. Several hundreds of hectares on Machair soils are rented by small-scale farmers or "crofters". Here crofters grow *A. strigosa* rather than the hexaploid modern cultivars because the crop can stand up to high winds and give a yield on the very light manganese deficient soils. The traditional value of the crop is also a reason for some to adhere to this landrace.

Distribution of *Avena strigosa* in the UK
In turquoise: past occurrences, before 1960, in black: occurrences between 1989–1999. The mainland present occurrences as rare casuals as bird-feed spills. In red circles: areas of cultivation. In 2004 as a crop it was only present on the Outer Hebrides, the Fair Isles, Shetlands islands and in very few locations in Wales.

Threat

On the short term crop cultivation is plagued by geese eating the grain and spoiling the feed. On the longer term the biggest threat for *A. strigosa* on the Scottish Islands is cessation of cultivation because of depopulation, an ageing crofters population and increased sheep instead of cattle farming.

Conservation

The Machair is one of the priorirty habitats for conservation in the UK. However, at present, *Avena strigosa* is not listed as a typical species of the Habitat Action Plan for the Machair.
Several accessions of *A. strigosa* are conserved in national and international gene banks.

Photograph showing the sandy soils of the Machair on North Uist (Outer Hebrides). In the background silaged fodder (hay and *A. strigosa* mixed with rye). Most, but not all, crofters have abandoned the traditional stacking in favour of silage.

The role of *Avena strigosa* in agriculture and sustainable development

- It is still a major feed on the Outer Hebrides were it survived as a crop in marginal agricultural circumstances due to its capability to stand up to high winds, tolerate manganese deficiency and very light soils.
- It is also grown as a fodder crop outside of Europe in South America.
- Its introduction as a crop of the European Union Common Catalogue is being discussed at present.
- *Avena strigosa* has breeding qualities such as a very high oil content [Podyma, 1994] and a very long rooting system which makes it an excellent fodder with soil erosion prevention qualities.

Literature cited

Podyma, W. 1994 Wystepowanie gatunku *Avena strigosa* Schreb. sensu lato oraz zmienosc cech morfologieznych i biochemicznych w populacjach tego gatunku (Distribution of *Avena strigosa* Schreb. *sensu lato* and morphological and biochemical differentiation within the genus) PhD, Radzikow, Blonie, Poland.

Weibull, J. L.L.Johansen Bojensen, V. Rasomavicius 2001 *Avena strigosa* in Denmark and Lithuania. Plant Genetic Resources Newsletter 131: 1-4

The PGR Forum Crop Wild Relative Information System (CWRIS): Information management for crop wild relatives illustrated with case studies

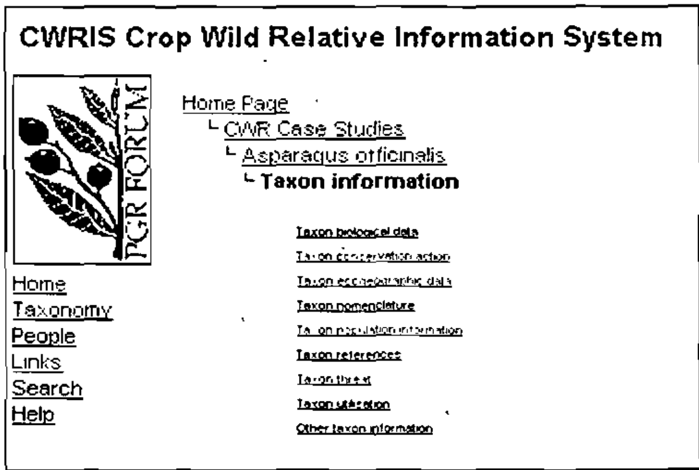
S.P. Kell, M. Scholten, N. Maxted, J. Moore, J. Iriondo, A. Asdal, L. Frese, J. Labokas and Z. Stehno

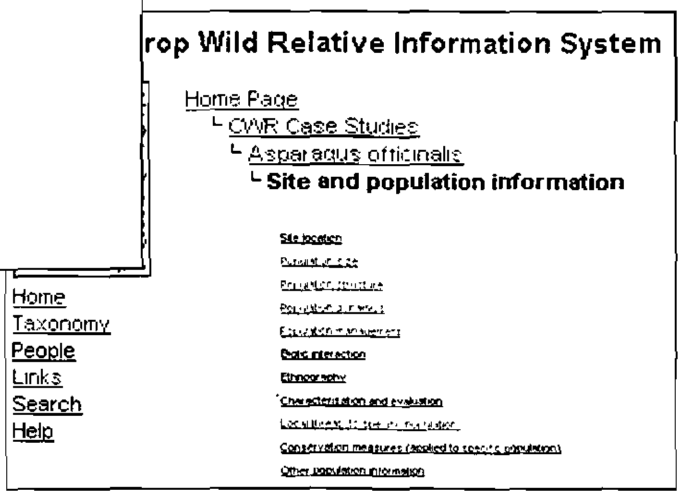
Purpose of CWRIS

The PGR Forum Crop Wild Relative Information System (CWRIS) is an online information management system specifically designed to facilitate CWR conservation and use. CWRIS has two main dimensions: the CWR Catalogue for Europe and the Mediterranean, containing more than 23,000 species and in excess of 243,000 distribution records, and the CWR descriptors for management of taxon data, including detailed site and population data. Aiming to serve a diverse range of user communities, including conservationists, plant breeders, policy-makers and protected area managers, great care has been given to data standardisation. Several case studies have been developed by PGR Forum participants to test CWRIS and some snapshots are shown here to provide a sample of the capabilities of CWRIS for management of conservation data.

Structure of the CWR descriptors

The information is organised along two dimensions: **taxon information** and **site and population information**. Site maps are shown for both taxon (left) and site and population information (below).





Utilisation: a defining characteristic of crop wild relatives

A defining attribute of a CWR is its utilisation. This can be direct, for example as wild salad, or indirect, as potential breeding material for the target crop. The relationship of the CWR to the associated crop is therefore an essential piece of information that is included in the CWRIS descriptors. The information given under **taxon utilisation** is shown (below) for *Beta vulgaris* subsp. *maritima* (L.) Arcangeli, wild or sea beet (Data: L. Frese).

Uses/Ethnobotany	Gene source: disease resistance genes; food: leaf vegetable
Target crop	Sugar beet
In breeding programmes	
Degree of relationship to crop	Primary gene pool

Threat

Threats are documented at two levels in CWRIS: for the taxon across its whole distribution or for a population of the taxon at a specific location. The threats are categorised according to the IUCN Threat Authority File.

Threats	1 1.5. habitat loss: abandonment
Red list assessment	Norway: National Red List. DC Declining, care demanding
Threats	3.2. harvesting: over-collecting, 1. habitat damage
Red list assessment	Lithuania. National Red List (2003): vulnerable

The example of *Arnica montana* L. (above) has multiple entries for taxon **threat**: the data for Norway provided by A. Asdal, for Lithuania by J. Labokas. For *in situ* conservation management of threatened species it is crucial to know the **local threats** to a particular population. The species illustrating this is the Western European maritime endemic *Asparagus offcinalis* subsp. *prostratus* (Dumort) Corb. Local threats to this species at a particular site, Port Eynon, Wales, are shown in the box below (Source: Rich *et al.* 2002). The same IUCN threat standards are used here to classify the local threats.

Site location	Port Eynon
Threat category	7.2 Natural disasters: Storms and floods and 10.1 Human disturbance: Tourism
Threat reason	Population may heve been reduced by collecting in the past.

Site location information

The example (top right) shows three of the **site locations** in the Czech Republic, where the near-threatened *Allium schoenoprasum* subsp. *sibiricum* (L.) Richter occurs.

Named area	*Nearest named place*
Krkonoše	Úpská jáma
Krkonoše	Úpská jáma, 2. lavinový svah (ve sm. V-Z), pod horním úpským vodopádem (2)
Nízký Jeseník	Suchá Rudná (Podlesí), PP Morgenland

In addition to location details, the webpage with the overview of the **site locations** gives the original source of the data: in this case the Czech National Phytosociological Database, made available by Z. Stehno. In the **Site location** table, for each location, habitat type, vegetation types and soil information are documented as shown (bottom right) for a site near Cañamares, Spain, one of a total of two locations of the Spanish endemic *Erodium paularense* Fern. Gonz. & Izco. The total population of this endangered species is 200 000 plants, divided over 5 populations. (Data by J. Iriondo)

Soil depth	5 - 10 cm
pH	6.0 - 6.5
Habitat type - IUCN	4.4

Population information

For every site location, the population should be documented for **population size, population structure** and **dynamics, population management**, etc. For some species this level of detail is available. The **population dynamics** data shown below were part of the preparation of the UK Biodiversity Action Plan for *Asparagus officinalis* subsp. *prostratus* (Dumort) Corb., which is known to have 28 populations in the UK and a total population size of only 1200 plants (Rich *et al.* 2002).

Survey first or sequence .. date	1996: several; 2001: 2 clumps
Trend	unlikely to survive because of small population size
Site location	Darvis s Point

For a full insight into the capabilities of CWRIS for management of CWR information, or to browse the CWR Catalogue for Europe and the Mediterranean, visit: http://www.pgrforum.org/cwris/htm

References:

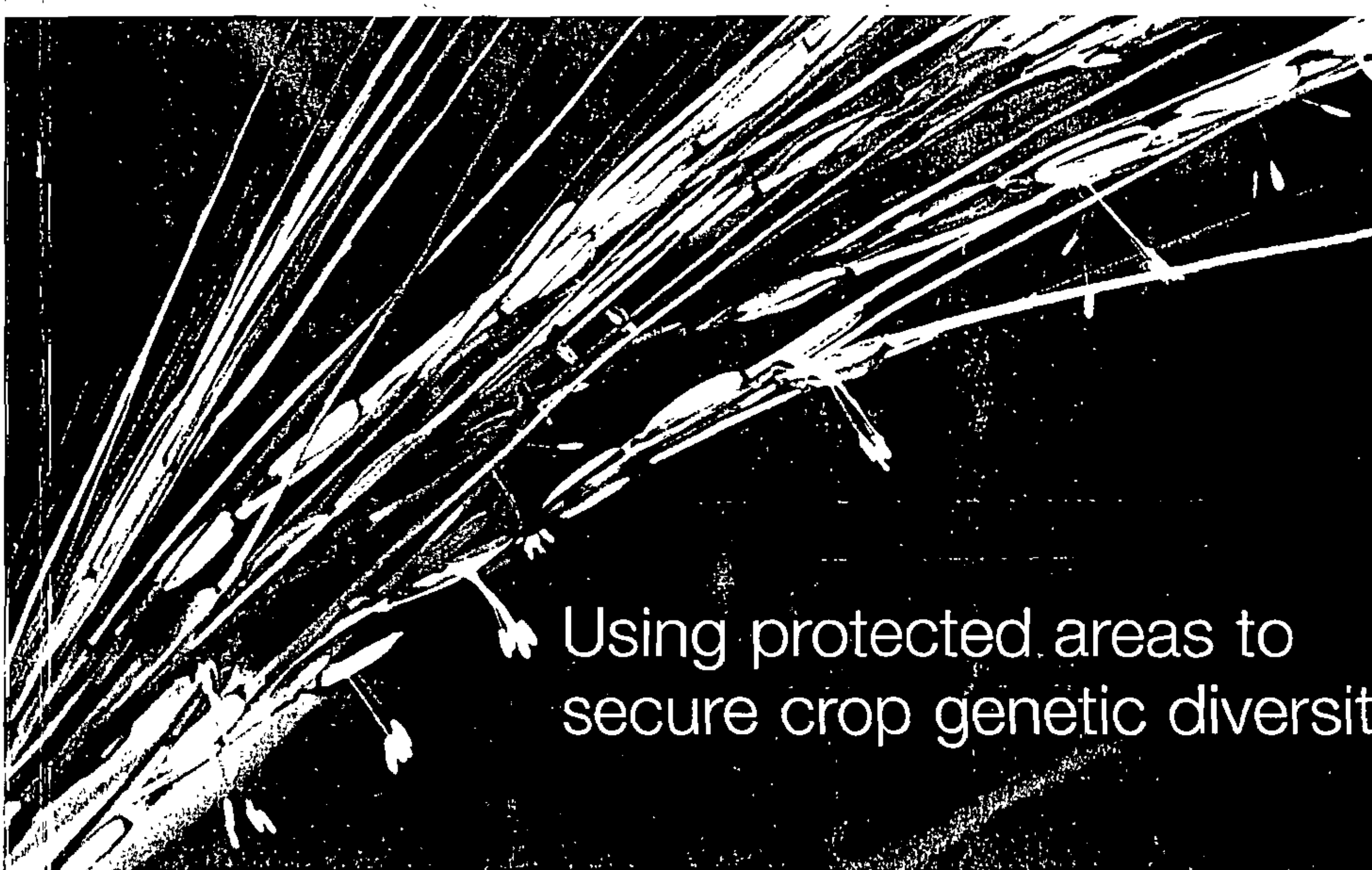
Rich, T.C.G., I.J. Bennallick, L. Cordrey, Q.O.N. Kay, A.J. Lockton and L.K. Rich (2002) Distribution and population sizes of *Asparagus prostratus* Dumort., Wild asparagus in Britain. Watsonia, 24 (2): pp 183 – 192

Anexo 4:

Título y contenido libros

"Food Stores" y

"Plant Genetic Conservation – The in situ approach" Ed. N. Maxted


Using protected areas to
secure crop genetic diversit

Arguments for Protection

Food Stores: Using Protected Areas to Secure Crop Genetic Diversity

A research report by WWF, Equilibrium and the University of Birmingham, UK

Written by Sue Stolton, Nigel Maxted, Brian Ford-Lloyd, Shelagh Kell, and Nigel Dudley

Published August 2006, WWF – World Wide Fund for Nature

ISBN: 2-88085-272-2

Cover design: HMD, UK

Cover photographs: *Top*: Potatoes in Peru © WWF-Canon / Udo Hirsch
Bottom: Wild rice (*Oryza nivara*) © WWF-Canon / Vin J. Toledo

Contents

This book has been prepared by WWF working in close collaboration with the School of Biosciences, University of Birmingham, UK.

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Complementary Conservation Strategies

N. Maxted, B.V. Ford-Lloyd and J.G. Hawkes*

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2.1 Introduction

The challenge facing the world's biological and conservation scientists is threefold: to classify the existing biological diversity, to halt the rate of ecosystem, habitat, species and genetic loss and to feed the ever increasing human population. It is generally agreed that a catastrophic loss of plant genetic diversity is occurring at this moment: species, gene combinations and alleles are being lost for ever and this process of genetic erosion is likely to become even more grave in the future. The conservation of plant diversity is of critical importance, because of the direct benefits to man that can arise from its exploitation in new agricultural and horticultural crops, the development of medicinal

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Selection of Target Taxa

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3.1 Introduction

The activities of conservationists will always be limited by the financial, temporal and technical resources available to them. Therefore they must prioritise and select the taxa they are to conserve. The implication of this, in terms of *in situ* genetic conservation, is that particular species and representative populations will be selected for protection in a genetic reserve or in traditional farming systems while others will not receive active protection.

4

Ecogeographic Surveys

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2 International Plant Genetic Resources Institute, Sub-Saharan African Office, ILRAD, P.O. Box 30709, Nairobi, Kenya

4.1 Introduction

It is essential to understand the habitat preferences and geographical distribution of the target species if a effective conservation strategy is to be developed. Key sources of information on these is the passport data associated with existing herbarium and germplasm collections. The passport data for a particular species might indicate that it has been previously found only in mangrove swamps of southeast Asia. Clearly, these

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Technical and Political Factors Constraining Reserve Placements

J T Williams*

* International Network for Bamboo and Rattan, DRC, New Delhi, India.

5.1 Introduction

There are a number of constraints to the effective placement of reserves for the *in situ* conservation of wild species related to crops, and particularly for those sufficiently related that they have foreseeable and potential use in the genetic enhancement of the crop itself. These constraints are scientific, practical and political. Additionally, there are few operational blueprints for fully comprehensive systems of genetic conservation

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Plant Population Genetics

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6.1 Introduction

Over the last decade, there has been an exponential growth in interest and investigation of the problem of how best to conserve populations of endangered species. As a result, there is now a very extensive and widely scattered literature on this subject. Among recent papers which cite a large number of references are those of Boyce (1992), Ellstrand and Elam (1993) and Nunney and Campbell (1993). Soule's (1987) book gives a valuable survey of the subject, in which the chapter by Lande and Barrowclough (1993) deals with the population genetics of the problem. Much of this literature is concerned with the

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Plant Population Ecology

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7.1 Introduction

Identification of an endangered species is not a trivial task. Information on some species is so limited that it is impossible to tell if they are threatened: indeed, it is likely that there are many species, particularly in the tropics, whose existence will never be known. However, there are detailed data available for many species which allows rare and possibly endangered species to be identified. This is particularly true in Britain and parts

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Reserve Design

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8.1 Introduction

In recent years a considerable literature has grown related to reserve design (Margules *et al.*, 1982; Margules and Nicholls, 1988; Shafer, 1990; Spellerberg, 1991a; Cox, 1993; Primack, 1993, 1995; Given, 1994; Meffe and Carroll, 1994). Most of it, however, deals with the conservation of habitats for endangered wild animal species, and particularly for mammals and birds at or near the top of the food chain (Shafer, 1990).

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Management And Monitoring

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[3] National Parks and Conservation Service, Ministry of Agriculture and Natural Resources, Réduit, Mauritius.

9.1 Introduction

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Locally-Based Crop Plant Conservation

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10.1 Introduction

Conservation of cultivated plants or domesticated animals follows the same principles and concepts for naturally occurring biological resources as outlined elsewhere in this book. This chapter focuses on crop plants, where a broad definition of a crop plant is applied. That is, we include plants grown under human cultivation and those exploited in natural stands, but under minimal

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Genetic Conservation Information Management

B.V. Ford-Lloyd and N. Maxted*

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11.1 Introduction

It is widely accepted that the management of genetic resources which are conserved *ex situ* will involve firstly the location and collection of the plant material and then its effective conservation, usually in some form of long term storage. Once actively conserved, the germplasm may be characterised, evaluated and may be regenerated as part of a routine management programme. If it is agreed that the major reason for conserving

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Estimation of Genetic Diversity

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12.1 Introduction

Plant conservation means different things to different people. To some it means ensuring that a particular species is represented in the flora of a particular region. To the contributors to this book, this objective is not sufficient; the primary aim is the conservation of the range of genetic diversity present within a plant taxon, so that we are actually considering the maintenance of a gene pool and the conservation of alleles. This may appear a facile comment to informed readers, but seems a point worth making since

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Conserving The Genetic Resources Of Trees *In Situ*

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2 Oxford Forestry Institute, Department of Plant Sciences, University of Oxford, Oxford OX1 3RB, UK

13.1 Introduction

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Integrating Plant and Insect Conservation

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* Department of Entomology and Animal Ecology, Lincoln University, P.O. Box 84, Lincoln, New Zealand.

14.1 Insects, reserves and restoration: diminishing 'natural' habitats

Since the 1500s the human population has increased exponentially (Cambell, 1983) and as a result landscapes have changed in dramatic ways. Depending on the fractal scale (Mandelbrot, 1982; Williamson & Lawton, 1991)

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Case Study 1:

THE AMMIAD EXPERIMENT

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[2] The Weizmann Institute of Science, Jerusalem, Israel.

[3] The Hebrew University of Jerusalem, Jerusalem, Israel.

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Case Study 2:

In Situ Conservation of Genetic Diversity in Turkey

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16.1 Introduction

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Case Study 3:

Genetic Conservation: A Role for Rice Farmers

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* International Rice Research Institute, Los Baños, Philippines

17.1 Introduction

* ORSTOM, Institut français de recherche scientifique pour le développement en coopération. Seconded to the International Rice Research Institute.

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Case Study 4:

Ethiopian *In Situ* Conservation

Melaku Worede*

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18.1 Introduction

The Ethiopian region is characterized by a wide range of agro-climatic conditions that account for the enormous diversity of its biological resources. Probably the most important of these is the country's various crop plants that farmers have adapted over centuries of selection and maintenance under various agro-ecosystems. Ethiopia is often referred to as a major Vavilovian

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Peruvian *In-Situ* Conservation Of Andean Crops

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19.1 Introduction

Most of the Andean crops are indigenous to that area and have become adapted to a considerable range of ecological zones, both in terms of altitude, as well as rainfall and

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Central Asian *In Situ* Conservation of Wild Relatives of Cultivated Plants

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* The Herbarium, N.I. Vavilov All Russia Scientific Research Institute of Plant Genetic Resources, 44, Bolshaya Morskaya, St. Petersburg, 190000, Russia.

At the present time, taxonomists, historians, and botanists tend to regard Central Asia and Kazakhstan as one cohesive region from the points of view of natural history and economy, and thus they refer to the Kazakhstan-Central Asian Region, one of the largest natural regions in the world (Tikhonov and Gerasimova, 1990). Unique ancient relict plants, endemic species, and even fragments of ancient landscapes are represented in

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Plant Conservation *In Situ* for Disease Resistance

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21.1 Introduction

In situ conservation of germplasm resources for disease resistance is a well appreciated need for wild germplasm as well as for land races. There is no doubt that diversity of sources of resistance is needed regardless of the protective management system(s) adopted. It is well documented that a wealth of resistance genes and resistance mechanisms is found in wild plants and land races (e.g. Frankel and Bennett, 1970;

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A Practical Model for *In Situ* Genetic Conservation

N. Maxted [1], J.G. Hawkes [1], B.V. Ford-Lloyd [1] and J.T. Williams [2]

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2. International Network for Bamboo and Rattan, DRC, New Delhi, India.

22.1 Introduction

Having discussed specific aspects of genetic reserve and on-farm conservation and provided Case Studies written by those actively engaged in conserving genetic diversity *in situ*, we would like to draw some overall conclusions concerning the practical

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Towards the Future

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Introduction

There is growing awareness of the importance of *in situ* conservation for plant genetic resources for food and agriculture (PGRFA). This recognition has grown out of:

a) the increasing influence of the environmental movement which has resulted in greater public awareness of the importance of conservation. Although the primary interest of many in this movement has been with conserving ecosystems (areas of natural beauty) and preserving high-profile endangered species (pandas, whales, butterflies and orchids), it has generated a recognition of the importance maintaining a wide range of different ecosystems and of conserving individual species *in situ.*

b) the increasing importance of wild species as a source of genes for crop improvement. With modern genetic manipulation techniques, all organisms become potential sources of useful genes. However, species that are more closely related to crops contain, arguably, the most valuable reservoir, whether these are introduced to crop species by conventional interspecific hybridization methods or through genetic engineering.

c) the recognition that it is impractical, for cost and technical reasons, to consider conserving all potentially useful genes *ex situ.* This is the case, for example, for clonally propagated crop species such as sweet potato and yam, and for those species which produce seed that cannot be stored *ex situ* for any length of time - recalcitrant seeded species. Many tropical trees such as mangoes and jackfruit fall in this

Anexo 5:

Títulos publicaciones entregados por N. Maxted en formato digital

Crop Wild Relative Conservation and Protected Area Management

1. INTRODUCTION

The Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and the Global Plant Conservation Strategy each provides a major incentive to link national biodiversity inventories to protected area management as a basis for effective and efficient biodiversity assessment and conservation action. Crop wild relatives (CWR) are identified as a critical component of plant biodiversity required for wealth creation, food security and environmental sustainability in the 21st century. Therefore it is perhaps surprising, considering their socio-economic importance, that the conservation of CWR taxa has not been more systematically addressed. Prior to effective and efficient biodiversity assessment and conservation there is an obvious need to establish what biodiversity exists, both in terms of taxonomic and genetic diversity, and therefore a first step is to prepare an inventory. But once the priority CWR taxa are known, the second step is to identify where those species are found and, unless they are very restricted endemics, in which protected areas they currently occur in. Then investigate how the protected area management plan might be adapted to facilitate CWR conservation and use.

It is undoubtedly the case that numerous, existing protected areas contain a wealth of CWRs. However these protected areas are likely to have been established to conserve habitats or mega-fauna rather than CWR species. Therefore, the number of CWR species monitored within the protected areas is unlikely to be large unless they are coincidentally keystone or indicator species as well as being CWRs. As such the management of the CWR species is passive and individual CWR populations may possibly decline or even be lost without changes to the management plan being triggered.

Sustainability for protected areas can only be enhanced by use of the protected area and by stimulating interest among stakeholder in the biodiversity located in the protected area. Just as botanic gardens often stimulate interest in the general public by including specimens of crops to show what the banana, coffee or rice plant looks like, so the protected area manager can raise the profile of their protected area by paying particular attention to the CWR species native to that protected area and advertising their presence to the potential user communities. So how would a protected area manager find which CWR species are present in the protected area they manage, how might they adapt their management to facilitate CWR conservation and how would the protected area manager draw the presence of CWR in the protected area to the attention of the potential user communities?

The answer to these questions may be considered in two interconnected phases, that result in the development of national CWR and individual CWR protected areas strategies (see Figure 1). Although the two strategies are interconnected they can also be seen as distinct with quite separate goals. The national CWR strategy developed for an individual country will aim to ensure the conservation of the maximum taxonomic and genetic diversity of the countries CWRs. While for the individual CWR protected area strategy the aim will be to ensure the conservation of the maximum CWR taxonomic and genetic diversity within the protected area while promoting use of the protected area. The former is more extensive and will have policy implications for national conservation and exploitation agencies, it will lead to the conservation of priority CWR taxa in key

Crop Wild Relatives: Catalogues, Threats, Conservation and Use

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1. Establishing the Context for CWR Conservation and Use

Crop wild relatives (CWR) are those species closely related to crops and to which they may contribute beneficial traits, such as pest or disease resistance or yield improvement or stability. They are identified as a critical group vital for wealth creation, food security and environmental sustainability in the 21st century. While traditionally, plant genetic resource conservation has focused almost explicitly on cultivated plants themselves, latterly other species such as crop wild relatives and wild harvested species have been viewed as plant genetic resources. As such plant genetic resources may be defined as the taxonomic and genetic diversity of plants that is of value as a resource for the present and future generations of people. They present a resource of tangible actual or potential economic benefit to humankind. For millennia, humans have exploited the variation within these species. Subsistence farmers in Mexico, for example, would annually grow cultivated corn near its wild relatives to facilitate introgression between the CWR and the crop as a means of crop enhancement. These species and this process are as important to humankind today they were to the earliest farmers.

Plant genetic resources are a finite world resource, that has economic, social and ethical value, and this resource is currently being eroded or lost by careless, unsustainable human practices. This loss of botanical diversity can occur at each biodiversity level: genes, species and communities but if species threat is taken as an example, it is estimated that of the 20,486 European vascular plant species (Euro+Med PlantBase - www.euromed.org.uk), 21 % were classified as threatened using the 1994 IUCN Red List Categories and Criteria, 50% of Europe's 4,700 vascular plant endemics are considered to be threatened to some degree and 64 are already extinct (www.redlist.org). While using the more objective 2001 IUCN Red List Categories and Criteria, only approximately 3.5% have been assessed thus far and these are nearly all tree species. The Gran Canaria Declaration calling for a Global Program for Plant Conservation (Anon, 2000), states that: "*as many as two-thirds of the world's plant species are in danger of extinction in nature during the course of the 21st century ...genetic erosion and narrowing of the genetic basis of many species*". The same declaration recognises that plants are vital for the planet in maintaining ecosystem stability and providing food, fibres, fuel, clothing and medicines for humankind. It is even more difficult, if not impossible, to estimate the precise rates of the loss of genetic diversity from within species. It must, however, always be faster than the loss of species, because there will be some genetic erosion (loss of genetic diversity) from the species that remain extant and complete loss of genetic diversity from species that become extinct. As such it seems likely that virtually all species are currently suffering loss of genetic variation to varying degrees and between 25-35% of plant genetic diversity will be lost between the ratification of the CBD and the 2010 target date (Maxted *et al.*, 1997). Loss of any genetic diversity means that plants may not be able to adapt to changing conditions quite so readily in the future.

The Convention on Biological Diversity (CBD) ratified in 1993 attempted to address these issues through promotion of biodiversity conservation, sustainable use its components and the equitable sharing of the benefits arising from use of biodiversity. Specifically in relations to plants the Global Strategy of Plant Conservation (GSPC) was adopted by CBD at

Towards a global strategy for conservation and use of Crop Wild Relatives

1. The global and local importance of CWR

- Definition of CWR
- A strong statement on why CWRs are important and for whom.
- Give one or more striking examples?
- Consequences of inaction.
- Global change dimension – will greatly increase the demand for germplasm adapted to new conditions.

2. Current situation

- Lack of inventories both nationally and globally

  – Indicate the scale of the problem
  – The causes of neglect

- Need for base-line data on CWR

  – Correct taxonomic identification and synonymy (refer to country Standard Floras); need for cooperation with national taxonomic institutions
  – Ecogeographical information – both desk-studies and field
  – Conservation status – including Red Listing, National Red Lists and Books

- Threats to CWRs in nature (habitat loss, fragmentation, simplification, and consequent genetic erosion), in Protected Areas, gene banks, etc

- Presence of CWRs in Protected Areas when known (status, number and size of populations and their representativeness, management (if any)), in Gene banks (number, state and representativensss of the accessions), etc.,

3. Targets/priority actions needed over next 5 and 10 years

General: Include CWR in national reporting system for the CBD? Increase emphasis on CWR in the ITPGRFA?

Establish targets for the year 2010... and for the year 2015... Relate them to the Millennium Goals, the CBD/ GSPC,

- Inventory – national/global
- Establishing national priority lists, crop priority lists
- Acquisition of base-line data
- Information management systems e.g. apply existing systems (PG forum, GEF Wild Relatives)

National approach for Crop Wild Relatives Red Listing: is it as difficult as we think?

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Crop Wild Relatives (CWR) have been identified as an important group of plant genetic resources for the 21st century. They include those species that are taxonomically related to socio-economic important crops to which they may contribute genes via traditional breeding and biotechnology. Their conservation and sustainable use is important for increasing crop production as well as for the maintenance of environmental stability.
However, this group of taxa is larger than had previously been appreciated. The European crop wild relative catalogue contains 23,818 species, which is 77% of the Euro-Mediterranean flora. This means that with limited conservation resources it is necessary to prioritise taxa for immediate conservation action. One means of objectively establishing priorities is conservation or threat status.
According to the Articles 6a and 7a of the Convention on Biological Diversity (1992), each ratifying country has the obligation to "identify the important biological diversity components" and to "develop national strategies, plans or programmes for the conservation and their sustainable use". Moreover, Target 2 of the Global Plant Conservation Strategy states that "a preliminary assessment of the conservation status of all known plant species, at national, regional and international levels" should be undertaken.
Threat assessment may be carried out in many different ways but in order for such assessment to be comparable it is preferable to employ a standardised system and the IUCN Red List categories are commonly applied. Using the IUCN regional categories and criteria to assess CWR taxa at a national level provides a means of assessing genetic erosion and extinction risk and helps establish comparable conservation priorities. However, for individual countries, this task has not always been considered straightforward. In this paper the methodological stages involved in IUCN Red Listing a countries' crop wild relatives are presented in a systematic manner. The limitations of this approach are discussed and possible solutions suggested using specific national case-studies.

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The main objective of this paper is to provide basic guidelines to undertake a national Red listing assessment of CWR.

Conservation and sustainable use of crop wild relatives

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Abstract

Conservation of crop wild relatives (CWR) is a complex interdisciplinary process that is being addressed by various national and international initiatives, including the IUCN SSC Crop Wild Relative Specialist Group, two GEF projects ('*In situ* Conservation of Crop Wild Relatives through Enhanced Information Management and Field Application' and 'Design, Testing and Evaluation of Best Practices for *in situ* Conservation of Economically Important Wild Species'), the European Community-funded project 'European Crop Wild Relative Diversity Assessment and Conservation Forum (PGR Forum)' and the European '*In Situ* and On Farm Network'. In tackling this topic effectively, the key issues are: (1) the definition of what constitutes a crop wild relative. (2) the need for a global clearing house and regional and national information systems; not only is an inventory of CWR needed for most countries and a global estimate of the numbers involved but the information that is available needs to be more easily accessible through electronic means including the WWW; given extensive progress made by the GEF and PGR Forum projects Information Systems, can such models be adopted for other regions and countries? (3) how to integrate the conservation of CWR into existing national, regional and international PGR programmes, including the integration of CWR data structures and information with other PGR information systems. (4) development and application of priority-determining mechanisms; it is certain that the number of candidate CWR species for conservation is much greater than the capacity likely to be available, therefore, a rational means of selection for priority species has to be applied. 5) assessment of the threat facing CWR and the effectiveness of *in situ* and *ex situ* conservation actions and evaluation of their cost-effectiveness; the conservation options for CWR range from detailed sampling and genetic conservation in special reserves to community management inside or outside protected areas; the effectiveness of these options and the costs involved are require much further study. (6) Promoting the use of CWR through *in situ* characterization of potentially important adaptive traits based on defining ecogeographic species envelopes and matching diversity to exploitation needs. (7) developing and enhancing national capacity, especially as the skills required for CWR conservation are different to those associated with gene bank based conservation; few countries have developed an integrated approach to CWR conservation and capacity is inadequate in many. (8) Raising awareness of the importance of crop wild relatives in agricultural development; this is necessary at local, national and international levels both for the scientific and lay communities. (9) Policy development and legal framework; this involves a range of complex issues including access, IPR and benefit sharing. Also areas of further research are highlighted. The above issues are illustrated by work on columnar cacti in Central Mexico, where wild, sylvicultural managed and cultivated populations coexist, and by European and Mediterranean crop relatives.

1. Introduction

From the beginnings of agriculture, when the first crops originated, natural crossing between wild species and the crops occurred and subsequently farmers used wild species as a source of genetic material to develop and improve the quality and yield of crops though traditional breeding methods. Explicit recognition, however, of the importance of crop wild relatives (CWR), their use in modern plant breeding and the need for their conservation, both in nature (*in situ*) and off site in genebanks and botanic gardens (*ex situ*), dates back to the beginnings of the 20th century, notably with the work of Vavilov, and later Harlan, de Wet, Frankel and Hawkes.

Ecogeographic surveys

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1. Introduction

Plant collectors are like detectives: they gather and analyse clues in order to trace plants of interest. The locations inhabited by each plant species will be defined by a differing sets of environmental and geographical constraints. The ecogeographic passport data associated with herbarium specimens and germplasm accessions can be used to decide what these conditions are likely to be. If such data for a particular species or phenotype indicates that previously it had only been found on limestone scree slopes above 2000 metres in South West Asia, then locations occurring within these constraints is clearly where one should look first if further material is being sought. A combination of ecological and geographical passport data from historical collections provides evidence that can be used to predict where species may be currently located.

The financial and practical resources available for germplasm acquisition will always be limited and as a result the most efficient use must be made of them. The efficiency of germplasm acquisition can be enhanced by planning accurately directed collection missions which maximise the genetic diversity sampled. In this context the phrase "accurately directed" means that each collecting mission has a clearly defined set of target taxa, target areas and target habitats. This is particularly pertinent for wild species. For crop material, the collection activity may simply involve visiting know breeding institutes and requesting specific accessions or breeders lines, while for wild species much time can be wasted if the habitat preferences or geographical distribution of the targeted species are not known prior to the start of the collecting mission. One way of clearly defining the mission targets is to undertake an ecogeographic study or survey prior to mission commencement.

IBPGR (1985) summarises the three major components of ecogeographic investigations as the study of:

! distributions of particular species in particular regions and ecosystems;
! patterns of infra-specific diversity; and

The use of ecogeography and genetic diversity as a guide to efficient plant genetic conservation

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Gap Analysis: a tool for effective genetic conservation assessment of agrobiodiversity

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Abstract

Introduction

Major goals of plant genetic resource conservation are to maximise the proportion of the gene pool of the target taxon which is conserved, whether *in situ* or *ex situ* in a complementary manner and to make it available for potential or actual utilisation. Historically, the goal as stated by Marshall and Brown (1975) is to conserve "95% of all the alleles at a random locus occurring in the target population with a frequency greater than 0.05". Lawrence *et al.* (1995) made theoretical calculations to suggest that this could be achieved for any one species by sampling just 172 plants. The important question is therefore whether either or both can be shown to have been achieved for any crop species. The latter would appear at first sight to be simple to achieve, but it will not necessarily fully address conservation needs. The reasons for this are twofold. Effective conservation of any one population of plants *in situ* is governed by population genetic parameters which dictate the minimum viable population that can be conserved, regardless of the total number of alleles that the species possesses. The other reason is only becoming clearer with the development of knowledge on genomics and gene networks; it may be necessary to conserve genotypes as much as possible rather than individual alleles so that important combinations of genes (including those which are regulatory) are conserved. How much effort will it take in the future to reconstruct 'adaptive gene complexes' if they have been lost in nature?

Notwithstanding these arguments, if world *ex situ* holdings for major crops (FAO, 1998) are considered then it would seem likely that the Marshall and Brown criterion may have been met for wheat with 800,000 accessions held *ex situ*, but how likely is it that it has been met for other crops? Even for the other major crops, such as barley, rice, maize and beans do we know that the accessions sampled adequately represent the taxon's ecogeographic range or adaptive amplitude, let alone its genetic diversity? The only way to answer this question would be to genetically analyse representative samples of a target taxon gene pool and estimate allele frequencies in many populations. In practice this has not been systematically undertaken for any crop and it is unlikely to be done without substantial financial resources. But this does not negate the need to undertake some form of routine assessment of conservation status when formulating conservation priorities. If the assessment indicates that one particular species is thought to be effectively conserved and a second species is less effectively conserved, then conservation priority will be given to the second species. If the assessment of current conservation status indicates gaps in conserved materials, whether *in situ* or *ex situ*, then further conservation action is likely to be required.

Genetic Erosion and Genetic Pollution Of Crop Wild Relatives

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1. Introduction

The Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and the Global Plant Conservation Strategy all recognize the need for more systematic conservation action and a better assessment of threats to biodiversity. The need to assess current threats to genetic diversity from erosion and extinction was specifically recognised by the Conference of the Parties (COP) to the CBD in their 2010 Biodiversity Target (www.biodiv.org/2010-target), which calls for a significant reduction in the current rate of loss of diversity. Crop Wild Relatives (CWR), defined as those wild species taxonomically related to socio-economic important crops and to which they can contribute genes via traditional breeding and biotechnology, constitute a critical segment of plant biodiversity that is vital for wealth creation, food security and environmental sustainability in the 21st century. This paper aims to review approaches to the assessment and prediction of genetic erosion and genetic pollution in CWR, and suggest how a catalogue of CWR might be prioritised according to the dual threats of genetic erosion and pollution.

2. Definition of Genetic Erosion

The level and structure of genetic diversity in plant species – whether wild or cultivated – is shaped by the five evolutionary forces of mutation, recombination, migration, genetic drift and selection (natural and artificial). Apart from mutation, these are in turn affected by the interaction of the plant with humans and its environment (biotic and physical) and by the reproductive biology of the species, through the intermediacy of the differential survival and isolation of individuals and populations.

Genetic diversity is always changing, but the Report on the State of the World's Plant Genetic Resources (FAO, 1998), summarizing country reports, suggests that "recent losses of diversity have been large, and that the process of 'erosion' continues." It points out that while loss of individual alleles is of particular concern, loss of gene complexes and unique combinations of genes (as in different landraces) can also have important consequences. Genetic erosion may thus be defined as a **permanent reduction in richness or evenness of common local alleles or the loss of combination of alleles over time in a defined area.** This definition recognizes that diversity has two distinct components in (i) the number of different entities and (ii) their relative frequencies. It also suggests that it is specifically loss of locally adapted alleles that is most significant. Genetic erosion will be detrimental to the short-term viability of individuals and populations, the evolutionary potential of populations and species, and the direct use of genetic resources (Brown *et al.*, 1997). Change is, however, universal and natural, and there is therefore a need to distinguish anthropogenic changes that are to the detriment of populations from normal background levels of change.

Planning Plant Genetic Conservation

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Abstract

Before conservationists embark on a project they must be clear about why the taxon warrants conservation. The reason for the selection of taxa to conserve should be based on a series of measurable criteria, such as genetic distinctness, the probability of species extinction, the threat of genetic erosion and the potential economic value of the taxon now and in the future. Once a taxon has been chosen for conservation, better outcomes will be achieved if conservationists develop an understanding of the taxon's geographic distribution, habitat preferences, phenology, genetics and taxonomy. This information, necessary to the formulation of an effective conservation strategy, is acquired by conducting an "ecogeographic survey". This consists of collating and analysing all the current information available on the target taxon from literature, passport data on herbarium specimens, databases and taxonomic experts. The information generated during the course of an ecogeographic survey can also be used to begin the characterisation of collections of conserved plant germplasm.

Introduction to Plant Genetic Conservation

Plant genetic resources have been defined as the "genetic material of plants, which is of value as a resource for the present and future generations of people" (IPGRI, 1993). Traditionally, this definition focused on crop plants and their wild relatives, but it is increasingly considered that all plant species are a potential resource for humanity. The ultimate goal of genetic resources conservation is to ensure that the maximum possible genetic diversity of a taxon is maintained and available for potential utilisation. Marshall and Brown (1975) described the process in the following model (Figure 1):

Figure 1 The exploration model (Marshall and Brown, 1975)

$$
\begin{tikzcd}
\text{Exploration} \arrow[d] & & \\
\text{Classification} \arrow[r] \arrow[d] & \text{Evaluation} \arrow[r] & \text{Utilisation} \\
\text{Conservation} & &
\end{tikzcd}
$$

TITLE: Developing National Plant Genetic Resource Strategy: Crop Wild Relatives

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Keywords: crop wild relative, biodiversity, national strategy, plant genetic resources, conservation

Abstract

Introduction

The Convention on Biological Diversity (www.biodiv.org), the International Treaty on Plant Genetic Resources for Food and Agriculture (www.fao.org) and the Global Plant Conservation Strategy (www.biodiv.org/programmes/cross-cutting/plant/) each appeals for conservationists to improve the efficiency and effectiveness of their conservation actions. The latter establishes explicit global targets that are to be achieved by 2010, "*60 per cent of the world's threatened species conserved* in situ; *60 per cent of threatened plant species in accessible* ex situ *collections...and 10 per cent of them included in recovery and restoration programmes*' and '*70 per cent of the genetic diversity of crops and other major socio-economically valuable plant species conserved*'. If these targets are considered in conjunction with the first UN Millennium Development Goals (www.un.org/millenniumgoals/) of eradicating extreme poverty and hunger, then the conservation and sustainable utlisation of plant genetic resources will have a key role. Plant genetic resources being that: "genetic material of plants which is of value as a resource for the present and future generations of people" (IPGRI, 1993). While traditionally, plant genetic resource conservation has focused almost explicitly on cultivated plants themselves, latterly other species such as crop wild relatives (CWR) are being given conservation priority because of their increasing value as gene donors to crops.

CWRs may be defined by their characteristics; they are species related to crops, the possible progenitors or direct ancestors of crops and species that can be possible gene donors to crops, contributing beneficial traits, such as pest or disease resistance or yield improvement or stability. As such they are a critical group vital for wealth creation, food security and environmental sustainability in the 21st century. Therefore it is perhaps surprising, considering their socio-economic importance, that the conservation of CWR taxa has not been more systematically addressed. The Conference of the Parties to the CBD adopted a strategic plan (decision VI/26),

PLANNING PLANT GENETIC CONSERVATION

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Abstract

Before conservationists embark on a project or write a project proposal for a grant, they must first decide whether the taxon warrants conservation. The selection of which taxa to conserve should be based on a series of measurable criteria, such as the threat of genetic erosion and the potential economic value of the taxon. Once a taxon has been chosen for conservation, conservationists must develop an understanding of the taxon's geographic distribution, habitat preferences, phenology, genetics and taxonomy. This preliminary information, necessary to the formulation of an effective conservation strategy, is acquired by conducting an "ecogeographic survey". This consists of collating and analysing all the current information available on the target taxon from literature, passport data on herbarium specimens, taxonomic experts, and databases.

Towards the Selection of Taxa for Plant Genetic Conservation

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Anexo 6:

Material diverso entregado por Dr. E. Schneider, PhytoConsulting

Diskussionspunkte Bailahuen 05 01 2007

A) Ergebnis aus Projekt der M.-Hermsen-Stiftung:

- Registrierung der Standorte
- Katalogisierung der Restvorkommen
- Handelsketten aufgezeigt
- Markt untersucht

B) Weitere Vorarbeiten für Empfehlungen zum Schutz natürlicher Populationen und der Regulierung der Nutzung:

1) Diskrepanz Verbreitungskarten – Standortkarten

2) Ökologisches Profil der Pflanze

3) Zeigerwerte

4) Qualität (z.B. phytochemischer Atlas)

5) Welche Faktoren beeinflussen Verbreitung ? z.B. Konkurrenz

6) Populationsdynamik (Problem Nachhaltigkeit der Hilfskräfte)

7) Dauerbeobachtungsflächen (Kooperation mit CONAF)

8) Zeitreihe Qualität, Variabilität

9) Mitwirkung der Bevölkerung (sozio-ökonomischer Aspekt)

10) Schutzzonenkonzept (in-situ-Schutz)

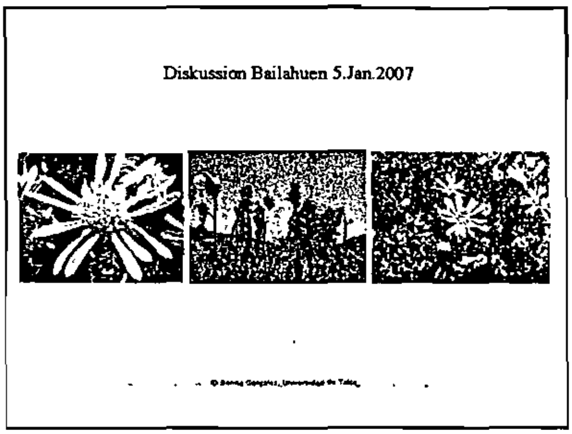
11) Training der Sammler

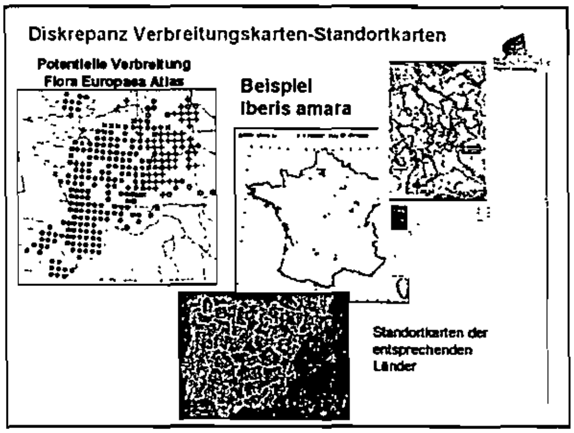
12) Legale Rahmenbedingungen und administrative Umsetzung

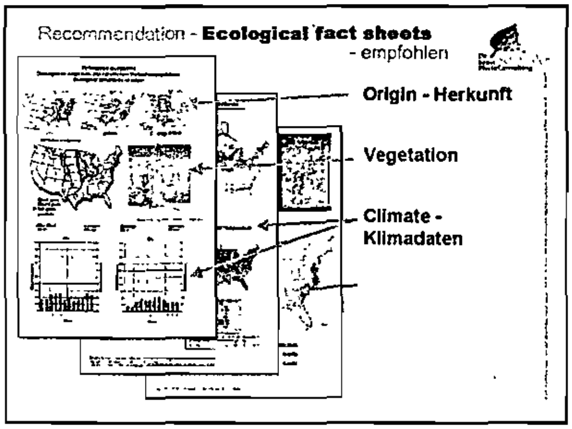
13) Ex-situ-Erhalt der genetischen Ressource (Genbank)

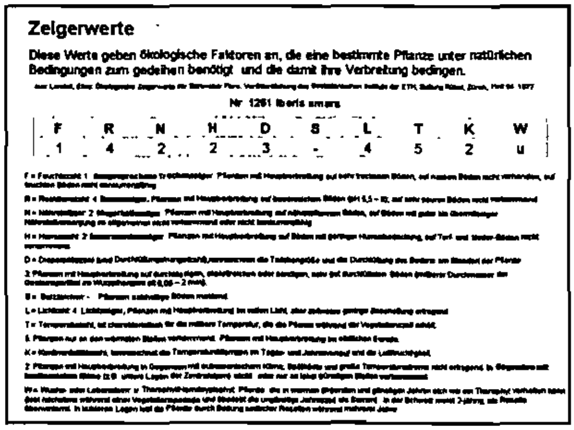
14) Domestikation

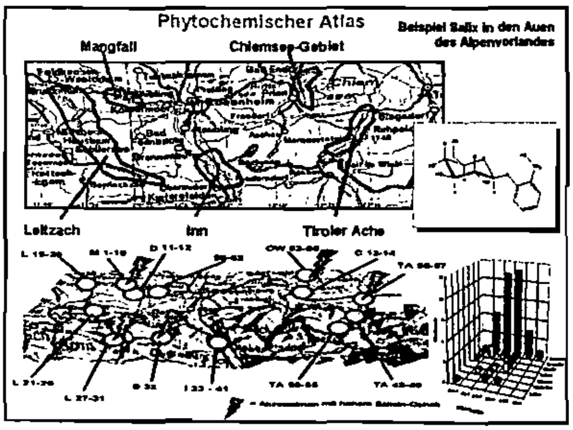
15) Endziel Anbau bei weiter steigendem Bedarf

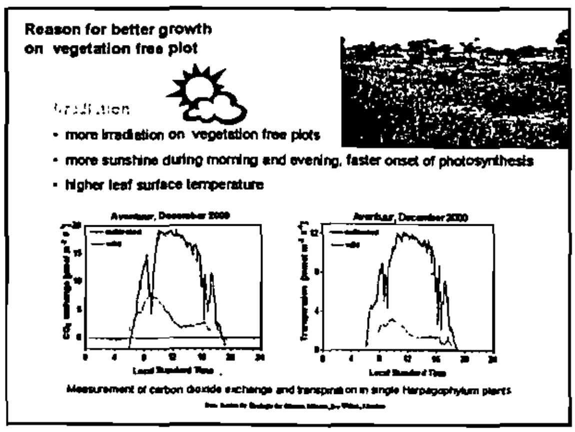

Diskussion Bailahuen 5.Jan.2007


Diskrepanz Verbreitungskarten-Standortkarten
Potentielle Verbreitung
Flora Europaea Atlas
Beispiel
Iberis amara
Standortkarten der
entsprechenden
Länder

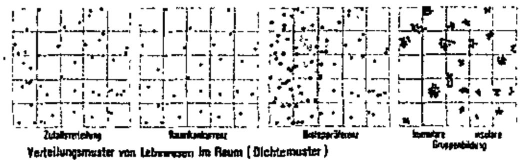

Recommendation - Ecological fact sheets
- empfohlen
Origin - Herkunft
Vegetation
Climate -
Klimadaten


Zeigerwerte
Diese Werte geben ökologische Faktoren an, die eine bestimmte Pflanze unter natürlichen Bedingungen zum gedeihen benötigt und die damit ihre Verbreitung bedingen.
Nr 1261 Iberis amara
F R N H D S L T K W
1 4 2 2 3 - 4 5 2 u


Phytochemischer Atlas
Beispiel Salix in den Auen
des Alpenvorlandes
Mangfall
Chiemsee-Gebiet
Leitzach
Inn
Tiroler Ache

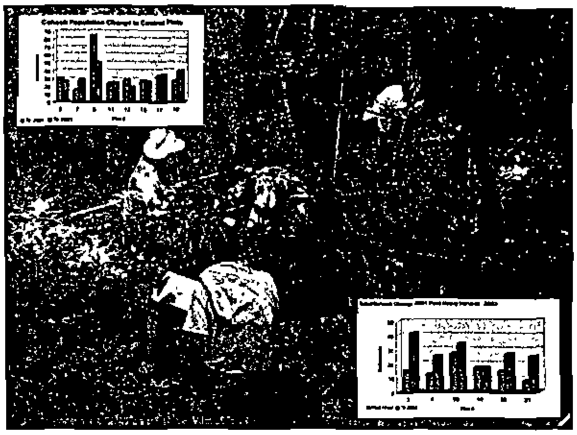

Reason for better growth
on vegetation free plot
• more irradiation on vegetation free plots
• more sunshine during morning and evening, faster onset of photosynthesis
• higher leaf surface temperature
Measurement of carbon dioxide exchange and transpiration in single Harpagophytum plants

Verbreitungsmuster , Pattern-forming



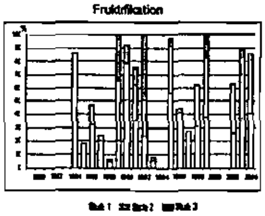
Verteilungsmuster von Lebewesen im Raum (Dichtemuster)

dtv - Atlas Biologie

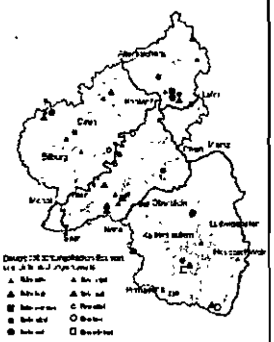


Buchen - Fläche 221A
Baumverteilungspläne

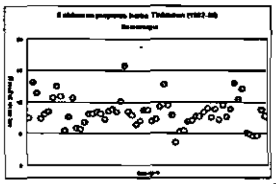
Fruktifikation



Dauerbeobachtungsflächen

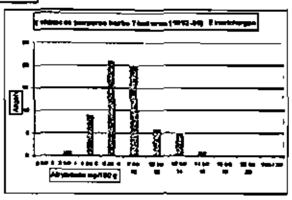


Zeitreihen Qualität - Variabilität



Gehalt von Chargen = Laborstatistik

Histogramm Gehalt von Chargen = Variabilität



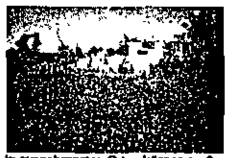
Artenschutz & Habitatschutz

Methodenansätze bei der Wildsammlung von Arzneipflanzen

Kroatien (war vor dem Balkankrieg) eines der wichtigsten Sammelgebiete

Behörden verweigern den alten Sammlern mit WWF-Argument die Sammelerlaubnis und Exportgenehmigungen für kriegszerstörte und danach verlassene Gebiete.

Traditionelle Sammlerfamilien, die das seit 150 Jahren machen, sind darauf angewiesen, sonst haben sie keinen Lebensunterhalt

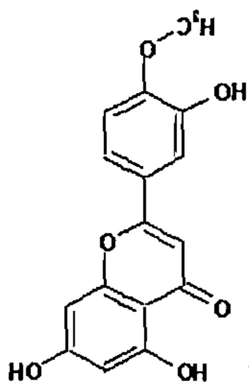


In ausgebrannten Orten können große Bestände an Taubnesselblüten und Brennnesseln gesammelt werden

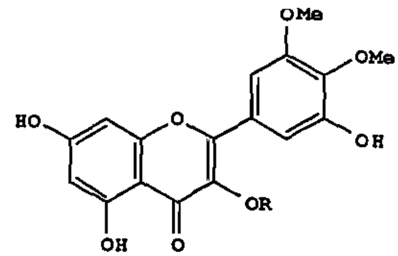
Problem der legalen Rahmenbedingungen und der administrativen Umsetzung

Diosmetin Vergleich mit Haplopappus

Diosmetin

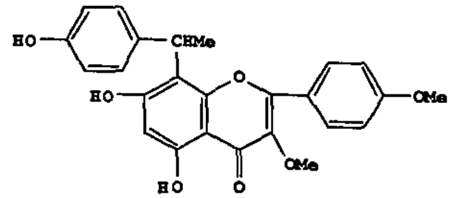


Haplopappus integerrimus var. punctatus
myricetin derivs I (R = H, Me)



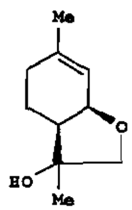
I

Haplopappin, an 8-(α -methylbenzyl)flavonoid from Haplopappus foliosus

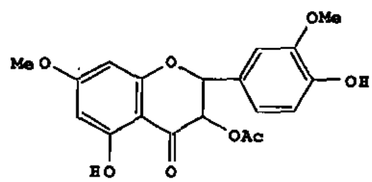


I

Haplopappus taeda Reiche



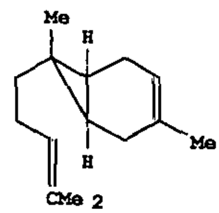
I



II

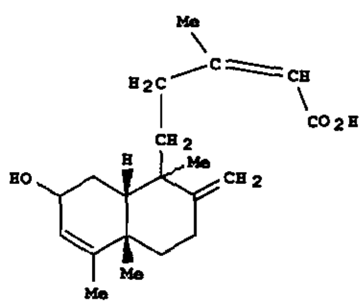
monoterpenoid taedol (I). new 3-acetoxyflavanone (II)

Isosesquicarene from Haplopappus tenuisectus



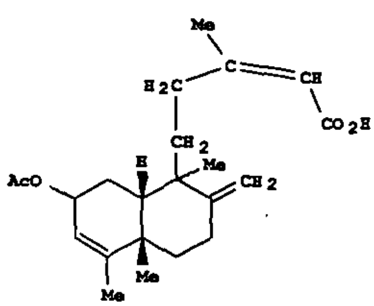
I

clerodane diterpenes from the surface of Haplopappus foliosus



I

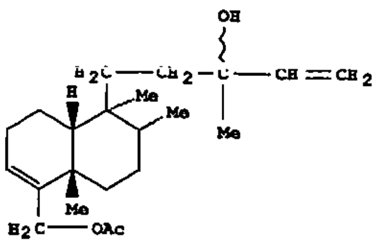
2-α-hydroxy-cis-cleroda-3,13(Z),8(17)-trien-15-oic acid



II

2-α-acetoxy-cis-cleroda-3,13(Z),8(17)-trien-15-oic acid

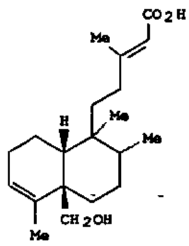
Diterpenoids from Haplopappus rigidus



I

rigidusol (I)

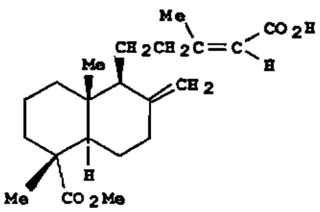
Clerodane diterpenes from Haplopappus deserticola



I

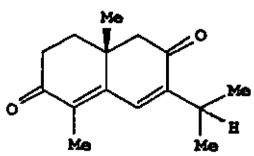
deserticolic acid (I),

resinous exudate of Haplopappus velutinus



I

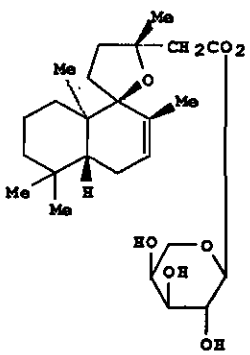
β -cyperone derivatives from Haplopappus freemontii.



8-oxo-β-cyperone (I),

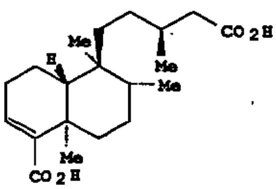
I

ent-labdanes, 9 from Happlopappus pectinatus, e.g. I (R = CH2OH; R1 = R2 = H).



I

dihydro-trans-clerodane diacid from Haplopappus ciliatus



haplociliatic acid (I)

I

European Crop Wild Relative **Diversity Assessment and Conservation Forum**

Welcome to the PGR Forum CD-ROM

Home
Introduction
CWR species
Project themes
Participants
Partner institutes
Publications
CWRIS
Meetings
CWR Conference
Web links
CD user information

The PGR Forum CD-ROM

The production of this CD-ROM has been made possible through funding from the European Community Fifth Framework Programme for Energy, Environment and Sustainable Development. The PGR Forum CD-ROM has been created to widely distribute and publicise the products of PGR Forum (European Crop Wild Relative Diversity Assessment and Conservation Forum).

The CD contains copies of:

- CWRIS: The PGR Forum Crop Wild Relative Information System, version October 2005
- The PGR Forum Crop Wild Relative Catalogue for Europe and the Mediterranean
- *Crop wild relative* Issues 1 to 5, the PGR Forum newsletter
- The PGR Forum web site and online publications

Information about the PGR Forum project can be found on the web pages on this CD. Follow the links from the menu on the left.

Crop wild relative and other online publications can be accessed via the link 'Publications'.

For an introduction to CWRIS and the PGR Forum CWR Catalogue for Europe and the Mediterranean click here.

For direct access to CWRIS and the PGR Forum Crop Wild Relative Catalogue for Europe and the Mediterranean follow the link 'CWRIS'.

Please note that access to and use of the information contained in CWRIS is strictly subject to the terms and conditions set out in the Legal Notice and Licence Agreement.

An online version of the PGR Forum web site can be viewed at: http://www.pgrforum.org

For online access to CWRIS go to: http://cwris.ecpgr.org

The online versions of CWRIS and the CWR Catalogue for Europe and the Mediterranean are subject to change over time. The copies published on this CD-ROM should therefore be viewed as snapshots of a system that is subject to ongoing development and updating.

System requirements

This CD-ROM software runs under Windows ME, 2000, or XP. It needs c. 500 MB when installed on the hard disk. Minimum memory: 128 MB. Recommended minimum memory: 512 MB.

This CD-ROM does not require a connection to the internet, but if your computer is connected to the internet, you will be able to access additional resources, from links within CWRIS and the PGR Forum web site.

Users may find that CWRIS runs slowly when accessed directly from the CD. To improve speed of use, users may wish to copy the contents of the CD onto their computer's 'C:' drive.

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Citation

Moore, J.D. and S.P. Kell (Editors) 2005. PGR Forum CD-ROM. University of Birmingham, UK.

Acknowledgement

The content of this CD-ROM is the result of collaborative efforts by all participants in the

PGR Forum project. A full list of names of PGR Forum participants can be found on the participants page.

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PGR Forum Home

European Crop Wild Relative Diversity Assessment and Conservation Forum

Publications

This page contains all available issues of *Crop wild relative* (the PGR Forum newsletter), case study handouts, workshop reports, poster presentations and other public documents.

The PGR Forum Crop Wild Relative Catalogue for Europe and the Mediterranean is available via the Crop Wild Relative Information System (CWRIS).

The PGR Forum CD ROM containing CWRIS and the contents of the public pages of this web site has been published and circulated with Issue 5 of *Crop wild relative*.

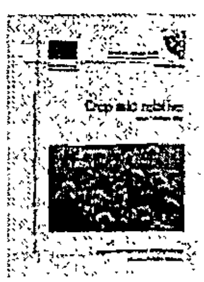
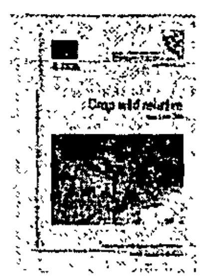
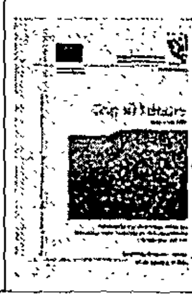
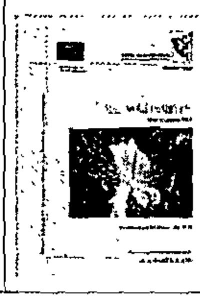
Workshop presentations and other work package documents are posted in the password protected project intranet.

Delegates at the First International Conference on Crop Wild Relative Conservation and Use can view oral presentations by clicking here (password protected).

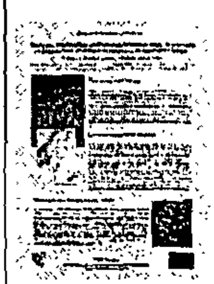
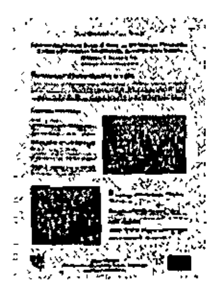
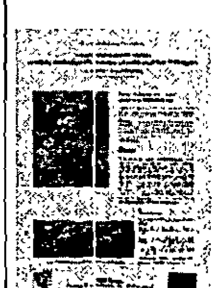
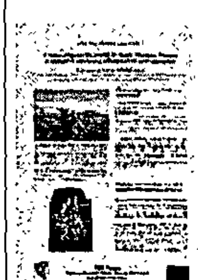
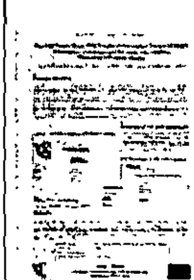
LINKS

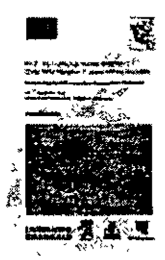
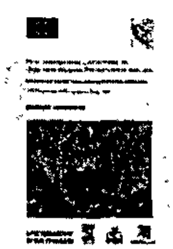
Newsletters | PGR Forum case study handouts | Workshop reports | Project documents | PGR Forum poster presentations | Research projects

First International Conference on *Crop Wild Relative* Conservation and Use: Programme | Book of abstracts | Poster presentations

NEWSLETTERS				
Crop wild relative Issue 1	*Crop wild relative* Issue 2	*Crop wild relative* Issue 3	*Crop wild relative* Issue 4	*Crop wild relative* Issue 5
PDF (1 MB)	PDF (1.8 MB)	PDF (3.2 MB)	PDF (1.3 MB)	PDF (640 KB)
				

Crop wild relative: Guidelines for Contributors	PDF (230 KB)	WORD (1.1 MB)

PGR FORUM CASE STUDY HANDOUTS				
Case study 1: Arnica	*Case study 2: Lupinus*	*Case study 3: Linum*	*Case study 4: Avena*	*Case study 5:* CWRIS
PDF (309 KB)	PDF (274 KB)	PDF (275 KB)	PDF (56 KB)	PDF (340 KB)
				

WORKSHOP REPORTS			
1. Report of Workshop 1: European crop wild relative assessment	PDF (2.7 MB)	WORD (3.4 MB)	PDF ZIP (1.1 KB) WORD ZIP (2.3 MB)
2. Summary report of Workshop 2: Threat and Conservation Assessment	PDF 161 KB		
3. Report of Workshop 3: *In Situ* Data Management Methodologies	PDF (500 KB)		
4. Report of Workshop 4: Population Management Methodologies	PDF (656 KB)		
5. Summary report of Workshop 5: Genetic Erosion and Pollution Assessment Methodologies	PDF (35 KB)		
PROJECT DOCUMENTS			
1. Description of Work	PDF (1.3 MB)	WORD (631 KB)	PDF ZIP (520 KB) WORD ZIP (88 KB)
PGR FORUM POSTER PRESENTATIONS			
1. Kell, S.P., N. Maxted and B.V. Ford-Lloyd 2004. Conservation of the threatened wild relatives of socio-economically important plants in Europe. 1.1 MB Poster presented at the Royal Society Scientific Discussion Meeting, *Beyond extinction rates: monitoring wild nature for the 2010 target*, 19-20 July 2004, London, UK and *Planta Europa: 4th European Conference on the Conservation of Wild Plants*, 17-20 September 2004, Valencia, Spain.	Abstract PDF (341 KB) Poster PDF (1.5 MB)		
2. Jury, S.L., S.P. Kell, H. KnOpffer, N. Maxted, and B.V. Ford-Lloyd 2004. PGR Forum, Euro+Med PlantBase and Mansfeld's Database: serving the crop wild relative user community. Poster presented at the 11th OPTIMA Meeting, 5-11 September 2004, Belgrade, Serbia and Montenegro.	Abstract PDF (58 KB) Poster PDF (2.6 MB)		
3. Kell, S.P., N. Maxted, B.V. Ford-Lloyd, C. Hilton-Taylor, C. Pollock and W. Strahm 2004. Crop wild relatives: a vital resource for a sustainable future. Poster presentation given at the 3rd IUCN World Conservation Congress, Bangkok, Thailand, November 2004	Poster PDF (1.8 MB)		
4. Kell, S.P., N. Maxted and B.V. Ford-Lloyd 2005. Crop wild relatives: a vital resource for a sustainable future. Poster presentation given at the Conservation and Sustainable Use of Dry Land Agrobiodiversity Conference, Aleppo, Syria, April 2005	Poster PDF (509 KB)		
First International Conference on *Crop Wild Relative* Conservation and Use	Programme (PDF 587 KB) 	Book of abstracts (PDF 772 KB) 	

First International Conference on *Crop Wild Relative* Conservation and Use		
POSTER PRESENTATIONS		
PGR Forum Case Studies		
Ecotypic exploration and characterization trials to promote conservation of *Arnica montana* L. in Northern Europe	Asdal, Å., J. Labokas, K. Olsson, J. Radušiene and	PDF (304 KB)

	K.W. Bladh	
Avena strigosa (Schreb.), a threatened crop wild relative of a historical crop	Podyma, W., M. Scholten and E. Bettencourt	PDF (254 KB)
Lupinus hispanicus Boiss. & Reut. in the Iberian Peninsula: a crop wild relative traditionally harvested for fodder	Iriondo, J.M., L. De Hond and M. Parra	PDF (600 KB)
The PGR Forum Crop Wild Relative Information System (CWRIS): information management for CWR populations, illustrated with case studies	Kell, S.P., J. Iriondo, N. Maxted, J. Moore, M. Scholten, A. Asdal, L. Frese, J. Labokas and Z. Stehno	PDF (248 KB)
Allium schoenoprasum subsp. *sibiricum* (L.) Richter in Central and Northern Europe	Stehno, Z., M. Scholten, J. Labokas, Å. Asdal and I. Chukhina	PDF (307 KB)
Linum dolomiticum Borbás, a strictly protected wild relative of cultivated flax in Hungary	Vörösváry, G., L. Holly and L. Udvardy	PDF (380 KB)
Session 1. CWR conservation and use: an overview		
The Italian national program to implement the International FAO Treaty on plant genetic resources for food and agriculture	Izzo, M., D. Avanzato and C. Fideghelli	PDF (266 KB)
Session 2. Establishing CWR inventories and conservation priorities		
Genetic diversity and phylogeographic structure of the genus *Vitis*: implications for conservation	Aradhya, M., B.H. Prins, G. S. Dangl, C. J. Simon and E. Stover	
Collecting of wild species in the National park Muran Plain	Benedikova, D. and P. Hauptvogel	PDF (2.2 MB)
Wild relatives for stone and pipe fruits and nuts in Georgia	Bobokashvili, Z., V. Kvaliashvili and K. Dzeria	PDF (1.0 MB)
Improvement exploitation and preservation of Sicilian vegetable genetic resources	Cartabellotta, D., and G. Spartà	
CWR: grapevine, small and minor fruits in Georgia (The Caucasus)	Chkhartishvili, N., D. Maghradze, K. Gogishvili and R. Tchipashvili	PDF (2.2 MB)
An overview on plant genetic resources in Albania, especially on crop wild relatives	Hyso, M., A. Salillari, T. Dishinica, F. Voci and R. Shehu	PDF (1.1 MB)
Investigation on trees biodiversity, growing in the Templum Valley of Agrigento	Leto Barone, G., C. Liotta and R. Sciarratta	
Concept for establishing an inventory of CWR in Germany	Roscher, S.	PDF (209 KB)
Conservation and utilization of officinal species germplasm in Sicily (Italy)	Tuttolomondo T., S. La Bella, I. Cammalleri, C. Leto, M. Licata and G. Gaeta	PDF(2.4 MB)
Conservation priorities for crop wild relatives in Hungary	Vörösváry, G., L.Holly and L.Horváth	PDF (1.1 MB)
Session 3. CWR threat and conservation assessment		
Helichrysum arenarium (L.) Moench conservation in Estonia	Pihlik, U.	
Session 4. Genetic erosion and genetic pollution of CWR		
The relationship between the agriculture modernization and the fruit genetic erosion observed by analysing the plants offer from the nurseries catalogues	Avanzato, D. and E. Raparelli	PDF (441 KB)
The importance of Sicilian phanerophytes as wild relatives of crop woody plants	Barbera, G., T. La Mantia and S. Pasta	
On the conservation of the endangered European crab apple (*Malus sylvestris*): threats from hybridization with domesticated apple (*Malus* × *domestica*)	Larsen, A. S., C. B. Asmussen, E. Coart, D. C. Olrik and E. D. Kjær	PDF (148 KB)
Session 5. *In situ* management and monitoring for CWR		
Monitoring of fruit wild relatives in Albania	Çarka, F., I. Çiçi, B. Ferraj and V. Vorpsi	PDF (658 KB)

Native litchi and their wild relatives: taxonomy gap, *in situ* conservation plan in Vietnam	Hoa, T.T. and L.T. Dinh	PDF (95 KB)
Microsatellites as a model for decision making in *in situ* management of wild beets	Poulsen, G., N. Syde and L. Dalgård	PDF (467 KB)
Identification of valuable populations of the widely distributed crop wild relatives using *Rubus idaeus* L. as an example	Ryabova, D.	PDF (492 KB)
In situ conservation in Peneda-Gerês National Park of Gerês lily (*Iris boissieri*), wild daffodil (*Narcissus pseudonarcissus subsp. nobilis*) and bastard balm (*Melittis melissophyllum*)	Silva, D. F. F. M., M. H. L. A. Tiago and A. S. C. Leite	
Session 6. *Ex situ* conservation of CWR		
Wheat wild relatives – a 25-year programme of *ex situ* conservation	Anikster, Y. and J. Manisterski	PDF (399 KB)
A national Italian network to improve seed conservation of wild native species ('RIBES')	Bonomi, C., G. Rossi and G. Bedini	PDF (198 KB)
Conservation and characterization of *Myrtus communis* germplasm	Bruna, S., C. Cervelli, A. Mercuri and B. Ruffoni	PDF (632 KB)
Tissue culture as a tool for *ex situ* conservation of wild pear: the role of exogenous carbohydrates	Caboni, E., M.A Palombi., C. Damiano and A. Frattarelli	PDF (6.7 MB)
Seed conservation studies in rare and threatened wild relatives of citrus in Australia	Hamilton, K.N., S.E. Ashmore and R.A. Drew	
Crop wild relatives in the Dutch genebank: importance and use	Hoekstra, R., W. van Dooijeweert and I.W. Boukema	PDF (963 KB)
Ex situ conservation of crop wild relatives in Hungary	Holly, L., G. Vörösváry and L. Horváth	PDF (2.8 MB)
Seed collections from nature for *ex situ* conservation	Horovitz, A.	PDF(210 KB)
Cryopreservation as a method of potato germplasm storage in gene bank	Kryszczuk, A. and E. Zimnoch-Guzowska	
The CNR Gene Bank of Bari Activities in Crop Wild Relatives	Perrino, P., V.F. Tomaselli, M. Terzi, G. Sarli, G. Maruca, L. Mallardi, I. Scarascia, M. Scarascia, P. Cataldo, K. Hammer and D. Lafiandra	PDF (71 KB)
Studies on CWR at the Institute of Plant Genetics	Pignone, D. and L. Monti	PDF (513 KB)
Genetic structure of island populations of wild cardoon [*Cynara cardunculus* L. var. *sylvestris* (Lamk) Fiori] detected by AFLPs and SSRs	Portis, E., A. Acquadroa, C. Cominoa, G. Mauromicaleb and S. Lanteri	PDF (983 KB)
The role of the Mediterranean species Botanic Garden (Agrigento district) played with the conservation and the valuation of the native botanic species	Sortino, M., A. La Mantia and S. Sortino	PDF (1.5 MB)
Session 8. CWR as gene donors for crop improvement		
The contribution of C.R.A. – "Istituto Sperimentale per la Floricoltura" – Palermo section to the conservation and exploitation of the native germplasm: the wild species collections of the *Limonium* genus (Plumbaginaceae) present in Sicily	Aprile, S. and A. La Mantia	PDF (1.4 MB)
Commercial utilization of the widespread Cornelian cherry (*Cornus mas* L.) population in Slovakia	Brindza, P., J. Brindza, D. Tóth and B. Stehlíková	PDF (654 KB)
Conservation of *Limonium* species and their use in a breeding program	Burchi, G. , E. Mercatelli, A. Mercuri, C. Bianchini and T. Schiva	PDF (402 KB)
The collection and conservation of wild mangifera species for the improvement of the commercial mango (*Mangifera indica* L.)	Campbell, R.	PDF (328 KB)
The wild olives of Sicily, their past and potential contribution to the improvement of the cultivated varieties	Cultrera G.M.N., L. Baldoni, A. Porceddu, C. Ricciolini and M.A. Germana	

Canada yew (*Taxus canadensis* Marsh.) and taxanes: a perfect species for field production and improvement through genetic selection	Daoust, G. and G. Sirois	PDF (58 KB)
Research on the volatile fraction in leaves of *Olea europaea* subsp.*oleaster* and *Olea europaea* subsp. *sativa*	Di Marco, L., M.A. Germanà, E. Palazzolo and F. Saiano	
Collecting and evaluation of wild *Medicago sativa* populations	Drobná, J. and P. Hauptvogel	PDF (1.9 MB)
Molecular and phytopathological characterization of natural populations of *Aegilops sharonensis* in Israel	Ezrati, S., E. Millet, J. Manisterski, P. Ben-Yehuda, M. Agami and Y. Anikster	PDF (392 KB)
Maintenance of and research on wild crop relatives at Department of Botany, Palacký University in Olomouc, Czech Republic	Lebeda, A., I. Doležalová, E. Křístková, B. Mieslerová, M. Duchoslav, P. Havránek and D. Vondráková	PDF (221 KB)
RAPD and ISSR fingerprinting in cultivated chickpea [*Cicer arietinum* (L.)] and wild species	Linga S. Rao, P. Usha Rani, P. S. Deshmukh, P. A. Kumar and S. K. Panguluri	
Fingerprinting of Sicilian cherry germplasm with Simple Sequence Repeats and incompatibility (S) locus primers	Marchese, A., R. I. Bošković, J. Clarke, A. Motisi, A. Raimondo, K. R. Tobutt and T. Caruso	PDF (194 KB)
Comparison of morphological characters in various accessions of *Solanum aethiopicum*	Oboh, B., O. Longe and C. Onejeme	
Influence of water deficit on SOD and POD accumulation in wild and cultivated olive tree	Satta, D., G. Nieddu and I. Chessa	
The secondary gene pool of Barley as gene donor for crop improvement	Scholz, M., B. Ruge-Wehling, A. Habekuß, G. Pendinen, O. Schrader, K. Flath, E. Große and P. Wehling	PDF (1.0 MB)
Utilization of Wild Relatives for commercial profitability in chickpea (*Cicer arietinum* L.)	Yadav, S.S.	
Session 9. Use of CWR and under-utilised species		
Evaluation of underutilised *Solanum americanum* lines	Adetula, O.A.	
Extraction of mulberry flavonoids for industrial and pharmacological use	Andreoni, N.	PDF (38 KB)
Diversity of wild and domesticated *Arracacia* species in Peru, as a unique reservoir to improve arracacha, one of the most promising Andean root and tuber crops	Blas Sevillano, R.H., A. Toussaint, M. Malice , M. Ghislain and J.P. Baudoin	
A methodology for conservation and sustainable use of the neglected/under-utilized tree species: *Q. ilex* subsp. *rotundifolia* (Lam) O. Schwarz.	Correia Sousa, C.M., N. Maxted and B. Ford-Lloyd	PDF (163 KB)
Identification and bio-agronomical study of seven biotypes of Azarole (*Crataegus azarolus* L.)	Giorgio, A., A. Gallotta and P. Losciale	PDF (773 KB)
Genetic variation in and between wild populations of *Origanum syriacum* in Israel	Hadas, R., O. Shmueli, S. Luhua, A. Sirota, T. Kroitor, G. Galiliand and N. Dudai	PDF (124 KB)
Diversity of under-utilized fruit species in West Bengal	Hasan, M.A and B.C. Das	
Establishment of a collection of *Salvia* with multipurpose potentialities	Ruffoni, B., C. Cervelli, A. Giovannini, C. Mascarello, M.C. Principato and A. Capponi	PDF (210 KB)
Domestication and field management trials of *Cicerbita alpine* (L.) Wallr.	Scartezzini, F., C. Vender, N. Aiello and P. Fusani	PDF (129 KB)

RESEARCH PROJECTS

Codd, R.B. 2005. Conservation action planning for UK crop wild relatives. A thesis presented to the Faculty of Science of the University of Birmingham in partial fulfilment of the requirements for the degree of Master of Research in Conservation Biology and Plant Genetics.	PDF 5.7 MB
Markkola, H. 2005. Regional Red List assessment and Biodiversity Action Plans for crop wild relatives in Ireland. A thesis presented to the Faculty of Science of the University of Birmingham in partial fulfilment of the requirements for the degree of Master of Science in Conservation and Utilisation of Plant Genetic Resources.	PDF 4 MB

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PGR Forum Home

Working Group on Medicinal and Aromatic Plants

Period covered under this report: 2004 – 2006

I. RESULTS

a. Comparison of workplan (milestones) versus obtained

Workplan (milestones)	Which results have been obtained	Which aims/goals have not been (fully) reached?	Completeness ratio (%)
1. MAP WG Meetings 2nd in 2004 3rd in 2007	The 2nd MAP WG meeting has been organized in Strumica (16-18 December 2004), Macedonia, review of the work done within each of the member countries, work plan (2005-2007) has been recommended	Report not ready, expected at the end of 2006	90 %
2. Development of descriptors for in situ and ex situ conservation for 10 model species (*Achillea millefolium agg., Artemisia absinthium, Carum carvi, Gentiana lutea, Hypericum perforatum, Melissa officinalis, Mentha spp., Origanum vulgare, Salvia officinalis, Thymus spp.)* *(2004 – 2006)*	5 categories of descriptors (Passport - accession descriptors + collecting descriptors; Management; Environment and Site, Characterization and Evaluation) have been identified, 4 categories elaborated, harmonized and used in surveying MAP distribution on the national levels of member countries as well as in characterization /evaluation of genetic resources	Management descriptors have not been elaborated. Refining of descriptor lists is expected to be achieved by the end of 2006	90 %
3. Monitoring (surveying) *in situ* and collecting of seed material (2004 – 2008)	Made in 2005 and ongoing activity in 2006; Specimens provided to the MAP genebank collections	-	100 %
4. *Ex situ* conservation and regeneration of autochthonous MAP accessions in the member countries (2005 – 2008)	Made in 2005 and ongoing activity in 2006	-	100 %
5. Submission of collaborative project proposal (RESGEN 06) (2005 or 2006) MAP conservation strategies	Planned for submission in 2006	Proposal not applied in 2005	-
6. Update and proactive management of the relational database by WG Chair 2006 - 2008	Ongoing activity on the Natonal level (Slovenia) 2005, 2006, coordinated by Chair of the WG	Upgrading of information (database) system presently limited to one country, external funds needed for international database	20 %

b. Contribution to the four ECP/GR priorities for Phase VII
1. Characterization/evaluation (including modern technologies) Due to the lack of biological knowledge on characterization and evaluation of MAP species, descriptor lists, based on current professional and scientific findings, have been developed for 10 model MAP species (*Achillea millefolium agg., Artemisia absinthium, Carum carvi, Gentiana lutea, Hypericum perforatum, Melissa officinalis, Mentha spp., Origanum vulgare, Salvia officinalis, Thymus spp.).* In member countries MAP accessions are successively characterized/evaluated according to their morphological, chemical and cytological characteristics, defined in a crop specific descriptors. The results are expected to be presented during the third WG Meeting in 2007. At that occasion a professional discussion is needed in order to find the most appropriate molecular tools for assessment of genetic variability among populations of 10 target species.
2. Task sharing At the second MAP WG meeting in Strumica (December, 2004) responsibilities for compilation of species-specific descriptors lists were shared among following members: *Achillea millefolium agg.*- Dea Baričevič (Slovenia); *Artemisia absinthium* - Stephen Jury (UK); *Carum carvi* - Karel Dusek (Czech Republic); *Gentiana lutea* - Dea Baričevič (Slovenia); *Hypericum perforatum* - Jolita Radušienė (Lithuania); *Melissa officinalis* - Jenő Bernáth (Hungary); *Mentha* x *piperita* and *M. spicata* Ana Maria Barata (Portugal); *Origanum* spp. - Jenő Bernáth (Hungary), *Salvia officinalis* - Hajri Haska/Tatjana Dishnica (Albania); *Thymus vulgaris* and *T. serpyllum* - Ana Maria Barata (Portugal). The elaborated descriptor lists were distributed among all WG members. After revision, the final drafts were distributed to WG members as working protocols.
3. In situ/on farm conservation and development Protocols for assessing the natural distribution of natural populations of target MAP species have been developeded. Each country should (dependent on disposal of national funds) make an inventory and survey on distribution pattern of the autochthonous populations of 10 model species. The survey results on distribution of MAP populations, on the degree of potential endangerness and data on eco-geographical characteristics of natural habitats were registered. The seed material from native populations were collected, recommendations on regeneration of seed/vegetative material were dispatched, so member countries had opportunity to regenerate the collected material, seed it into *ex situ* collections for characterization/evaluation in 2006.
4. Documentation and information The background information on EURISCO descriptors of registered populations/accessions obtained during national surveys, which should be sent to national focal point coordinators, were provided to WG members.
c. Relevance (regional/international)
Information on surveys and mapping of MAPs in member countries will enable regional and international review of distribution and estimation of abundance of natural populations of 10 model species, together with registration/evaluation of eco-geographical data on their natural habitats and monitoring the impacts with bad influence on the status of observed populations. Such a review will enable estimation of the level of endangerness of target species in the European region and in case of noticed biodiversity drop, actions should be undertaken to control or remove the factors that cause the threats, the detailed management or recovery should be planned and implemented through natural resource managers, local communities and policy makers.
d. Lessons learnt (recommendations)
Collecting, Environment and Site descriptors, as well as approaches, developed for survey (expedition) purposes, could be used by members of other WG or Networks (for example *In situ* Network, Sugar, Starch and Fibre Crops Network).

II. ANALYSIS	
a. Bottlenecks	
What were the experienced bottlenecks?	How do you plan to solve the bottlenecks?
1. Time consuming morphological, chemical and citological characterization/evaluation.	Getting external funds for additional man power.

2. Problems with purification of DNA and molecular markers for identification of genetic variability among populations.	Application of international project with special emphasis on developing rapid and cost efficient molecular tools for screening of genetic variability among populations of MAP species with high content of fenolic compounds.
2. Lack of experiences and literature references for development of management descriptors	Setting up experiments on maintenance of genetic material, study of floral biology of 10 model species, study of environmental impacts and post-harvest handling on seed viability.
3. Providing apropriate standard or reference cultivars (standard varieties) for *ex situ* evaluation	The key for selection of standard varieties and distribution pattern will be determined at the next MAP WG meeting in 2007 (Czech Republic).
4. National financing insufficient	Application of international projects.
b. Internal support needed (Secretariat, Steering Committee, other Working Groups, etc.)	
The Group considers necessary to provide an internal support in order to enable participation of WG members from some of the South-Eastern European Countries to the 4th Symposium on Breeding research on MAPs, which will be held in Slovenia in 2008. The agenda of the Symposium cover all relevant topics which are important for understanding MAP conservation issues, pre – and post-harvest activities and processing of genetic material (diversity evaluation, conservation biology, maintenance of genetic material; post-harvest handling of wild/domesticated material; reproduction biology; conventional breeding; molecular markers and genetic engineering; special analytical methods for breeding,...). This is the reason why the symposium is supposed to be organized under the auspices of the IPGRI and/or ECP/GR. Due to a high registration fee (450 EUR) participants of at least following South-Eastern European Countries: Albania, Bulgaria, Estonia, Georgia, Latvia, Lithuania, Macedonia (FYR), Romania, Montenegro, Serbia, could not attend to the Symposium, unless internally supported.	
c. External resources needed (collaboration, external funding)	
Upgrading of information system (relational database) is presently limited to one country, external funds are needed to develop international database. The database incorporates all Environment and Site descriptors, Characterization and Evaluation descriptors (up to now for 10 model species). The data (survey data, specimen characters, environment and site descriptions, ...) management system anticipates a standardized input/output formats. Continuation and proactive management of the database and its internationalization has been foreseen for ECP/GR Phase VIII with the collaboration/support of all MAP WG members, Documentation & Information Network and Sugar, Starch and Fibre Crops Network.	
III. PLANS	
a. Planned activities	b. Expected results
Refining the descriptor lists of target 10 model species (2006 – 2008)	Distribution and abundance of natural populations *in situ* registered, eco-geographical data of natural populations analysed, characterization and evaluation data obtained for *in situ* specimen or *ex situ* accessions.
Development of management descriptors, elaboration of technical design and protocols for implementation of techniques, needed either for generative or vegetative regeneration of descendants of native populations (2006-2008)	Regeneration of autochthonous plant material and conservation in *ex situ* collections.
Review and corrections of the criteria for election of next group of priority/model species in member countries (2007 – 2008)	The list of MAP species that need urgent conservation in European region
Development of a model approach used for estimation/identification of wild species that indicate a trend in economic importance in member countries (2007-2008).	Promotion of domestication of wild species that indicate a trend in economic importance in member countries, independently on the species endangerness status.

Preliminary remarks

The following list of descriptors has been developed based on other Descriptor Lists produced by IPGRI. It has been adapted according to the decisions made at the first meeting of the ECP/GR Working Group on Medicinal and Aromatic Plants (MAPs)[1] and further discussions held at the second meeting of the Working Group (Dec. 2004, Strumica, Macedonia). The descriptors belong to the following categories:

Con formato: Numeración y viñetas

I. **Passport descriptors (accession descriptors + collecting descriptors):** these provide the basic information used for the general management of the accession (including registration at the genebank and other identification information) and describe parameters that should be observed when the accession is originally collected.
II. **Management descriptors (management descriptors + multiplication/regeneration descriptors):** technological instructions needed for the management of accessions within a genebank for their regeneration and multiplication
III. **Environment and Site descriptors:** describe the environmental and site-specific parameters that are important when characterization and evaluation trials are held
IV. **Characterization descriptors:** crop-specific. Characterization will normally be the responsibility of genebank curators
V. **Evaluation descriptors:** crop-specific

Within IPGRI's Descriptor Series, IPGRI encourages the collecting of data from the first four categories – *Passport, Management, Environment and Site*, and *Characterization* – that should be available for any accession.

Categories IV and V (Characterization and Evaluation) are developed on a crop-specific level and are not included in the present document. Characterization and Evaluation Descriptor lists are under development for the priority species identified by the MAP Working Group.

The descriptors belonging to the multicrop passport descriptors category are indicated in the text as [MCPD][2]. These 27 descriptors are mandatory to ensure compatibility with the EURISCO format and are not to be modified.

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1 Baričevič, D., J. Bernáth, L. Maggioni and E. Lipman, compilers. 2004. Report of a Working Group on Medicinal and Aromatic Plants. First meeting, 12-14 September 2002, Gozd Martuljek, Slovenia. International Plant Genetic Resources Institute, Rome, Italy.

2 Alercia, A., S. Diulgheroff and T. Metz. 2001. List of Multicrop Passport Descriptors. FAO (Food and Agricultural Organization of the United Nations)/IPGRI (International Plant Genetic Resources Institute) (http:/www.ipgri.cgiar.org).

DRAFT DESCRIPTORS LIST *Artemisia absinthium* L.

Locality: Country, GPS
Date:
Specimen Nr. (in case of *in situ* characterization):
Accession Nr. (in case of *ex situ* characterization/evaluation):

Literature used:
(I) = J. Genet. & Breed. 49:319-326 (1995),
(II)= Folia Geobotanica 2003. 38, 333-343,
(III)= Planta Medica. 2003. 69: 2, 158-161.

To make a correct plant description it is necessitated:
- measurements made on 20-25 individuals in both *ex situ* and *in situ*,
- under *ex situ* condition:
  - a) the seeds are sown in greenhouse,
  - b) seedlings of 10-12 cm height are planted out,
  - c) spacing of seedlings is 60 x 40 cm
  - d) irrigation and fertilization is applied by local experiences (amounts should be documented)
  - e) the soil-type used for growing should be analyzed and documented,
  - e) manual weeding
  - f) drying of fresh material at 40°C

	Characterization	
	In situ	*Ex situ*
7.4 Morphological descriptors		
7.4.1 Plant descriptors		
7.4.1.1 Developmental stage		
1 – Vegetative stage		
3 – Butonization		
5 – Beginning of the blooming		
7 – Full bloom		
9 – After blooming		
11 – Seed maturity		
7.4.1.2 Growth habit (I)		
1 – Prostrate		
2 – Erect		
7.4.1.3 Number of stems per plant (I)		
7.4.1.4 Plant height (cm) (I)		
7.4.1.5 Variability of population (I)		
1 - High (very heterogeneous)		
3 - Medium (relative homogeneous)		
5 - Low (homogeneous)		
7.4.2 Stem		
7.4.2.1 Branching of stem		
1 – Sparse		
3 – Medium		

5 – Dense		
7.4.2.2 Color of the stem (using RHS Color Chart or as bellow)		
1 – Green		
3 – Reddish –green		
5 – Reddish		
7.4.2.3 Number of internodes (from the ground to the first flowering node)		
7.4.2.4 Length of the longest internode (cm)		
7.4.2.5 Density of foliage		
1 – Sparse		
3 – Medium		
5 – Dense		
7.4.3 Leaf (on the base of the longest internode; measurements made not less than on 30 leaves)		
7.4.3.1 Leaf shape		
1 – Whole		
3 - Three times dissected		
5 - Lower leaves twice dissected		
7 - Two to three times dissected		
7.4.3.2 Leaves peduncle		
1 - Present		
3 – Not present		
7.4.3.3 Shape of the flowering stem leaves		
1 - the majority whole		
3 - the majority dissected		
7.4.3.4 Shape of leaf segments		
1 – Obtuse		
3 - Rounded		
5 – Sharpen		
7.4.3.5 Segments width (mm)		
7.4.3.6 Lower leaves at blooming time		
1 - Not present		
3 – Present		
7.4.3.7 Lower leaves		
1 – Sessile		
3 – Petiolate		
7.4.4 Flowering stem		
7.4.4.1 Distance between the ground and the first flowering node (cm)		
7.4.4.2 Number of capitula in terminal inflorescence		
7.4.4.3 Length of capitulum (mm)		
7.4.4.4 Width of capitulum (mm)		
7.4.4.5 Ratio length/width		

7.4.5 Seed	**if present**	
7.4.5.1 Weight of 1000 seeds (g)		
7.4.5.2 Germination (in %)		
7.4.5.3 Seed yield per plant (g)		
7.5 Cytological characters		
7.5.1 Number of chromosomes (ploidity number)(II)		
2n= 18		
2n= 36		
7.6 Chemical characters		
Essential oil content (%)		
Essential oil contain mainly (III):		
1 - (Z) – epoxyocimene and chrysanthenyl acetate		
3 - (Z) – epoxyocimene and ß – thujone		
7.7 Yield descriptors	**Evaluation**	
7.7.1 Age of the plant		
7.7.2 Flowering period (recorded in days) (I)		
1 - Early flowering (1-15 July)		
3 - Medium flowering (15-31 July)		
5 - Late flowering (1-15 Avgusr)		
7 - Very late flowering (15-31) avgust		
7.7.3 Fresh biomass per plant in g (I)		
7.7.4 Dry biomass per plant in g (I)		
7.7.5 Plant yield (kg/ha) (I)		
7.8 Biotic stress susceptibility		
7.8.1 Presence of disease (I)		
1 - Present		
3 - Not present		

DRAFT DESCRIPTORS LIST *Salvia officinalis* L.

Locality: Country, GPS
Date:
Specimen Nr. (in case of *in situ* characterization):
Accession Nr. (in case of *ex situ* characterization/evaluation):

Literature used:
(I) Essent. oil. Res., 4, 291- 293) (May/Jun 1992),
(II) Acta horticulturae 576, april 2002: 180- 187,
(III) J. Agric. Food Chem., 47 (5), 2048-2054, 1999

To make a correct plant description it is necessitated:
- measurements made on 20-25 individuals in both *ex situ* and *in situ*,
- application of control cultivar 'Extracta',
- under *ex situ* condition:
    a) the seeds are sown in a greenhouse,
    b) seedlings of 10-12 cm height are planted out,
    c) spacing of seedlings is 50 x 50 cm
    d) irrigation an fertilization is applied by local experiences (amounts should be documented)
    e) the soil-type used for growing should be analyzed and documented,
    e) manual weeding
    f) drying of fresh material at 40 °C
- the quantity of essential oil has to be determined by steam distillation, as defined in Ph. Eur. IV, and the quality of essential oil by GC.
- Seed testing procedures has to be the same as recommended by ISTA.

Descriptors	Characterization	
	In situ	***Ex situ***
7.4 Morphological descriptors		
7.4.1 Plant		
7.4.1.1 Developmental stage		
1 – Vegetative stage		
3 – Butonization		
5 - Beginning of blooming		
7 – Full bloom		
9 – After blooming		
11 – Seed maturity		

Below please find comments on questions (marked with yellow, blue or green colour) regarding "Proposal for a MAP Descriptor List", that left open after our second meeting in Strumica.

Our suggestions are highlightened with grey colour

Comment I:

Under preliminary remarks of proposal, when listing types of descriptors, we propose using Roman numerals before the name of descriptor, in order to avoid confusion with Arabic numerals within categories of individual descriptors.
So, preliminar remarks would be as follows:

Preliminary remarks

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IV. **Characterization descriptors:** crop-specific. Characterization will normally be the responsibility of genebank curators

V. **Evaluation descriptors:** crop-specific

Con formato: Numeración y viñetas

Comment II:

1.10.1 Synonyms

Include here any previous identification other than the current name. Collecting number or newly assigned station names are frequently used as identifiers

DESCRIPTOR 1.10.1 IS CANDIDATE FOR DELETION, SINCE DESCRIPTOR 1.10 ALREADY ALLOWS FOR MULTIPLE NAMES. COMMENTS FROM THE WG MEMBERS ARE WELCOME

MAP SubGroup: KERR

[redacted]

[1] Baričevič, D., J. Bernáth, L. Maggioni and E. Lipman, compilers. 2004. Report of a Working Group on Medicinal and Aromatic Plants. First meeting, 12-14 September 2002, Gozd Martuljek, Slovenia. International Plant Genetic Resources Institute, Rome, Italy.

CAPITULO VII: FLORA

RECURSOS BIÓTICOS (BIODIVERSIDAD)

Conceptos Generales

El Concepto de biodiversidad

Una primera aproximación a la problemática asociada a la biodiversidad o diversidad biológica necesariamente requiere consensuar qué entendemos por biodiversidad. En este contexto, el concepto más comúnmente aceptado es que la biodiversidad es la variabilidad de los organismos presentes en un sitio y los complejos ecológicos en los cuales estos organismos viven. Adicionalmente se reconoce que existen cuatro distintos niveles de organización en los cuales opera tal diversidad, esto es a) nivel genético, el que considera la variabilidad genética de cada especie b) nivel específico, es decir el número de especies de un área determinada, c) nivel ecosistémico, que incluye el número de ecosistemas que dichas especies conforman y finalmente d) los biomas.

Crisis de la Biodiversidad

En la historia de la vida en el planeta han ocurrido cinco grandes eventos de extinción masiva, la más popular es aquella en que desaparecieron los dinosaurios (cerca de 60 millones de años atrás). Algunos investigadores creen que actualmente estamos presenciando el sexto mayor evento de extinción en la historia de la vida y a diferencia de los eventos de extinción temprana, los cuales fueron debido probablemente a cambios en el ambiente físico causado por factores como el impacto de meteoro o pulsos de volcanismo, este evento actual esta siendo originado por el hombre. Opera a través de modificaciones que el ser humano está provocando en el planeta a través de cambios en el uso del suelo, invasión de especies, alteración y destrucción de hábitat y cambios atmosféricos y climáticos.

A tal punto llega este gran evento de pérdida de diversidad biológica, que las actuales tasas de extinción de especies son entre 100 y 1.000 veces mayores a los niveles que existían antes de la aparición de la especie humana (niveles prehumanos), valores que podrían aumentar drásticamente si se incluye la extinción esperada de las especies que actualmente están en peligro de extinción.

Origen y distribución de las especies

De acuerdo a su origen y actual distribución, las especies pueden ser clasificadas como:

Endémicas: Son todas aquellas especies propias o exclusivas de un área o país determinado. Por ejemplo, son especies endémicas de Chile la palma (*Jubaea chilensis*), la garra de león (*Leontochir ovallei*), la tenca (Mimus thenca) y la chinchilla chilena (*Chinchilla lanigera*).

Nativas: Se refiere a aquellas especies que viven naturalmente en un área, la que puede incluir a más de un país, por ello no son exclusivas, sino indígenas. En plantas también se les llama "autóctonas". Por ejemplo, el puma (*Felis concolor*) vive en gran parte de América y es nativo en Chile, asi como lo es el guanaco (*Lama guanicoe*), el maitén (*Maytenus boaria*) y el bailahuén (*Haplopappus baylahuen*) entre muchos otros.

Introducidas o Adventicias: Se denomina a aquellas especies que fueron transportados a un nuevo hábitat por los seres humanos o por cualquier cirscunstancia fortuita. En nuestro país son introducidas la alfalfa (Medicago sativa),

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Investigarán los secretos ancestrales del maqui y el bailahuén

Investigadores de la Universidad de Chile analizarán las características químicas, farmacológicas y toxicológicas del maqui y el bailahuén, dos de las plantas medicinales nativas más utilizadas, para comprobar sus efectos benéficos y validar su uso en la industria medicinal

Las hojas del maqui y el bailahuén serán investigadas durante un año completo con el objetivo de caracterizar y certificar las propiedades químicas, farmacológicas y toxicológicas de estas dos especies nativas de Chile, y cuyos resultados servirán para elaborar una monografía sobre el bailahuén y para comprobar las cualidades antioxidantes, antiinflamatorias y antimicrobianas del maqui.

El estudio estará en manos de investigadores y académicos de la Facultad de Química y Farmacia de la Universidad de Chile, quienes recibirán financiamiento de la Fundación para la Innovación Agraria, del Ministerio de Agricultura, y su meta será la de identificar los principios activos presentes en las hojas del Haplopappus baylahuen Remy (bailahuén) y el Aristotelia chilensis (maqui).

Gabriela Casanova, jefa de Estudios y Proyectos de FIA, explica que "estas investigaciones contribuirán a generar información validada que no existía en el país y que servirá para completar el conocimiento científico existente sobre las especies y promover el aprovechamiento sustentable de estos recursos, al mismo tiempo de describir y difundir sus cualidades farmacológicas y sus usos terapéuticos".

Del bailahuén, los investigadores medirán, entre otros factores, la actividad hepatoprotectora (protección del hígado), su efecto antiinflamatorio, tanto en aplicaciones tópicas como administrado por vía oral, y la actividad antibacteriana, descrita en infecciones intestinales, urinarias y cutáneas.

Por su parte, las hojas del maqui serán investigadas para caracterizar sus compuestos activos y su potencial antiinflamatorio, analgésico, antioxidante y antimicrobiano. Además, se comprobará si las hojas de la Aristotelia podrían ser utilizadas como fuente de nuevos fármacos o productos dermatológicos para ser utilizados por la industria farmacéutica nacional.

Los estudios incorporarán ensayos preclínicos y trabajo multidisciplinario, a fin de acotar y comprobar al máximo la descripción de los principios activos de estas especies. Entre otros avances, se detallará la composición química y las propiedades farmacológicas y toxicológicas científicamente comprobadas. Paralelamente, se dispondrá de métodos de análisis morfológicos y químicos de la droga vegetal que permitan establecer formas de reconocimiento y control en su recolección, expendio y utilización.

El equipo estará conformado por botánicos, químicos, biólogos, químico-farmacéuticos, fotoquímicos e inmunólogos. También trabajarán alumnos como memoristas y en unidades de investigación de los programas de postgrado.

Klingenberg, Lieselotte:

Monographie der südamerikanischen Gattungen *Haplopappus* Cass. und *Notopappus* L. Klingenberg (Asteraceae - Astereae)

VIII, 334 Seiten, 230 Abbildungen, 30 Tabellen
(Bibliotheca Botanica, Heft 157)

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Peumus boldus Mol.

Prepared by
Gloria Montenegro Professor of Botany
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Pontificia Universidad Catolica de Chile
Santiago Chile

Workshop of MAPs National Focal Points
Trieste, Italy
30 May, 2005

Peumus boldus Mol.

Botanical name with authority and synonyms: *Peumus boldus* Mol.
***Boldea boldus* (Mol.) Looser.**
Family: Monimiaceae. Only species of the genus in Chile.

Common name in trade: Boldo, boldo de Chile

SERIE
FORESTAL
N° 10

PRODUCTOS FORESTALES NO MADEREROS EN CHILE

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Mélica Muñoz Schick, Museo Nacional de Historia Natural

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GRUPOS FUNCIONALES EN ARBUSTOS DESERTICOS DEL NORTE DE CHILE, DEFINIDOS SOBRE LA BASE DE LAS FUENTES DE AGUA UTILIZADAS*

FUNCTIONAL GROUPS IN NORTH CHILEAN DESERT SHRUB SPECIES, BASED ON THE WATER SOURCES USED

Francisco A. Squeo[1], Nancy Olivares[1,2], Sandra Olivares[1], Alberto Pollastri[3], Evelyn Aguirre[3], Ramón Aravena[4], Carmen Jorquera[1] y James R. Ehleringer[5]

RESUMEN

La productividad primaria y la estructura de la vegetación en ecosistemas áridos están determinadas por la disponibilidad de agua. En un estudio realizado en el secano costero del norte-centro de Chile (29•43'S; 71•14'O, 300 m) se compararon los mecanismos de utilización de distintas fuentes de agua por las especies arbustivas, en dos años con precipitaciones contrastantes. Se entregan antecedentes de estudios fenológicos, de arquitectura radicular y de las fuentes de agua utilizadas por arbustos mediante el uso de isótopos estables. Se reconocen 6 grupos funcionales basados en la obtención y utilización del agua. Los grupos funcionales fueron definidos en base a su hábito (deciduo y siempre-verdes), sus sistemas radiculares (superficial, dimórfico o profundo) y a la capacidad de utilizar distintas fuentes de agua (superficial y/o profunda). Debido al impacto diferencial sobre los distintos grupos funcionales, se postula que el sobre pastoreo con caprinos resultaría en una menor utilización de aguas superficiales. Un plan de manejo y/o restauración debería maximizar la utilización de todas las fuentes de agua disponibles para recuperar la productividad primaria y la estabilidad del sistema.

PALABRAS CLAVES: fuentes de agua, proporción de isótopos estables, δ^2H, $\delta^{18}O$, zonas áridas, relaciones hídricas, fenología, sistema radicular, Desierto de Atacama, Chile.

ABSTRACT

Primary productivity and vegetation structure in arid ecosystems are determined by water availability. In a study conducted in the coastal dryland of north-central Chile (29•43'S, 71•14'O, 300 m), the mechanisms to use different water sources by shrubs species, in two contrasting rainfall years were compared. Information on phenological studies, root architecture and water sources used by shrubs through the use of of stable isotopes is brought. Six functional groups based on water uptake and water use are recognized. The functional groups were defined based on their habits (deciduous and evergreen), their root systems (shallow, dimorphic and deep), and their ability to use different water sources (surficial and/or deep). Because of the differential impact of the goat overgrazing on different functional groups, this would result on a lower utilization of surficial waters. A management plan and/or restoration should maximize the use of all water sources availables to recover the primary productivity and the system stability.

KEYWORDS: water sources, stable isotope ratio, δ^2H, $\delta^{18}O$, arid zone, water relations, phenology, root system, Atacama Desert, Chile.

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INTRODUCCION

La definición de grupos funcionales provee una herramienta efectiva para analizar la diversidad de respuestas ecofisiológica en los ecosistemas naturales (Chapin 1993, Körner 1993, Larcher 1995, Lambers et al., 1998). Originalmente, un "grupo funcional" fue definido como un conjunto de especies que cumplen un cierto rol funcional en el ecosistema (Cummins 1974, MacMahon et al., 1981, Hawkins et al., 1989). Sin embargo con el tiempo se ha utilizado como sinónimo de gremio (sensu Root 1967), al incoporar en la definición la forma en que se utilizan los recursos (Mengue et al., 1986). Root (1967) define "gremio" como "un grupo de especies que explotan la misma clase de recurso ambiental de una manera similar". Simberloff & Dayan (1991) plantean que el estudio de grupos de especies que utilizan recursos similares de una manera similar, independientemente de como se llamen, ayudará a resolver la pregunta de como las interacciones interespecíficas conducen la coevolución en la naturaleza. A pesar de que se requiere de una evaluación crítica del significado de cada característica que se considera con relevancia ecológica para la existencia de una planta en un ambiente particular, es posible distingir tipos funcionales ecofisiológicamente diferentes (Körner 1993, Larcher 1995). Los esquemas de estrategias ecológicas / fisiológicas (por ejemplo, formas de vida (*sensu* Raunkiaer 1934); triángulo de competencia - estrés - perturbación (Grime 1977); formas de crecimiento (Chapin 1993, Larcher 1995); tipos funcionales de economía hídrica (Larcher 1995) permiten describir el funcionamiento del componente biológico del ecosistema en términos de un número limitado de grupos funcionales, y de esta forma facilitar su análisis (Lambers et al., 1998).

El agua es el recurso más importante que influencia la productividad primaria y la estructura de la vegetación en ecosistemas áridos (Whittaker & Niering 1975, Hadley & Szarek 1981, Ehleringer & Mooney 1983, Smith & Nobel 1986, Polis 1991, Gutiérrez 1993, Squeo et al., 1994b, 1998, Reynolds et al., 1999). Sin embargo las especies pueden responder diferencialmente a los eventos de precipitación (Ehleringer et al., 1991). Especies con diferentes formas de vida aparentemente difieren en su capacidad de utilizar ciertos eventos de precipitación. Mientras los arbustos leñosos con raíces profundas presentan baja habilidad para utilizar agua desde las capas superficiales del suelo, muchas especies herbáceas pueden usar esta fuente de humedad para su crecimiento y reproducción (Ehleringer et al., 1991). La disponibilidad de agua afecta directamente las características del intercambio de gases y la productividad, la interacción entre las especies y la estructura de la comunidad (Barbour 1969, Mooney et al., 1974, Ackerman 1979, Hadley & Szarek 1981, Ehleringer & Mooney 1983, Arroyo et al., 1988, 1993, Osmond et al., 1990, Chapin 1993, Squeo et al., 1994a).

La baja productividad del recurso forrajero a consecuencia de la escasez de agua es reconocido como uno de los factores más importantes que limita la producción de los caprinos en el norte chico de Chile, principal fuente de proteína animal y recurso económico con que cuentan sus comunidades agrícolas (Meneses 1991, 1993, Meneses et al., 1990). Por lo tanto, el conocimiento de la fuente de agua que utilizan los arbustos nativos es fundamental para los planes de restauración / incremento de la productividad del secano costero de la región. El aumento de la productividad vegetal en estos sectores depende, en parte, de optimizar la utilización de las fuentes de aguas disponibles (aguas subterráneas, neblina, precipitaciones). El cambio en la composición y abundancia de especies vegetales a consecuencia del sobre pastoreo y extracción de leña, probablemente ha resultado en una menor capacidad de captura de agua para la producción de materia seca. Una reducción en la cobertura de arbustos puede significar, además, una menor infiltración de agua y capacidad de colecta de neblinas, incremento en la tasa de evaporación y lavado de nutrientes, etc. (Keeley & Johnson 1977, Jaksic & Montenegro 1979, Gutiérrez et al., 1992).

El objetivo de este trabajo es definir grupos funcionales en base a comparar los mecanismos de utilización de distintas fuentes de agua que presentan las especies arbustivas del desierto costero del norte-centro de Chile.

Los antecedentes que se entregan en este trabajo incluyen información publicada o en preparación referente a estudios fenológicos (Olivares & Squeo, 1999); arquitectura radicular (Olivares et al., 1998, Olivares & Squeo, en preparación) y fuentes de agua utilizadas por arbustos mediante el uso de isótopos estables (Squeo et al., en preparación).

SITIO DE ESTUDIO

El estudio fue realizado en la Quebrada El Romeral ubicada a 29°43' S y 71°15' O, 300 msnm, a 21 km al norte de la ciudad de La Serena (Fig. 1).

CLIMA

La Quebrada El Romeral se ubica dentro de la región climática tipo mediterráneo-árido con influencia de neblinas. La precipitación promedio anual en La Serena de los últimos 16 años bordea los 90 mm (Fig. 2). Durante este período, son frecuentes los años con precipitaciones inferiores a los 50 mm (años secos) en comparación a los escasos años lluviosos (con precipitaciones por sobre los 200 mm). Estos últimos se encuentran asociados a ENSO (El Niño Southern Oscillation) (Maya & Arriaga 1996, Jorquera et al., en preparación).

Antecedentes de este siglo muestran que la precipitación en La Serena, calculado como la media móvil de 30 años, ha caído desde valores promedio cercanos a los 170 mm a principios de siglo hasta cerca de 80 mm en la actualidad (Fig. 3). La precipitación media histórica para La Serena es de 114,4 mm. Mientras la precipitación se concentra en los meses de invierno, el aporte de agua por neblina se hace más importante en primavera (Jorquera et al., en preparación).

Las temperaturas promedio mensuales fluctúan entre los 12,4°C y 21,7°C. Las temperaturas abso-lutas varían entre los 4,4°C y 30,2°C. La Humedad Relativa promedio mensual varia entre 70 y 80%

VEGETACIÓN

La cobertura vegetal de especies arbustivas en la Quebrada El Romeral varía entre un 20 y 30%, con cambios en las especies dominantes (Squeo et. al., 1990). En las planicies del sitio de estudio, la especie dominante es *Haplopappus parvifolius*, seguida de *Senna cumingii* y *Pleocarphus revolutus*. En las quebradas, las especies dominantes más importantes son *Pleocarphus revolutus* y *Senna cumingii*. En las laderas de exposición norte, dominan *Heliotropium stenophyllum, Haplopappus parvifolius, Opuntia miquelii y Cordia decandra*, mientras que en las laderas de exposición sur, las especies dominantes son *Haplopappus parvifolius, Balbisia peduncularis, Proustia cuneifolia y Baccharis paniculata.*

RESULTADOS Y DISCUSION

RESPUESTA FENOLÓGICAS

Las especies arbustivas estudiadas por Olivares y Squeo (1999) pueden agruparse básicamente en dos grupos funcionales respecto a su similitud temporal en el crecimiento vegetativo. En este estudio fenológico de dos años de duración (1996, pp= 46,6 mm; 1997, pp= 233,4 mm), se separan claramente las 5 especies siempre verdes (incluyendo a *Senna cumingii*, potencialmente considerada decidua de sequía extrema), de las restantes especies deciduas (Fig. 4). Dentro de las especies deciduas, 8 de las 9 especies estudiadas por Olivares y Squeo (1999) iniciaron su actividad vegetativa en forma sincrónica, luego de las primeras precipitaciones invernales, y presentaron una actividad vegetativa de mayor magnitud y duración luego de un invierno lluvioso, indicando su mayor dependencia de las precipitaciones.

El agua es uno de los factores abióticos más importantes en el crecimiento de la planta y el inicio de las fenofases (Beatley 1974, Kemp 1983, Kramer & Boyer 1995). En el ecosistema desértico costero del norte-centro de Chile, las precipitaciones se concentran en los meses de invierno, generando condiciones favorables para desarrollar los procesos reproductivos (Mooney et al., 1974). La precipitación de invierno es el mejor predictor de germinación masiva en el desierto costero del norte-centro de Chile (Vidiella 1992). A los 30°S, la cantidad total de precipitación se encuentra sobre el umbral mínimo de germinación una vez cada dos años, y a los 27°S una vez cada cinco años. Squeo et al. (1994b) muestran que la forma de crecimiento de *Encelia canescens* y la magnitud del crecimiento se correlacionan positivamente con las precipitaciones ocurridas en un gradiente de aridez en el norte-centro de Chile.

En otras regiones desérticas, las precipitaciones también son un factor que regula el crecimiento y los eventos reproductivos (Beatley 1974, Kemp 1983, Grazanfar 1997, Keya 1997, 1998). Según Beatley (1974), los eventos fenológicos en el Desierto de Mojave y la mayoría de los fenómenos biológicos son indirecta o directamente dependientes de las precipitaciones, donde usualmente son gatillados por lluvias mayores a 25 mm. Para una comunidad de arbustos desérticos del noroeste de México, Maya y Arriaga (1996) muestran que las especies se pueden agrupar de acuerdo a su producción de estructuras vegetativas en relación a la disponibilidad de agua, y que estas son afectadas diferencialmente por años excepcionalmente húmedos asociados a ENSO. En el Desierto de Omán, el inicio y la duración del crecimiento y la floración en todos los grupos funcionales están también correlacionados con la ocurrencia y la magnitud de las precipitaciones (Grazanfar 1997).

En nuestro sistema, la primera lluvia invernal significativa sincroniza el inicio del crecimiento, lo que se traduce en una alta similitud de las fenofases vegetativas entre las especies. Sin embargo, a medida que avanza la estación de crecimiento, las fenofases reproductivas son cada vez más disimiles. Este resultado sugiere una menor influencia de las precipitaciones en determinar las fenofases de floración y fructificación. Sobre estas fenofases podrían haber actuado otros factores selectivos adicionales (e.g., depredación, polinización, dispersión, competencia interespecífica, temperaturas extremas, sequía) (Arroyo et al., 1981, 1985, 1988; Rathcke & Lacey 1985; Herrera 1986; Rozzi et al., 1989; Jones 1992; Kramer & Boyer, 1995; Willson et al., 1995; Notzold et al., 1998). En un estudio de demografía inferido por los anillos de crecimiento realizado por Milton et al. (1997) en el desierto de Koroo en Sudáfrica, se mostró que las precipitaciones explicaban sólo el 33% de la variación en reclutamiento. Estos autores sugieren que otros factores, como la reducción de competencia por sequía o pastoreo, podrían tener una gran influencia en los patrones de reclutamiento.

ARQUITECTURA RADICULAR

Los arbustos estudiados presentan cuatro arquitecturas radiculares básicas: sistema radicular superficial, superficial suculento, dimórfico y profundo (Fig. 5, Olivares et al., 1998). Una interpretación parsimoniosa de estos patrones sugiere que las especies con sistema radicular profundo utilizarían primariamente agua subterránea, las especies con sistema radicular superficial utilizan el agua de las precipitaciones, mientras que las con sistema radicular dimórfico tendrían acceso a ambas fuentes de agua. Las especies con sistema radicular superficial suculento, junto con utilizar las precipitaciones, tienen la capacidad de almacenar el agua en sus tejidos.

La mayoría de las especies caducifolias poseen un sistema radicular superficial o dimórfico, teniendo potencialmente acceso a una fuente de agua superficial. Por otro lado, las especies perennifolias poseen arquitecturas radiculares superficial, dimórfica o profunda (Olivares et al., en preparación). Nuestros resultados indican que, independiente de la arquitectura radicular, todas las especies presentaron la mayor actividad vegetativa en los meses de invierno - primavera, y los mínimos a fines de verano y otoño. Adicionalmente, luego de un invierno lluvioso, todas las especies presentaron una mayor duración de la estación de crecimiento.

Estudios de excavación de plantas de desierto han mostrado que las raíces pueden ocupar probablemente todas las zonas del suelo que son anualmente recargadas con agua, que unas pocas penetran hasta el nivel freático, y que las raíces de las plantas anuales están limitadas a la capa superior del suelo (Cannon, 1911; Forseth et al., 1984; Cody, 1986; Manning & Barbour, 1988; Manning & Groenveld, 1989). Sin embargo, otros autores (e.g. Drew 1979; MacMahon & Schimpf, 1981) sugieren que la excavación de raíces *per se* ha contribuido muy poco al entendimiento de las fuentes de agua utilizadas por diferentes especies. El hecho que la mayoría de la biomasa radicular se localice en las capas superiores del suelo no significa que todas esas raíces están funcionalmente activas para absorber agua o que el agua siempre es extraída de esa zona. Por ejemplo, la mayoría de las raíces de *Artemisia tridentata* están localizadas a menos de un metro de profundidad, sin embargo raíces profundas (> 3 m) y de pequeño diámetro, son importantes para la absorción de agua durante los meses de verano (Caldwell & Richards 1989; Caldwell 1990). Esto puede significar que raíces de diferentes profundidades poseen diferentes propósitos funcionales, por ejemplo, las raíces profundas podrían ser primariamente para la absorción de agua mientras que las raíces superficiales servirían para la absorción de nutrientes.

LAS FUENTES DE AGUA DE LAS PLANTAS DE DESIERTO

Las especies vegetales en los ecosistemas áridos son sensibles a eventos episódicos (1-10 años) tales como prolongados períodos de sequía o inusuales períodos de alta precipitación, los que pueden resultar en importantes cambios fisiológicos y dramáticas modificaciones en la composición de la comunidad (Stockton & Meko, 1975; MacMahon & Schimpf, 1981; Vidiella & Armesto, 1989; Turner, 1990; Vidiella, 1992; Armesto & Vidiella, 1993). La sobrevivencia de las especies perennes durante prolongados períodos de sequía es producto de la habilidad de las raíces para adquirir el agua remanente en el suelo y de la habilidad de la parte aérea de tolerar estrés hídrico (MacMahon & Schimpf, 1981; Ehleringer, 1985; Smith & Nowak, 1990). Con una aparente menor variación interanual, la neblina costera es potencialmente una importante fuente adicional de agua para las especies herbáceas y leñosas de estos ambientes, que adicionalmente modera las temperaturas y disminuye el déficit de presión de vapor y consecuentemente la tasa de transpiración (Mooney et al., 1980; Aravena & Acevedo, 1985; Aravena et al., 1989; Ingraham & Matthews, 1990; Rundel et al., 1991; Vidiella, 1992; Arroyo et al., 1993; Gutiérrez, 1993; Dawson, 1998). Adicionalmente, en algunos ecosistemas de desierto costero, agua proveniente de la neblina puede infiltrar en el suelo y recargar el sistema de agua subterránea (Clark et al., 1987; Ingraham & Matthews, 1990). El agua subterránea es también una potencial fuente de aguas para especies con sistemas radiculares profundos. Por ejemplo, en un trabajo pionero en Chile, Aravena y Acevedo (1985) mostraron que *Prosopis tamarugo* de la Pampa del Tamarugal estaba utilizando sólo agua subterránea. A pesar de esta información, la importancia relativa de cada fuente de agua a nivel comunitario es virtualmente desconocida.

En la Quebrada El Romeral, las potenciales fuentes de agua para las plantas son las lluvias invernales, las neblinas, y el agua presente en el suelo profundo y/o de agua subterránea (Squeo et al., en preparación). La composición de isótopos estables de hidrógeno y oxígeno en el agua provee una útil herramienta para determinar las fuentes de agua utilizadas por las plantas (Ehleringer & Dawson, 1992). En el trabajo de Aravena y Acevedo (1985), las ramas de *P. tamarugo* tenían un valor de δ^2H = -60‰, muy cercano al del agua subterránea (• 62‰), y distante del agua atmosférica (-106‰) y del suelo (-52‰).

Nuestros datos de Quebrada El Romeral (1996 - 1998) muestran que la neblina tiene un δ^2H que oscila entre los -2‰ y -18‰, con un promedio de -11‰. La lluvia puede ser dividida en dos grupos, las más débiles con δ^2H generalmente cercanos a -25‰, y las mas importantes cercanas a -42‰. El agua subterránea también puede ser dividida en dos grupos, las obtenidas de los pozos situados hacia tierra adentro (Quebrada Romeral, entre -37‰ y -46‰, promedio -41‰); y las más cercanas a la costa con δ^2H que oscilan entre los -92‰ en los años secos y los -81‰ luego de un invierno lluvioso, indicando mezcla de aguas de dos orígenes distintos. La principal fuente de agua de los pozos cercanos a la costa son de origen cordillerano (i.e., el agua del Río Elqui tiene un δ^2H= -101‰), y contribuye en distintos porcentajes agua proveniente de la Quebrada Romeral (• 41‰). Dada su composición isotópica, el acuífero de Quebrada El Romeral sería recargado por las grandes precipitaciones que ocurren asociadas a los eventos ENSO. En nuestro sistema, las aguas provenientes de las neblinas o de las lluvias someras parecen no tener influencia en estos acuíferos. En contraste, los valores de δ^2H encontrados en el agua subterránea de El Tofo (-33‰) y Fray Jorge (-30‰) estarían indicando una contribución de la neblina al agua subterránea en esas dos localidades costero-montañosas. El bajo contenido de tritio en el agua subterránea de Fray Jorge y de Quebrada El Romeral indica que su tiempo de permanencia en el acuífero es mayor a 35 años (Aravena et al., 1989, Jorquera et al., en preparación).

Los contenidos isotópicos del agua extraída de tallos de 14 especies arbustivas que habitan en fondo de quebrada muestran el uso directo de dos fuentes de agua: las primeras asociadas a un estrato superficial no superior a los 50 cm de profundidad (zona del suelo recargada directamente por las precipitaciones) y otras a un estrato más profundo que se asocia a aguas más profundas y/o subterránea (Tabla I). Esta tendencia se mantiene en los años secos (1994-1996, pp < 50mm), sin embargo, en un año inusualmente lluvioso asociado a un evento ENSO (1997, 233 mm), todas las especies son capaces de utilizar directamente el agua de lluvia (Squeo et al., en preparación). Esta respuesta oportunista en años lluviosos de las especies leñosas independiente de su hábito y/o sistema radicular también ha sido documentada en otras comunidades desérticas (e.g., Reynolds et al., 1999). Por último, en nuestros datos no se evidencia una contribución directa del agua proveniente de las neblinas al agua que es transpirada por las plantas.

Para un desierto frío al sur de Utah, Ehleringer et al. (1991) mostraron que todas las especies perennes (herbáceas, leñosas y suculentas) utilizaban el agua caída durante el invierno. Sin embargo, durante el verano, sólo las especies anuales y suculentas de la comunidad respondieron y utilizaron exclusivamente las precipitaciones de verano. Las especies perennes herbáceas y leñosas usaron diferentes mezclas de aguas caídas en verano e invierno (las perennes herbáceas usaron un 91% de las lluvias de verano y las leñosas un 57%). Basados en estos datos, Ehleringer et al. (1991) postularon que los cambios en la precipitación de verano, predichos por los modelos de cambio climático global, resultarían en un incremento paulatino en la frecuencia de las especies perennes herbáceas y suculentas, mientras que la frecuencia de las especies leñosas podría disminuir.

También se han documentado cambios estacionales de las fuentes de agua que utilizan especies leñosas en otras comunidades (por ejemplo, *Pinus edulis, Juniperus osteosperma, Artemisia tridentata, Ambrosia dumosa, Encelia farinosa* en Norte América, y *Pistacia lentiscus, Phyllirea angustifolia, Quercus ilex* en Europa), otras especies no utilizan las lluvias de verano, siendo capaces de obtener el agua desde niveles más profundos del suelo (por ejemplo, *Chrysothamnus nauseosus, Acacia greggii, Cercidium floridum, Chilopsis linearis, Ephedra viridis* en Norte América, y *Q. pubescens, Q. cerris* en Europa) (Ehleringer & Cook, 1991; Flanagan & Ehleringer, 1991; Flanagan et al., 1992; Valentini et al., 1992).

Gregg (1991) entregó evidencias de un cline en la capacidad de respuesta a las lluvias de verano en una especie arbórea. A lo largo de un gradiente geográfico, donde la fracción de precipitación de verano varía entre el 18% y el 40%, Gregg (1991) observó que los árboles de *Juniperus osteosperma* responden a la lluvia de verano sólo en los sitios con considerable precipitación de verano. No es sorprendente que exista una variación ecotípica en la estructura de la raíz a lo largo de un gradiente geográfico, pero es poco usual la sugerencia sobre la falta de una respuesta inducida por las lluvias de verano en esos árboles de zonas áridas (Gibson & Nobel, 1986).

LEVANTAMIENTO HIDRÁULICO

El levantamiento hidráulico se refiere a la redistribución de agua realizada a través de los sistemas radiculares desde las capas profundas hacia los niveles más secos cercanos a la superficie del suelo (Richards & Caldwell, 1987). En la actualidad existe evidencia de levantamiento hidráulico en más de 30 especies (Caldwell et al., 1998). Este proceso puede mejorar significativamente el estado hídrico y nutricional de la planta, así como puede proveer beneficios a sus vecinos (Caldwell & Richarson, 1989; Caldwell, 1990; Dawson, 1996; Dawson & Pate, 1996; Caldwell et al., 1998). Entre las ventajas del levantamiento hidráulico se encuentran el proveer humedad a las capas superiores del suelo lo que facilita la actividad y sobrevivencia de un sistema radicular fino superficial, así como mejora las condiciones biogeoquímicas que estimulan los procesos microbianos y la biodisponibilidad de nutrientes (Caldwell et al., 1998). Por otro lado, Burgess et al. (1998) demostraron recientemente que el agua caída durante la estación lluviosa puede ser transportada por las raíces desde la superficie húmeda hacia los horizontes más profundos, fenómeno conocido como levantamiento hidráulico reverso. En nuestro sitio de estudio, dos especies muestran evidencia indirecta de levantamiento hidráulico, ambas especies son siempre verdes y con sistemas radiculares dimórficos. Durante las excavaciones de los sistemas radiculares de *Pleocarphus revolutus* y *Senna cumingii* se encontraron a profundidades intermedias (i.e., 30-120 cm) estratos con mayor contenido gravimétrico de agua (4-5%), los que coincidían con la ramificación lateral de estos sistemas radiculares. Por sobre y bajo estos estratos, el suelo tenia mucho menor contenido de agua (ca. 1%). No descartamos que otras de las especies estudiadas presenten este fenómeno.

GRUPOS FUNCIONALES

Puesto que el agua es el primer factor limitante de la productividad primaria en ecosistemas, es posible postular una mayor productividad en condiciones de mayor diversidad de grupos funcionales basados en la obtención y utilización de este recurso limitante, tal como lo plantea Tilman et al. (1996, 1997). Por otro lado, una mayor estabilidad del ecosistema se produciría en condiciones de mayor redundancia de especies dentro de cada grupo funcional (Naeem & Li 1997). En nuestro sistema, los grupos funcionales pueden ser definidos en base a su hábito (deciduo y siempre-verdes), sus sistemas radiculares (superficial, dimórfico o profundo) y en la capacidad de utilizar distintas fuentes de agua (superficial y/o profundo). Basados en estos aspectos, en el sistema estudiado se pueden reconocer 6 grupos funcionales básicos (Tabla I).

Entre las especies arbustivas perennifolias se encuentran:

a) aquellas con sistema radicular profundo capaces de utilizar agua profunda. En este caso se encuentra *Haplopappus parvifolius*, especie que es dominante en los llanos, y co-dominante en los fondos de quebrada.

b) con sistema radicular dimórfico, capaces de utilizar ambas fuentes de agua, y potencialmente realizar levantamiento hidráulico re-movilizando agua subterránea hacia las capas más superficiales del suelo.

c) con sistema radicular superficial, capaces de explotar intensivamente los estratos superficiales e intermedios del suelo.

Entre las especies de arbustos caducifolios se presentan:

d) con sistema radicular superficial utilizan sólo agua proveniente de las precipitaciones invernales desde las capas superficiales del suelo.

e) con sistema radicular superficial suculento, capaces de utilizar y almacenar en sus tejidos el agua desde las capas superficiales del suelo.

f) con sistema radicular dimórfico y/o profundo, que utilizan ambas fuentes de agua, dependiendo de su disponibilidad.

Implicancias para planes de manejo y restauración ecológica.

Entre las causas de la pérdida de productividad primaria en el norte-centro de Chile están el sobre pastoreo y la extracción de leña, los que habrían provocado un cambio en la composición y abundancia de especies, y una reducción potencial de la cobertura arbustiva (Squeo et al., 1990).

Las especies arbustivas consumidas por el ganado caprino pertenecen a los grupos funcionales de las caducifolias con sistema radicular superficial (e.g., *Bridgesia incisifolia*), superficial suculento (e.g., *Oxalis gigantea*) y dimórfico (e.g., *Balbisia peduncularis* y *Flourensia thurifera*), y en menor medida a las perennifolias con sistema radicular superficial (e.g., *Ephedra chilensis*). En el otro extremo, las especies no palatables integran a perennifolias y caducifolias con sistema radicular dimórfico o profundo. En consecuencia, el sobre pastoreo podría resultar en una menor utilización de aguas superficiales. Esta misma tendencia se observa en otras comunidades vegetales de zonas áridas. Agnew (1997) indica que el sobre pastoreo reduce la cobertura de gramíneas, grupo funcional con sistema radicular superficial, reduciéndose de esta forma la capacidad de utilizar pequeños pulsos de precipitación.

En ausencia casi completa de especies arbóreas en este sistema, la extracción de leña se concentra en arbustos leñosos con madera dura. Entre las especies estudiadas más utilizadas para leña se encuentran *Cordia decandra* (caducifolia, superficial) y *Ephedra chilensis* (perennifolia, superficial).

Un plan de manejo y/o restauración debería tender a maximizar la utilización de todas las fuentes de agua disponibles para recuperar la productividad primaria y la estabilidad del sistema. Esto se lograría a través de reforzar los grupos funcionales más afectados, y a las especies facilitadoras (e.g., que presentan levantamiento hidráulico, fijadoras de nitrógeno). Estos planes deben considerar además el escenario futuro, que incluye aspectos tan disímiles como las tendencias climáticas (e.g., disminución de las precipitaciones) y cambios socio-culturales (e.g., promoción de la crianza intensiva del ganado caprino en vez de extensiva).

INTERACCIONES INTER ESPECÍFICAS

Para entender la dinámica de una comunidad vegetal se requiere profundizar en el conocimiento de cada grupo funcional y de sus interacciones. Suponemos que las interacciones ecológicas entre especies de un mismo grupo funcional definido en base al mecanismo de adquición y uso de un recurso limitante (por ejemplo, agua, nutrientes) deberían ser más estrechas que entre especies de diferente grupo funcional. Sin embargo, fenómenos como el levantamiento hidráulico podrían resultar en interacciones de facilitación entre especies de distintos grupos funcionales.

La variación inter anual en las precipitaciones, una característica intrínseca de los sistemas desérticos, establece otra fuente de variación a las presiones selectivas que están operando. Briones et al. (1998) mostró que la intensidad de la competencia inter específica por agua depende de la disponibilidad de agua en el suelo. Especies de tres grupos funcionales del Desierto de Chihuahua no compiten por agua en años con baja precipitación, sin embargo aparecen interacciones negativas luego de lluvias intensas (Briones et al. 1998).

Un reto adicional al estudio de las interacciones entre y dentro de grupos funcionales en los ámbitos de la co evolución y la dinámica de los ecosistemas desértico lo imponen las rápidas fluctuaciones climáticas en el contexto del cambio global. Una pregunta abierta que habría que evaluar en términos de composición de especies y productividad primaria, es cuáles serán las consecuencias a nivel comunitario en el largo plazo de la disminución paulatina de la precipitación en el centro-norte de Chile.

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Fecha de publicación: 30 de junio de 1999

Tabla 1.- Relación entre la fuente de agua utilizada y las características de hábito y sistema radicular en 14 especies arbustivas del desierto costero del norte-centro de Chile, 30°S.

Código	Especie	Hábito[1]	Sistema Radicular[2]	Fuente de Agua[3]			
				Jul 96	Nov 96	Abr 97	Jul 97
Bi	*Bridgesia incisifolia*	D	s	-	A	-	-
Cc	*Calliandra chilensis*	D	s	-	A	A	-
Cd	*Cordia decandra*	D	s	-	A	-	-
Ec	*Encelia canescens*	D (SV)	s	-	A	-	A
Ep	*Ephedra chilensis*	SV	s	B?	A	A	B?
Hs	*Heliotropium stenophyllum*	SV	s	B	B	AB	B
Og	*Oxalis gigantea*	D, TF, PF	ss	-	A	-	-
Ls	*Lobelia polyphylla*	D	ss	-	A	-	-
Bp	*Balbisia peduncularis*	D	d	-	A	AB	-
Ft	*Flourensia thurifera*	D	d	-	A	-	-
Pr	*Pleocarphus revolutus*	SV	d	B	B	B	B
Sc	*Senna cumingii*	SV (D)	d	B	B	B	B
Hp	*Haplopappus parvifolius*	SV	p	B	B	B	B
Pc	*Proustia cuneifolia*	D	p	-	B	-	A

[1] Hábito: D decidua, SV siempre-verde, TF= tallo fotosintético, PF peciolo foliar fotosintético (peciolo foliar persiste por un tiempo luego de la caída de la hoja) (según Olivares & Squeo, 1999).
[2] Sistema radicular: s= superficial, ss= superficial suculento, p= profundo, d= dimórfico (ver Fig. 5, según de Olivares et al. 1998).
[3] Fuente de Agua: en base al análisis de composición isotópica se diferencian dos estratos: A (superficial) y B (profundo). (según Squeo et al., en preparación).

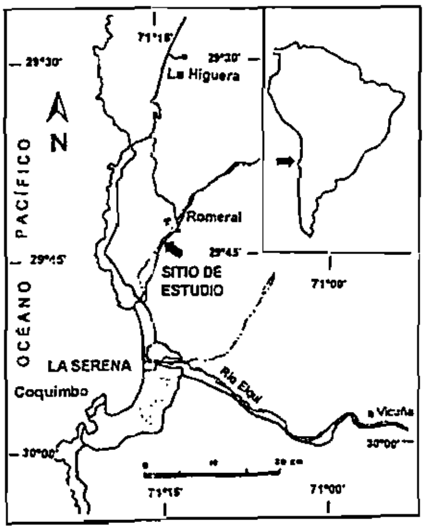

FIG. 1. Localización del sitio de estudio, Quebrada El Romeral, norte-centro de Chile.

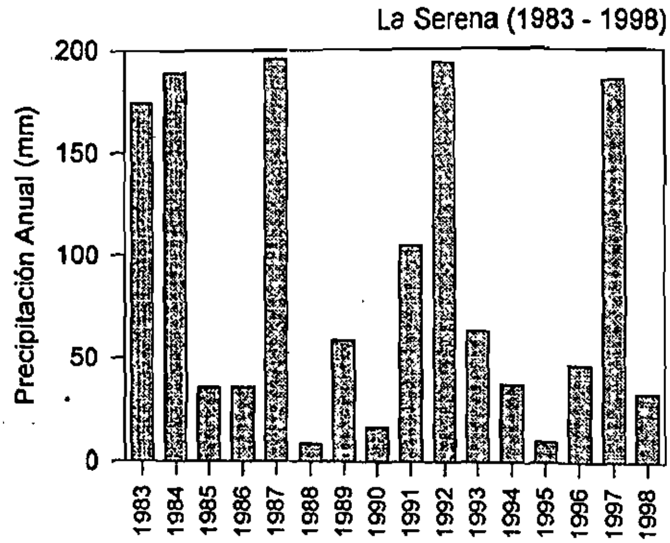

FIG. 2. Precipitación Anual entre 1983 y 1998 en La Serena. Datos aportados por la Dirección General de Aeronáutica de Chile, Aeropuerto La Florida, La Serena.

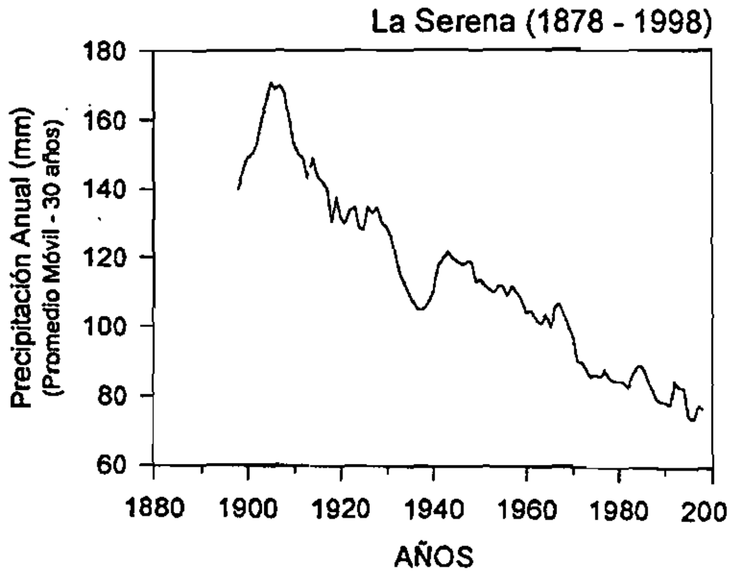

FIG. 3. Promedio móvil (30 años) de la pluviometría en La Serena, período 1878 y 1998 (modificado de Fuenzalida en Soto & Ulloa, 1997).

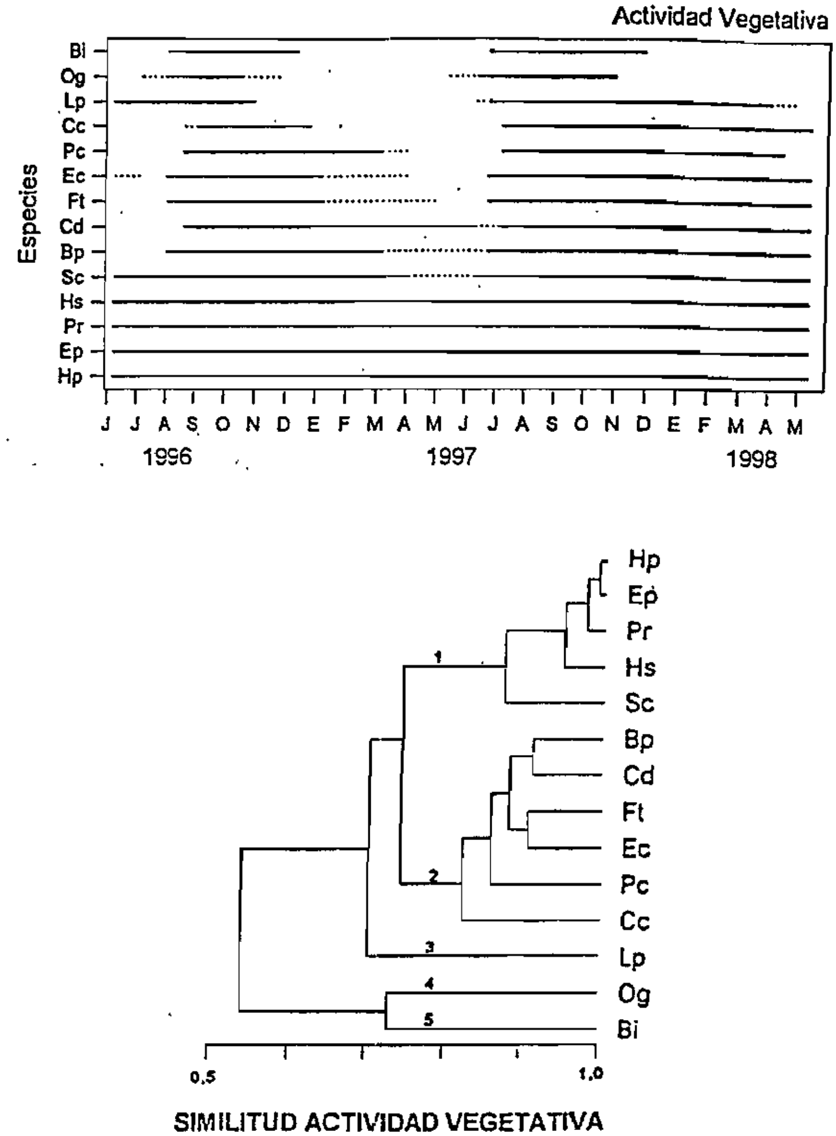

FIG. 4. Fenofase de actividad vegetativa en 14 especies arbustivas durante dos ciclos de crecimiento anual, Quebrada Romeral, norte-centro de Chile. Las líneas indican que sobre el 5% (línea punteada), 25% (línea continua delgada) ó 50% (línea continua gruesa) de los individuos se encontraban en esta fenofase. Ver los códigos de las especies en Tabla 1 (según Olivares & Squeo, 1999).

Para evaluar si existían grupos de especies con un comportamiento fenológico semejante, se realizó un análisis de similitud utilizando el índice de Colwell & Futuyma (1971):

$$S_{jk} = 1 - \frac{1}{2} \sum_{i=1}^{t} \left| P_{ij} - P_{ik} \right|$$

donde P_{ij} y P_{ik} son la proporción de la fenofase en el tiempo i-esimo para las especies j y k. El dendrograma se construyó a partir de la matriz de similitud (Goldsmith et al., 1986).

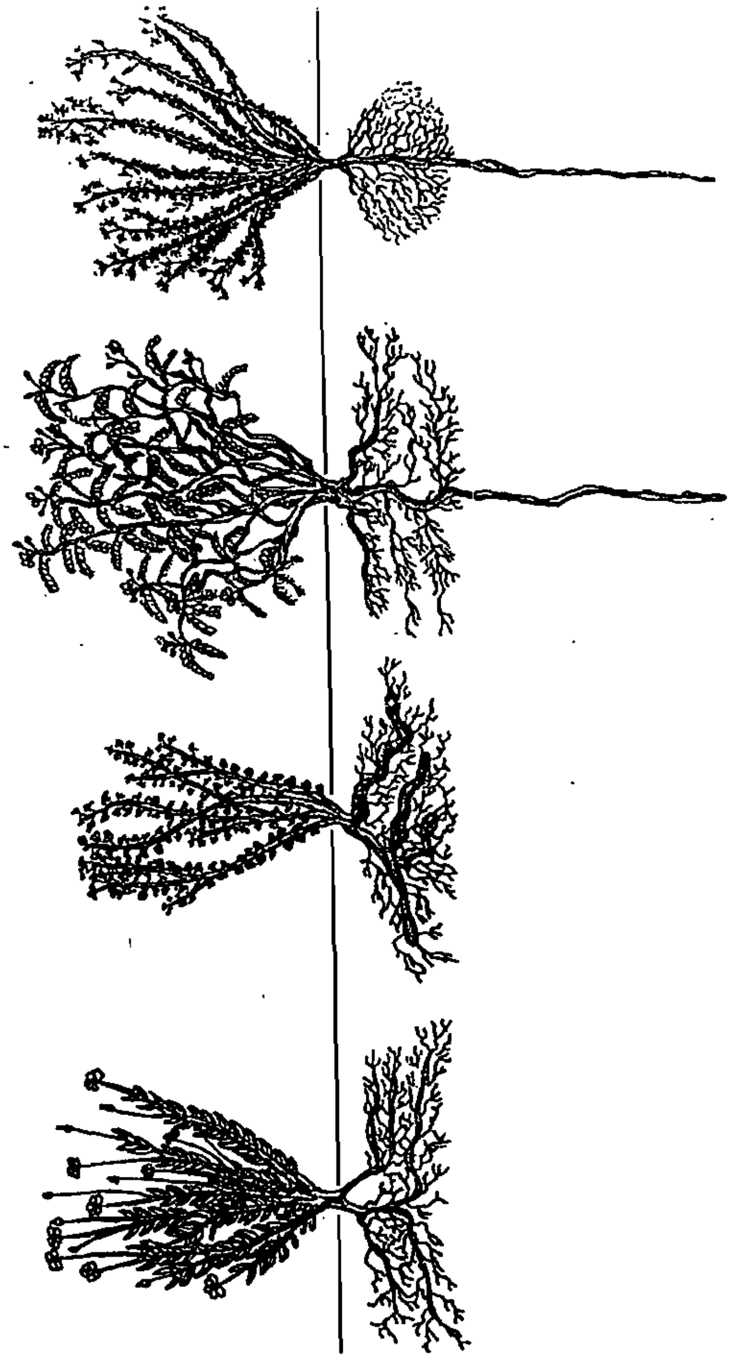

FIG. 5. Arquitecturas radiculares que presentan las especies arbustivas estudiadas en Quebrada El Romeral, norte-centro de Chile (según Olivares et al,. 1998). Arquitecturas radiculares superficial (*Encelia canescens*), superficial suculenta (*Oxalis gigantea*), dimórfica: (*Senna cumingii*) y profunda: (*Haplopappus parvifolius*).

Illustrated Handbook for Sustainable Harvest in Semi-wild Populations of *Harpagophytum procumbens* and Preparation of Good Quality

Guideline on the commercial collection of the medicinal plant
Harpagophytum procumbens from the environment,
GHP / GColP
Good Harvesting/Collecting Practice for Education of Diggers, Traders, Exporters and Nature Conservation Authorities

Prepared by
Dr. E.Schneider, Salus-Haus
for the
KALAHARI HARPAGOPHYTUM PROJECT
Teufelskralle - Devil's Claw - Grapple Plant - Sengaparile
Conservation by Cultivation and
Sustainable Harvest in Semi-wild Population

Farm Avontuur, Gert Olivier, Kuruman, SA
Firmenkonsortium Salus - Bioforce - Parceval
Universität Münster - University Durban-Westville
GTZ

2nd Edition July 2000

Guideline on the commercial collection of the medicinal plant Harpagophytum procumbens from the environment, GHP / GCoIP, Good Harvesting/Collecting Practice for Education of Diggers, Traders, Exporters and Nature Conservation Authorities

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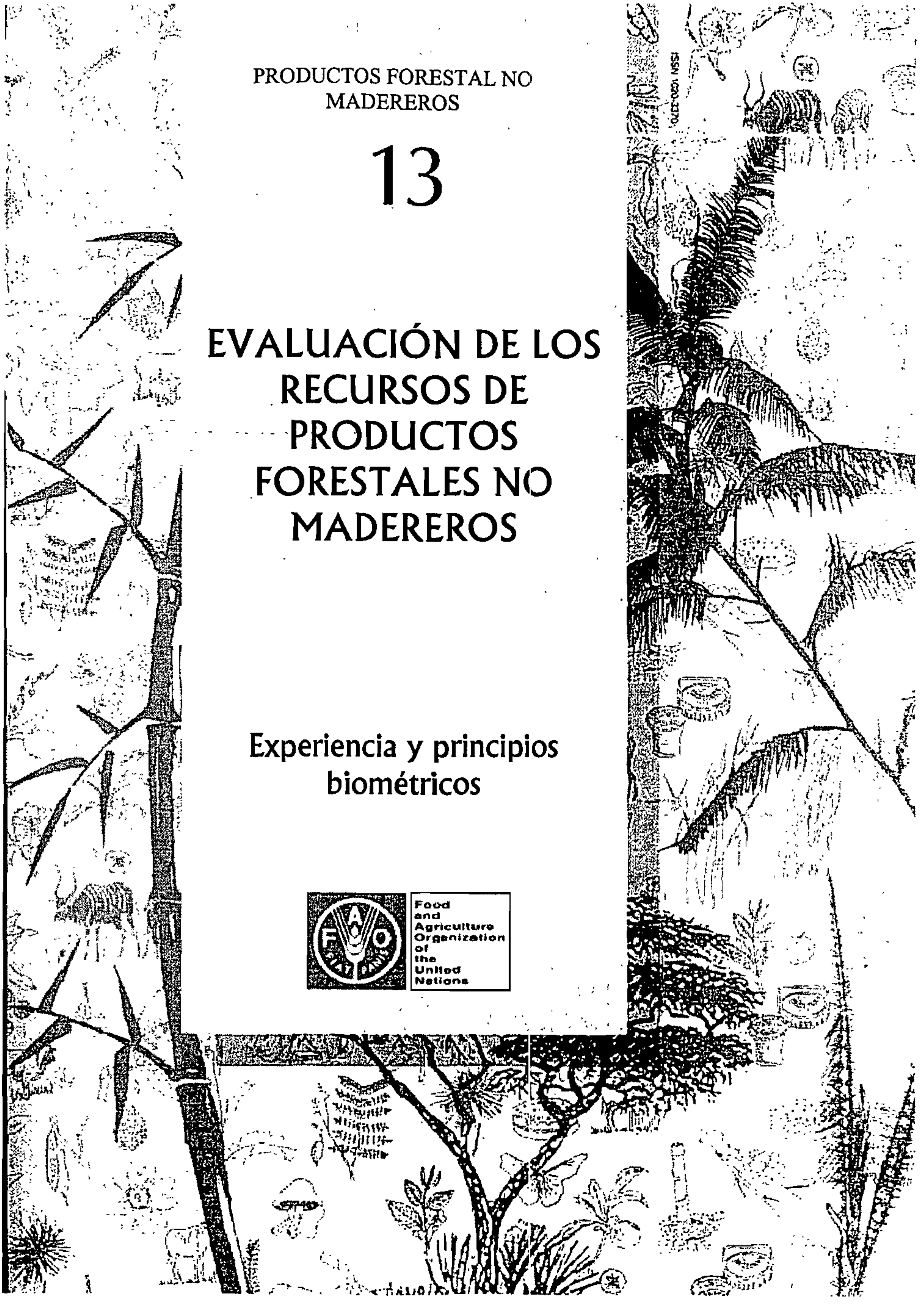

PRODUCTOS FORESTAL NO MADEREROS

13

EVALUACIÓN DE LOS RECURSOS DE PRODUCTOS FORESTALES NO MADEREROS

Experiencia y principios biométricos

Food and Agriculture Organization of the United Nations

ISSN 1020-3370

PRODUCTOS FORESTAL NO MADEREROS

13

EVALUACIÓN DE LOS RECURSOS DE PRODUCTOS FORESTALES NO MADEREROS

Experiencia y principios biométricos

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2001

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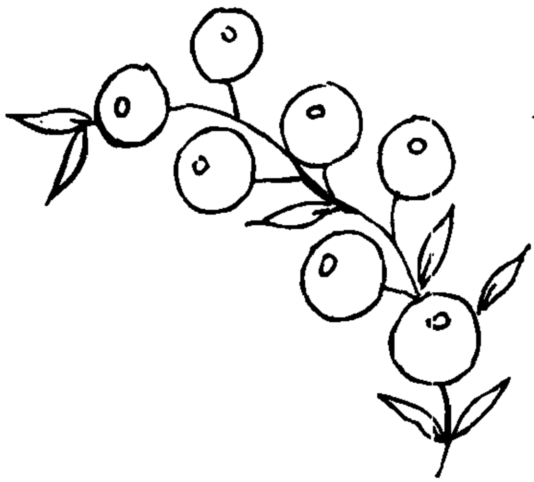

Cuadros

Figuras

Recuadros

Estudios de casos

Report of a Working Group on Medicinal and Aromatic Plants

First meeting — 12-14 September 2002 — Gozd Martuljek, Slovenia

D. Baričevič, J. Bernáth, L. Maggioni and E. Lipman, *compilers*

The International Plant Genetic Resources Institute (IPGRI) is an independent international scientific organization that seeks to advance the conservation and use of plant genetic diversity for the well-being of present and future generations. It is one of 15 Future Harvest Centres supported by the Consultative Group on International Agricultural Research (CGIAR), an association of public and private members who support efforts to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment. IPGRI has its headquarters in Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The Institute operates through three programmes: (1) the Plant Genetic Resources Programme, (2) the CGIAR Genetic Resources Support Programme and (3) the International Network for the Improvement of Banana and Plantain (INIBAP).

The international status of IPGRI is conferred under an Establishment Agreement which, by January 2003, had been signed by the Governments of Algeria, Australia, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Chile, China, Congo, Costa Rica, Côte d'Ivoire, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Greece, Guinea, Hungary, India, Indonesia, Iran, Israel, Italy, Jordan, Kenya, Malaysia, Mauritania, Morocco, Norway, Pakistan, Panama, Peru, Poland, Portugal, Romania, Russia, Senegal, Slovakia, Sudan, Switzerland, Syria, Tunisia, Turkey, Uganda and Ukraine.

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The European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR) is a collaborative programme including most European countries aimed at facilitating the long-term conservation and the increased utilization of plant genetic resources in Europe. The Programme, which is entirely financed by the member countries and coordinated by IPGRI, is overseen by a Steering Committee composed of National Coordinators nominated by the participating countries and a number of relevant international bodies. The Programme operates through ten networks in which activities are carried out through a number of permanent working groups or through *ad hoc* actions. The ECP/GR networks deal with either groups of crops (cereals, forages, vegetables, grain legumes, fruit, minor crops, industrial crops and potato) or general themes related to plant genetic resources (documentation and information, *in situ* and on-farm conservation, inter-regional cooperation). Members of the working groups and other scientists from participating countries carry out an agreed workplan with their own resources as inputs in kind to the Programme.

The geographical designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of IPGRI or the CGIAR concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. Similarly, the texts and taxonomic definitions in these proceedings reflect the views of the respective authors and not necessarily those of the compilers or their institutions.

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Medicinal Plant Conservation

MEDICINAL PLANT SPECIALIST GROUP

Silphion

Volume 12

IUCN The World Conservation Union

Newsletter of the Medicinal Plant Specialist Group
of the IUCN Species Survival Commission

Chaired by Danna J. Leaman

Species Survival Commission

ISSN 1430-95X

1 November 2006

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Phytotherapie

Inhalt Heft 2/06

Rheumatische Erkrankungen

Chronisch-entzündliche Erkrankungen des Stütz- und Bewegungsapparates sind sehr aufwendig in Diagnose und Therapie. Eintritt und Verlauf der Beschwerden sind häufig unvorhersehbar. Was die klassischen Naturheilverfahren leisten, zeigt der Praxisteil – mit Schwerpunkt Phytotherapie. Relativ neu ist hier die Gabe von Weihrauchpräparaten.

Viele Geschichten und Mythen ranken sich um die Alraune. Tatsächlich gehört sie zu den ältesten und kulturhistorisch bedeutenden Arzneipflanzen; sie ist bereits im Papyrus Ebers (ca. 1550 v. Chr.) erwähnt. Ihre wirksamkeitsbestimmenden Inhaltstoffe, einige Tropanalkaloide, sind heute in reiner Form verfügbar, so dass sich die Bedeutung der Droge auf den Bereich der Homöopathie reduziert hat.

Titelbild:
Iberis amara L. – Blütenstände mit Früchten
Foto: Beat Ernst, Basel
Diese Seite oben: Roland Spohn
Porträt einer Arzneipflanze: Roland Spohn

Anexo 7:

Material taller

“Assessing the sustainable yield in medicinal and aromatic plant collection”

BfN Bundesamt für Naturschutz

100 Jahre Naturschutz als Staatsaufgabe

Zukunft mit Natur

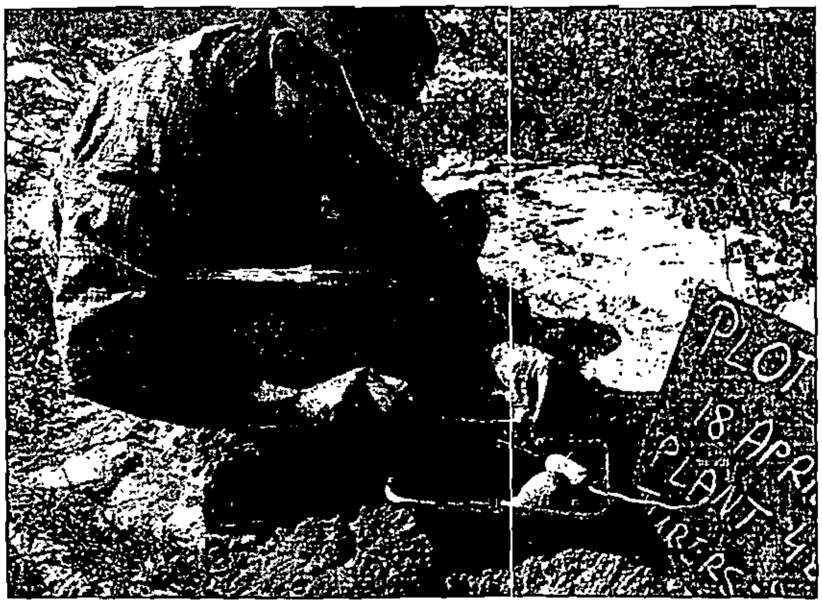
UNIVERSITÄT KOBLENZ · LANDAU

Assessing the Sustainable Yield in Medicinal and Aromatic Plant Collection

International Academy for Nature Conservation, Isle of Vilm, Germany

14 - 17 September 2006

ABSTRACTS



Title photo: Marianne Strohbach measuring *Harpagophytum procumbens* growths rates on permanent plots near Gobabis, Namibia.

Contents

What makes a medicinal and aromatic plants special?

DAGMAR LANGE[1]

A starting point: the term MAP

Assessing the sustainable yield in medicinal and aromatic plant collection – thus the title of this expert workshop. To get a common ground for discussions, an elementary need is at the beginning to define the subject. Two questions arise: What is a medicinal and aromatic plant (MAP) and further what makes a MAP special? Living without plants – unimaginable! Since time immemorial, people have used plants above all for food, construction, shelter, tools, fuel, and of course for health care and cosmetic purposes. "Medicinal" and "aromatic" are terms describing properties of chemistry and use. While medicinal plants prevent, alleviate or cure diseases, aromatic plants contain fragrants, essential oils and are valued as perfumes, herbs, spices, and as medicines. Further important plant use areas are sweets, beverages, spirits, liqueurs, varnishes, and also insecticides. The overlap between all these categories of plant use supports the view to apply the term MAP to the whole range of plants used not only medicinally *sensu stricto* but also in the neighbouring fields of, e.g. condiment, food and cosmetic in particular from the point of view of commercial harvest, trade, conservation and agriculture.

Other terms in use ...

Besides MAPs, there are many more different terms used in this field: i.a. NWFPs (non-wood forest product), NTFPs (non-timber forest product), pharmaceutical plant, botanical (drug/herb), herbal drug, officinal drug, non-officinal-drug, resin, and gum. Some are associated with the use, such as officinal drug or pharmaceutical plant, others are focusing on the product obtained from plants (botanical, resin, gum, pharmaceutical plant) or even more general on products of biological origin, like NWFP or NTFP. The latter include also the habitat origin. Only the term MAP is not product oriented; instead it focuses on plant **species**, an important distinction to all other terms. Consequently, the terms MAP on one side and NWFP / NTFP on the other side are not directly comparable. NWFP excluding all wood is ± a subset of NTFP including wood for uses other than for timber. Both products are of biological origin and are derived from forests or other wooded land (and in some definitions also from trees outside forests). In contrast, botanicals (= pharmaceutical plants) obtained from MAPs are of plant origin, and may be gathered not only in forests, but also e.g. in grasslands, wetlands, alpine communities, arable land, and ruderal areas.

How many species are MAPs?

The number of plant species that are used for medicinal and aromatic purposes can only be roughly assessed. An estimated 70,000 plant species are used in folk medicine world-wide, a figure recently confirmed by a country-based calculation of national medicinal floras. Of these many plant species, ca. 3,000 species are in international trade, a figure based on investigations of the German MAP trade (ca. 1,500 MAPs), a survey of the equivalent European market (ca. 2,000 MAPs), and the fact that Germany is an important trade centre for MAPs, with trade connections to all regions of the world.

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What makes MAPs special – or – characteristics of MAPs

What do we know about the production of MAPs? In general, there are three options: MAPs may be harvested from the wild, cultivated or obtained from both sources. Although cultivation of MAPs is known since several thousand years (e.g. opium poppy since at least 2700 B.C.), in particular in central Europe with its long tradition of growing MAPs, dating back to the medieval gardens, and today with 70,000 ha of MAP plantations within the European Union, only around 150 MAPs are commercially cultivated within Europe, and about 900 MAPs worldwide. In terms of species numbers, about (70-) 90 % of all MAPs are primarily harvested from the wild - a surprisingly high share. To calculate the share of wild-collected botanicals in terms of volumes is much more difficult. There are no or only few exact figures available of the total production of MAPs or of those under cultivation. Based on some country-based available information e.g. of China (60 % of the quantities in trade are said to be sourced from the wild) of Nepal (wild-collection of 15,000 t of botanicals/a) , and a rough calculation of the quantity of wild-collected botanicals in east and southeast Europe in the late 1990s amounting to a minimum of 30,000-45,000 t of dry plant material, the share of wild-collected plant volumnes is estimated to about 50 (-70%).

MAPs are a very diverse group of plant species. They span all life forms (annual, perennial herbs, shrubs, trees), all plant parts are used, root, stem, wood, bark, leaf, flower, fruit, seed, and they grow in all habitats and all climatic regions of the world. Many internationally traded MAPs show a wide geographic distribution. The geographical origin of the botanicals used in Germany may illustrate these facts well; in general, they originate from all geographical regions of the world, with dominance of the temperate regions of Asia, Europe, and North America not tropical regions. A high number of not less than 605 species are native to Europe, the majority of them distributed across several geographical units, e.g. the Mediterranean area, Eurasia or even the Northern Hemisphere; only 16 species are limited to Europe. A further interesting fact is that 71 of these species are introduced to Europe. Analysing the life form of the MAPs used in Germany, the dominance of perennial herbs (625 species) is striking. This fits well to their geographical origin mostly of temperate regions, as hemicryptophytes and cryptophytes are well represented in the equivalent vegetation types.

Susceptibility to collection varies among species depending on their different biological characters such as life form, growth rates, reproductive systems, and on the different plant parts used. The susceptibility of species to over-collection is above all to a function of life form and plant parts used, well illustrated by the fact that medicinal plants on the CITES lists are mainly the ones harvested for their roots.

Generic issue 1:
Inventory and monitoring methods as information base for resource assessment

Resource assessment methods for medicinal and aromatic plants: Designing sound inventories

JENNY WONG[1]

In order to provide guidelines for the assessment of a sustainable yield for MAPs we have first to develop an understanding of what we mean by various terms and establish some generic principles. The collection and use of MAPs is of interest to a great many

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stakeholders representing a range of cultures including a number of academic disciplines. Each of these disciplines uses a range of terms such as 'inventory' and 'assessment' but with little cross-disciplinary consistency. This is itself a considerable barrier to the development of standards for MAP management. This paper opens by laying out some basics as responses to the following questions:

- **What do we mean by 'inventory'?** – In ethnobotany this usually means a simple list of species available at a site or habitat with names particular to an ethnic group. However, if we are concerned with assessing management options, *inventory* should be taken as meaning a set of objective sampling methods designed to quantify the spatial distribution and quantities of species within specified levels of precision for the purpose of management.
- **What is the difference between an *inventory* and an *assessment*?** – This is an important distinction, *inventory* should provide objective data while *assessment* interprets them in the context of management objectives; in other words an inventory will give the stocking of a species as 0.25 stems/ha while an assessment will say whether this is too much or little to support current levels of harvesting.
- **What do we mean by 'sound' and why is this an issue and to whom?** – Colloquially this would mean 'undertaken according to agreed standards', in a statistical sense this becomes an inventory designed according to statistical principles. This in turn means adopting a sampling approach where a number of samples are independently and objectively selected from the area and species of interest. A measure of the quality of an inventory is its ***precision*** (how close sample measurements are clustered) and ***accuracy*** (how close the values estimated from the sample are to their true values). We can measure precision as the standard error of the mean of sample data with small errors indicating precise results. Obviously considerations of desirable levels for the sampling error of an inventory are only of concern to those familiar with academic science but remember that this usually includes statutory regulatory authorities such as Forestry Departments. However, basing management decision on good quality data is important to all stakeholders.

If we take it that there are circumstances where statistically-sound, quantitative information of the quantities of MAP resources for a defined area will be required, then the next question is **how can we obtain these data in an efficient manner** as financial resources for fieldwork are often severely limited. Unfortunately, *in situ* quantification of MAP resources is not straightforward for a number of reasons which will be elaborated further by CHRISTOPH KLEINN in another contribution to this workshop.

A common response to these difficulties is to avoid statistical issues altogether and argue that we can either do without statistical data and use qualitative information or accept data arising from simple, one-size-fits-all protocols (i.e. designs of low sophistication) even if these generate data with large errors and hence low precision. There are of course many circumstances and purposes for which statistical data is not required and for which qualitative methods are perfectly acceptable. We therefore need to **establish guidelines for the appropriate use of qualitative and quantitative methods.** A simple decision aid to determine an appropriate level of 'soundness' for NWFP studies has been proposed in the new FAO NWFP assessment guidelines and this will be presented for consideration by the workshop participants.

It is further contended that when statistical sound inventories are required, it is a **fallacy to confound cost-efficiency, simplicity and low sophistication.** It is suggested that an alternative response is to *increase* the sophistication to generate cost-efficiency by tailoring protocols to the species, habitats and available resources. It is also contended that more **sophisticated methods can also be simple to use,** especially if they are intuitive and bring together indigenous knowledge and statistical approaches. A few methods drawn from a range of disciplines which appear relevant to MAPs and could be further investigated will be introduced to the workshop.

Guidelines for tailoring inventory protocols to the specific characteristics of MAP species as developed for the FAO NWFP assessment will be briefly presented. These are based on the following considerations:

- Sampling design requires consideration of population density and distribution;
- Plot layout requires consideration of life-form and size of target species;
- Measurements made need to consider the commodity or harvested part and its form;
- Estimation of quantities of a resource (stocking) requires estimation of the spatial extent of the species.

The challenge for this workshop is therefore to

- o agree if, or when, statistical data is required and,
- o to devise a programme to develop and test protocols suitable for the assessment of sustainable yields for MAPs.

Forest inventories: Principles, experiences and lessons for NWFP inventories

CHRISTOPH KLEINN[1]

This paper gives an overview of basic technical principles of forest inventories with reference to designing inventories for NWFPs. The role of forest inventories is described as a **tool for data provision** to support decisions that are oriented towards sustainability of the utilization of the forest resource. As an example, sustainability of timber production is illustrated with some historical background.

Information needs of the natural resource manager can be formulated in **simple questions** to which forest inventories need to generate a suitable data set:

- How much is out there and where and in what quality?
- How much of the growing stock is accessible for harvesting?
- How does the resource change over time, how do human interventions affect the resource and its development?

These questions are the same for timber inventories and for inventories of non-wood forest products. And the most difficult question is probably: To what extent / precision / resolution need these questions actually to be answered?

Forests are complex systems and data collection on the forest resource is likewise a complex undertaking. Many information sources are being utilized to efficiently prepare and implement data collection. Field data are the most comprehensive and valuable source of information. Remote sensing plays a prominent role in forest area estimation and can excellently be combined with field inventories; however, for the inventory of NWFP, its application is probably limited to deliver ancillary information for example for forest type stratification.

Field data are collected on a sampling basis. The **three basic design elements of sampling studies** that need to be worked on and defined when devising a sample based inventory are presented and described: (1) sampling design, (2) response design and (3)

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estimation design. Examples are presented from forest inventories and extensions made towards the inventory of NWFPs. Models which are widely available for forest inventories are largely missing and need to be derived for NWFPs.

While many principles of forest inventories apply immediately also to the inventory of NWFPs, the latter is even more complex and difficult. Some inventory-relevant characteristics of NWFPs are discussed. Probably, for many non-wood forest products an efficient **integration of local knowledge** is required to make inventories workable and efficient, being one of various research topics identified.

Generic issue 2:
Indigineous knowledge as information base for resource assessment

Participatory science: Community experiments as a reliable information base for sustainable harvesting

ANNA LAWRENCE[1]

This presentation focuses on the challenge of **enabling ('empowering') local users** to manage medicinal plants sustainably. Specifically, it places sustainability in the context of **adaptive collaborative management**, examines the information needs of different stakeholders, and proposes ways in which those information needs can be met. The approach described can also be used by private resource managers, but will benefit from sharing research processes with other users and from established relationships with partners with the appropriate technical training.

The impact of harvesting medicinals and other NTFPs must be assessed accurately in order to make decisions for adaptive management. This is a particular challenge where the forests are managed by, or in partnership with, rural communities. Local users, harvesters and merchants will engage with sustainability where it affects their livelihoods within cultural context. Whilst reliable data are essential for management, field-based researchers emphasise the **need for methods which are simple, rapid, focused on species with high potential for livelihood improvement**, scientifically valid but usable by non-scientific forest managers. Our work searches for an acceptable balance between locally relevant and valid, and scientifically reliable, information.

To social researchers and development workers the validity of local knowledge is so evident that it can still surprise them that such knowledge needs to be defended to scientists. The approach described in this paper takes it as axiomatic that local knowledge about the resource exists, is evolving, is relevant and contextualised, and complements scientific knowledge, but that parts of it may be dormant or subconscious, or overridden by concerns about resource access and security. Furthermore, it is proposed that the contribution of scientific knowledge may relate more to methodology than to content. This approach therefore requires an open-minded and constructivist approach to knowledge creation, from the start.

Briefly, the **process** consists of the following. A research team is formed, in the tradition of much farmer participatory research, consisting of resource users, other influential or important local stakeholders, foresters and the facilitators (in this case from national NGOs).

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After a participatory and systemic examination of their medicinal plant harvesting situation, and exchange of local with scientific knowledge, the research team propose hypotheses about the effect on yield of biological, social and management factors, including harvest level, period and method. They then **define 'business as usual'** or BAU, a process which can in itself involve much debate and learning. BAU is taken to be the formalised description of what most people do most of the time, when they are harvesting. It has to be standardised, in order to permit rigorous comparison with any alternative management, and defining it requires sharing and negotiation among research team members. Alternative management and harvesting methods are then proposed and defined in the same way.

A key step is the explicit formulation of a **hypothesis** along the lines of "If management is changed from BAU to the alternative, yields and / or regeneration will increase / stabilise because ...". With the support of foresters and researchers, **research plots** are then established based on principles of randomisation, replication and controls. These compare indicators, test correlations between indicators and make recommendations about useful proxies for measuring sustainable yield. Data is collected, and analysed in collaboration, and results interpreted in meetings with the wider community of forest users.

The paper examines the effects on different stakeholders of the process, including the formulation of hypotheses about management and yield, usability of indicators of sustainable yield, the need for both quantitative and qualitative data, comparison of scientific monitoring with local monitoring, reliability and validity of the information generated. It concludes with the important consideration of the effects of such monitoring on local perceptions and action, and overall implications for governance.

The paper draws on the experience of a UK DFID Forestry Research Programme project working with NGOs and forest-managing communities in India and Nepal, and complements the paper by G.A. Kinhal.

Participatory resource estimation of medicinal plants: A case study from India

GIRIDHAR A. KINHAL, JAGANNATHA RAO and M. ARTHUR SELWYN[1]

Local communities and their knowledge related to natural resources are being increasingly recognized globally. Participatory approach integrates people of different socio-economic and cultural status and helps to establish a need based and objective oriented local institution. Such an institution is aimed to facilitate coherent action and help the stakeholders to contribute in designing, implementation and appraisal of methodology. It also helps the resource managers to decentralize and broad base the conservation of valuable medicinal plants and other NTFPs, which provide livelihood support to many people.

Capacity building through **constituting a local institution called *Task Team*** was attempted in Agumbe of Karnataka state in India, providing opportunities to all stakeholders to apply traditional and scientific knowledge at village level for resource accounting and developing an adaptive management methodology for sustainable harvesting. Documentation of traditional knowledge and practices related to selected medicinal plants and NTFPs was undertaken to characterise and assign roles to different stakeholders in the *Task Team*. A sequential filter technique was applied to enable the local *Task Team* to set objectives for resource

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management. The specific objective was to **evaluate the community's resource assessment potential under different harvest regimes**, and costs involved in undertaking these activities. The *Task Team* members' capacity to estimate the resources was enhanced through training, whenever physical measurements were involved.

The Lauraceae species *Cinnamomum macrocarpum* Hook.f. (locally known as Kadu dalchini), leaves of which are harvested for their high medicinal value, was selected for resource assessment. Different site, plot and tree related parameters were assessed by the community. Resource quantification (leaf yield) was done using visual estimation and actual harvesting under two harvest regimes such as BAU (Business as Usual) and test harvest (selective harvest). The tree leaf yield was assessed visually by the *Task Team* members based on their experience prior to the actual harvest in two harvest regimes. The results were compared and variations between estimated and actual yield were recorded to calculate the accuracy in community's resource estimation. Mean accuracy in estimation was 89% in test harvest and 83% in BAU and variations in leaf weight proved to be non-significant. The *Task Team* members maintained their accuracy across height classes without significant variation between the estimation and actual harvest, which was not the case in respect of girth classes. The labour costs involved in undertaking these two assessment exercises were also juxtaposed. The results justify that a strategically constituted stakeholders' team can set objectives for resource management, assess resource potential, and efficiently estimate possible harvest with high accuracy.

Generic issue 3:
When do we consider an impact of harvest detrimental for the population?

Ecological implications of collecting medicinal and aromatic plants at the population, community and ecosystem levels

TAMARA TICKTIN[1]

A growing number of studies have assessed the ecological impacts of harvesting medicinal plants. I present a review and synthesis of the literature on MAP harvesting impacts with the **objectives** of (1) illustrating emerging patterns in the ways in which MAP harvest can have impacts at different ecological scales; (2) identifying the range of ecological methodologies used to make these assessments; and (3) based on this, providing some thoughts and some questions on **potential appropriate and affordable methodologies** for assessing MAP harvest sustainability.

The MAP literature illustrates that MAP harvest can have impacts at the levels of **individuals, populations, communities and ecosystems**. Harvest sustainability for any one species is heavily influenced by variation in biological factors such as the plant part harvested and life history strategies, as well by variation in ecological and environmental factors, including both abiotic and biotic factors. Moreover, the literature has shown that variation in management practices for wild harvested MAP carried out at a **variety of scales**, including those targeted at individuals (such as harvest methods), at the community level (such as weeding, light manipulation) and at the landscape level (such as fire, grazing, logging, agricultural practices) have large effects on harvest impacts and can interact with

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each other. In addition, harvest sustainability at one ecological level may not translate into sustainability at another level, raising the question of what 'impacts' are.

A wide spectrum of methodologies have been used in assessment of ecological sustainability of MAP harvest, including experimental harvests and measures of vital rates; assessment of genetic structure and diversity; documentation of patterns of abundance, density and population structure; modelling of population dynamics and sustainable harvest levels; and assessments of community structure and composition and resource cycling, among others. The majority of ecological assessments for MAP has been at the population level. Many of these methods represent high costs in time and resources. Several case-studies illustrate the ways in which they can be problematic or erroneous when interpreted without adequate analysis of socio-economic, political and cultural factors. However, some high input ecological methods, such as population modelling, have yielded informative results on harvest sustainability that are not obtainable with other more affordable methods, and also shed light on harvest sustainability for many other MAP. The MAP literature, and the gaps in it, suggests ways in which key species for these kinds of studies can be selected.

Patterns emerging from the literature on MAP harvesting impacts point to some ways in which ecological assessments for many MAP may be more affordable and effective, especially when combined with local or **traditional methods** for assessing resource status. Several studies illustrate the ways in which the latter can be highly effective as tools for assessing conservation status of MAP at different ecological levels and lead to **adaptive management**. The latter is particularly important since the MAP literature illustrates the importance of assessing sustainability over the long term, though this is rarely done. Sustainable harvest assessments from market documentation and qualitative observations at the community and ecosystem levels have also been illustrated to be effective. An understanding of the life-history, ecological, socioeconomic, cultural, political context of harvest for any given MAP is key in identifying what methods and combinations of methods can be employed.

How much impact on plant populations is tolerable? – An approach to determine thresholds for significant detrimental impacts in the context of the ISSC-MAP

ULRICH SUKOPP[1]

The International Standard for the Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) provides a long list of principles and criteria compiled to ascertain the sustainability of wild collection of MAP resources. A basic and most important principle postulates that the 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. The collection intensity should be well **balanced with the species ability to regenerate**. Furthermore, **resilience** of the species against (over-)exploitation is requested.

The mentioned criteria of harvest sustainability and resilience should be precisely determined in science-based case studies provided that time, experts and financial resources are available. Regrettably, these scientific and economic criteria alone can not adequately reply to the question how much detrimental impact on MAP populations is acceptable. They

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provide information exclusively on the extreme limit of exploitation: in case of harvesting in a not sustainable manner or reducing the populations to a not resilient size we are obviously beyond the limit and have caused an undesired damage to a part of nature. **Leaving a MAP unexploited or over-exploiting a MAP are two extreme situations opening up a long range of scenarios in between.** It remains an ethical task to determine the threshold of significant detrimental impacts on MAP populations. Scientifically sound data about population parameters and the condition of nature and environment essentially contribute to setting these thresholds. Such **normative** standards correspond to more general nature conservation goals and need to be fixed and legitimized in some sort of societal agreement. In addition, it is most important to consider and address negative environmental impacts which indirectly influence other wild species, habitats, ecosystems and the landscape.

The theoretical concept of environmental damages and its application in the context of cultivation of genetically modified crops is currently elaborated in a joint project of the Federal Agency for Nature Conservation with the Technical University Berlin (INGO KOWARIK, ROBERT BARTZ, ULRICH HEINK). The results of this project can be adapted to the questions raised by ISSC-MAP. **Three conclusions** are particularly important: (1) the definition of environmental damages, (2) the further operationalisation using criteria and indicators and (3) the setting of normative standards for significant detrimental impacts.

(1) An environmental damage caused by wild collection of MAP is a **significant direct or indirect detrimental impact** on a biotic subject of protection/regulation (animals, plants, fungi, microorganisms) or on an abiotic subject of protection/regulation (soil, water, air/climate). The damage may affect the subject of protection/regulation as a whole or any of its components or the functional and structural relations of the protected/regulated subject or the sustainable use of the protected/regulated subject including its functional and structural relations. The definition is based on clearly named **protected/regulated subjects (any biotic or abiotic part of nature)** and on the **causality** of wild collection to the damage. It is important to note that not every impact is seen as detrimental, but a threshold of significance is applied. The significance of an adverse effect arises from its intensity as well as from the value of the protected/regulated subject (two-dimensional approach of environmental risk assessment).

(2) The above definition is operated by selecting and applying various criteria and indicators for (a) the nature conservation **value** of the protected/regulated subjects and (b) the **intensity** and range of the negative impact. As **criteria and indicators** for the particular value of the protected/regulated subjects are suggested: rareness and endangerment, responsibility for world-wide conservation, closeness to (pristine) nature of habitats, biocoenoses and ecosystems, importance in land use history, typical composition of species and structures, conflict with local nature conservation goals, legal protection status. The intensity and range in space and time of the negative impact can be indicated by parameters relating to the collection activities (e.g. frequency, period allowed for collection, collected quantities), to the target species' populations (e.g. size, distribution and structure), to non-target species' populations, to habitats directly or indirectly affected by collection, to diversity, structures and functions of ecosystems and landscapes.

(3) The setting of thresholds for significant detrimental impacts is based on **normative** conventions. It is usually performed by expert panels which agree case-specifically on **tolerable negative effects**. The results should be consistent with more general nature conservation goals.

For each unique case of wild collection of MAP as many as possible of the above listed criteria and indicators should be assessed and ranked on a gradual scale. After calculation of the ranking results for both dimensions of the assessment – the value of the affected biotic or abiotic subjects and the intensity of the impact – and after the application of predefined thresholds of significance a clear answer can be given, whether the impact is acceptable or not. The described procedure is a well-known standard of **environmental risk assessment** undertaken for many other human interventions in nature.

Balancing statistical reliability and cost efficiency in resource assessment

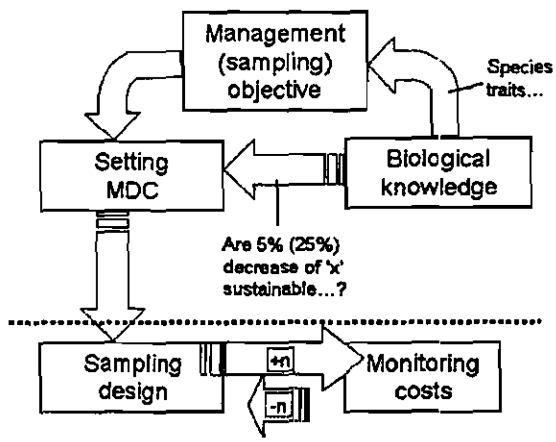
HORST TREMP[1]

In resource assessment of medicinal and aromatic plant species monitoring is part of the adaptive management cycle. The way of application of monitoring results to management activities should be identified before any data are collected. Typically a baseline study of a resource (initial evaluation) and trend monitoring of a used resource can be distinguished. **Monitoring** of a statistically defined plant population means repetitive observations at permanent locations at specified time intervals.

If neither a data intensive (eco-) system approach nor a laborious population viability analysis are intended, cost efficiency in monitoring can be achieved. The **term cost efficiency** is used in that respect that no money should be spent for supplementary data collection and analysis which is not necessary for management decisions. Plant resource monitoring can be simply structured because contrary to vegetation studies not many explanatory variables for species increase/decline exist but only one: **the harvest**. This variable with its direct and indirect effects is known and to a certain extent under control. Further it is questioned if the important scientific concept of cause and effect explanation which needs several hypotheses testing procedures is necessary in every resource assessment procedure.

If carefully defined limits, i.e. securing sustainable population viability, are implemented in the management cycle it might not be necessary to explain specifically why a used plant species resource declines. More important is the ability to adjust harvest procedures in time.

No concessions should be made in setting a **minimum detectable change** (MDC) of viability parameters of the species population.



MDC is directly related to statistical test power and has consequences for the sampling design. Its setting requires consideration of both the biological implications (How large a change should be considered biologically meaningful?) and the monitoring costs which increase with sample size and – but not necessarily – with more sophisticated sampling designs. Thus MDC **links ecologists, statisticians and financing partners** (see figure).

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It is proposed that in resource monitoring a core element should be to state which size of change of a resource is desired to be detected. If no preliminary data about statistical distribution properties and variability of the investigated variables (needed for MDC) are available a pilot study has to be undertaken. This will be more cost efficient as the responsible person can avoid missing a true decline of the resource (plant population) and failing to take action.

But note, the above described concept might not be applied to rare species and such with particular distributions. This however does not limit its applicability in a multitude of cases.

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Resource assessment: Case studies

Community management of medicinal plants in Nepal: Practices and trends towards sustainability

NIRMAL BHATTARAI[1] and MADHAV KARKI[2]

Nepal has been a traditional supplier of about **100 species** of wild harvested medicinal and aromatic herbs to the Indian and other international markets. Some 20 high demand and high value herbal products constitute about 80% of the volume and value. Historically the people of Nepal's far flung mountains controlled and managed the collection of herbs in their forests and pastures primarily for local uses and supplementary cash income. Today, uncontrolled commercial extraction of a number of medicinal plant species has significantly eroded the country's resource base that calls for urgent action towards sustainable management of medicinal plants in the wild.

Sustainability has many different definitions but in the ecological context of medicinal plants, harvesting can be considered sustainable if the harvest has little or no long term harmful effect on the populations being extracted, when compared to equivalent natural populations not subjected to harvest.

In Nepal, although there is considerable evidence of over harvesting of medicinal plants, quantitative analysis of the effect of unsustainable extraction on natural populations are lacking. There are scientific ways to properly extract medicinal plant resources in nature with minimum physiological and ecological damages. However, this requires research and implementation of guidelines of sustainable management. Ideally, technical inputs combined with traditional knowledge should produce an adaptive technology that is based on the cultural, social, environmental and economic factors that are relevant to the local population

Nepal's current forest policy has promoted the **community-based forest management principles and practices.** At the community level, local people are the true resource managers, with a vested interest in sustaining the integrity of natural resources on which they

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heavily depend. Consequently, the management of national forests is being systematically handed over to community of users. As a group they share the rights and responsibilities of managing the forest according to their needs and benefits. About 21% of the national forest totaling approximately 11,85,565 ha represented by 14,227 forest patches have been handed over to the local community of users for management, benefiting 16,35,664 households representing about 29% of the country's population.

An ICIMOD-based project funded by the *Medicinal and Aromatic Plants Programme in Asia* (MAPPA) and operational since 2002 in the Baitadi and Darchula districts of western Nepal has been increasing the **capacity of local communities** by building the technical and institutional capacity of the district chapters of the Federation of Community Forestry Users-Nepal (FECOFUN). Objectives are the conservation and efficient management of medicinal plants and other NTFPs and to generate household income in an economically equitable and environmentally sustainable manner.

The project activities included strengthening of the leadership skills and technological knowledge of the Community Forest User Groups through training and capacity building. The major elements of research conducted so far have been: training and skill development in MAP inventory; collection of baseline data on the size-class structure and yield characteristics of the plant population; sample-based quantitative assessment of plant stock; regeneration surveys; life cycle studies and rotational harvesting practices on selected species; determination of the optimum harvestable amounts and periodic adjustment in harvest levels, establishment of medicinal plant nurseries for *in situ* enrichment plantations and *ex situ* cultivation; and impacts of different levels of harvesting on sustainability in *in situ* and *ex situ* experimental plots

The sustainable wild collection and quality control aspects have been concerted with the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (**ISSC-MAP**). Likewise, the WHO Guidelines on Good Agricultural and Collection Practices (**GACP**) for Medicinal Plants have been used to blend the traditional practices. The progress to date is encouraging. Valuable data and information are being generated that are likely to serve as a model for sustainable management of medicinal plants in the wild. This is expected to be replicated in other areas communities alike.

Sustainable harvest of *Actaea racemosa* from Appalachian forests

JAMES CHAMBERLAIN[1] and A.L. (TOM) HAMMETT[2]

Black cohosh (*Actaea racemosa*; Syn.: *Cimicifuga racemosa*) is an erect perennial found in rich cove forests of eastern North America. Products made from the roots to treat menopausal symptoms have been used for more than 40 years by Europeans and have been more recently available in the United States. The American Herbal Products Association estimates that more than **83,000 kg of roots were harvested in 2001**, and more than **95 % of this was wild harvested.** In 2001, the estimated retail value of cohosh exceeded US$ 6.2 million. NatureServe gives black cohosh a global and national conservation ranking of "apparently secure", while some conservation groups list the species 'at risk', and two states in the US consider it endangered.

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In 2000, the Medicinal Plant Working Group of the Plant Conservation Alliance (which includes representatives from ten federal agencies and more than 250 nonfederal cooperators) fostered a partnership between the Garden Club of America, a non-governmental organization dedicated to the conservation of native plants, and the USDA Forest Service to address growing conservation concerns regarding this species. The group established a **study protocol** to examine the **frequency** and **abundance** of black cohosh, as well as the impact of harvest levels on population sustainability. An overall goal of the project has been to provide information and knowledge that will improve the decision making abilities of the National Forests to better understand sustainable harvest levels to improve management activities for black cohosh. Recognizing that the lack of funding was a major constraint the group designed the study to use **volunteer "citizen scientists"**. The studies are conducted on public land, either National Forests or National Parks. Local Forest Service or National Park Service scientists coordinate the research aspects, while a Garden Club member coordinates volunteer participation.

For the first three years, field activities were limited to the National Forests of North Carolina. 25 permanent plots, each measuring 10 x 10 meters were established in 4 different cove forests. 16 plots were harvested with two different intensities (30 and 60 %). Data have been collected on **number of plants, stem height, canopy width**, as well as **number of inflorescences** for five year. In 2005, more than 50 volunteer citizen scientists participated in the two day data collection activity. Summaries of data provide insight into the effects of harvesting.

In 2003 and 2004, the study was expanded to include one site in the neighboring state of Virginia. In 2005, the original Virginia site was discontinued due to poor site conditions, and two new Virginia sites were established. That year, more than 20 volunteers participated in data collection. The dimensions of the Virginia plots varied from the North Carolina plots (to reflect local plant densities and growth conditions), but similar data collection methods were used. The data collected will aid in **correlating above and below ground biomass**, with the expectation that better and **non-destructive inventory methods** would be developed to estimate the volume of potential root harvest. As data from the Virginia sites have only been collected for two years it is too soon to expect reliable correlations.

Several challenges have surfaced through these projects that influence the viability and reliability of the study. In some locations, particularly North Carolina, black cohosh is often found growing with Yellow cohosh (*Actaea podocarpa*, Syn.: *Cimicifuga americana*) and discerning the difference between them is challenging, even for a trained botanist. Training volunteers in scientific methods as well as plant identification is challenging. Often, volunteers may not understand the necessity for accuracy and rigor. **Keeping volunteers committed** to collecting data though adverse weather conditions can be particularly challenging. In 2006, data collection in both the North Carolina and Virginia sites were suspended due to lack of volunteers. The future for this study is in doubt due to lack of fiscal support for the research coordinators.

This presentation examines the nuances of assessing sustainable harvesting of an important medicinal plant in the Eastern US. In this case the **need for scientific rigor must be balanced with the availability of funds and volunteers**. To ensure greater reliability and broader application of data and results, more replications are needed over a broader geographic scale. To achieve this will require greater investment in time and money, and as each of these are limited, the future of this and similar studies is questionable. Lessons learned from this experience, however, may help develop monitoring and inventory systems where funding and other resources are constrained.

Collecting *Arctostaphylos uva-ursi*, *Gentiana lutea* and *Thymus* in Northern Spain

ROSER CRISTÓBAL and ROSER MELERO[1]

Arctostaphylos uva-ursi, *Gentiana lutea* and *Thymus* spp. are the most important species collected in Spain for industrial uses. Additionally, there are others herbs harvested for the local market or domestic uses like: *Arnica montana, Jasonia glutionosa, Equisetum arvense, Juniperus communis, Ramonda myconii, Rosmarinus officinalis, Santolina chamacyparissus, Tanacetum partenium, Viscum album*, etc.

With the aim of taking advantage of the use of natural resources as an economical activity in the mountain areas, we have worked during the last seven years with *Arctostaphylos uva-ursi, Gentiana lutea, Arnica montana, Thymus vulgaris, Lavandula angustifolia, Satureja montana, Rosmarinus officinalis and Lavandula latifolia* studying different aspects of the wild populations. We have studied the overall condition in some of these species (arnica, rosmary, lavender and savory). In some other species (bearberry, yellow gentian, thyme, savory and lavender) we have evaluated the impact of wild harvesting on the natural habitats and on the species survival, in order to find the best practices to collect them.

During three years different experimental studies were carried out with ***Arctostaphylos uva-ursi*** with the aim to know: (1) the aerial biomass production under different environmental conditions and during different harvesting season; (2) the regeneration capacity of the plant according to the last pruning and to the different intensity of previous gathering, and (3) the best harvesting season for obtaining the highest arbutin concentration. In all the localities, the biomass obtained in spring was a little higher than in autumn. The highest biomass was obtained from localities characterized by a minimum forest cover, southern exposure and calcareous soil. The plants' sprouting capacity was higher in plots gathered previously in autumn than in spring. The sprouting rate also showed higher values in plots where a minimum pruning was applied. The populations gathered every year show, in the third year, a fitness reduction due to a significant decrease in sprouting capacity. In autumn the arbutin concentration is higher than in spring.

Regarding ***Gentiana lutea***, we have carried out different experimental studies focused on the resource assessment in the Pyrenees and on its biology, giving special attention to the reproduction. Also, these first studies evaluated the effect of the traditional harvesting on the regeneration of the plants, considering the extraction intensity. Among the most interesting results, we found that vegetative multiplication is the main way of *G. lutea* populations to grow and survive and that no more than 50% of plants should be harvested during the autumn season. As a conclusion, it was thought that the traditional collection technique could be improved by cutting and planting some of the harvested shoots. Nowadays we are evaluating this recommendation in order to verify any change in the population growth rate.

Finally, the studies of wild collection of mediterranean MAP species, like *Thymus vulgaris*, *Lavandula angustifolia* and *Satureja montana*, evaluate the effect of the collection technique on the survival and on the yield of these species in the wild. The collection technique includes the harvesting method itself, the extraction rate and the collection periodicity.

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Compiling a handbook on NWFP inventories: A project of FAO's Forestry Department

CHRISTOPH KLEINN[1] and JENNY WONG[2]

The Forest Products Division of FAO has projects in various NWFP related topics. A series of widely accepted NWFP issues are the starting point for FAO's NWFP research activities, among them the **lack of sufficient quantitative information** on production, consumption and trade. Other issues are the lack of management prescriptions, unclear user rights and a lack of awareness, policy and regulatory instruments.

FAO's mission covers the fields of definitions, standards and technical assistance. Programme priorities are institutional strengthening, provision of information, conservation and sustainable utilization, and international processes. For these priorities, data on the resource base are required; wherever possible in a good quality and following clear definitions.

Therefore, FAO engaged in the development of a **handbook on NWFP inventory**: "Non-wood forest products. Resource Assessment Guidelines", with JENNY WONG as senior author. That handbook draws upon the experience from various NWFP field projects in Africa and embraces a **compilation of a variety of sampling strategies for field inventories** of a wide range of different NWFPs. There is no such thing as one single ideal sampling technique for all NWFP in all regions so that a wide range of sampling techniques needs to be considered when planning an inventory for NWFP. The handbook offers such an overview of sampling techniques at a statistical level and language which should be accessible to most NWFP project planners.

Structure and contents, and also limitations, of these guidelines are presented and discussed. In addition, some case studies that are part of that FAO handbook are presented.

A preliminary assessment of the harvest impact on *Pelargonium sidoides* in South Africa and Lesotho

DAVID NEWTON[3]

Pelargonium species in general (at least 18 species), have been used in southern Africa as useful medicinal plants for many years providing relief for colic, diarrhoeas and dysenteries. The species harvested medicinally and researched in this report, namely *Pelargonium sidoides* forms part of a group of *Pelargonium* species with red-coloured fleshy roots used to treat the above mentioned abdominal upsets and upper-respiratory tract infections. *P. sidoides* occurs in Lesotho and the Eastern Cape, Free State, Gauteng and Mpumalanga provinces of South Africa.

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During 2003, TRAFFIC was contracted to undertake a **preliminary field assessment** of harvest impact on this species in and around the Eastern Cape towns of Alice, Grahamstown, Wesley, Peddie, Hogsback and Thomas Baines Nature Reserve. During 2006, TRAFFIC also conducted a preliminary analysis of the *P. sidoides* industry in Lesotho.

Annual harvest volumes are estimated to range from 9,000 kg to 45,000 kg. However, based on preliminary field observations **this species does not appear to be facing any imminent threat** because of the plants rapid re-sprouting from remnant root segments, its wide distribution and large populations, the lack of harvesting in other areas of its range, the ease with which the plant propagates from shoot and root cuttings, and existence of commercial plantations in the Western Cape (50 hectares).

In **assessing the impact of harvest** on *P. sidoides*, it became evident that all harvest was being conducted illegally and without the use of formal or informal management plans by conservation staff, harvesters or traders. Hence a methodology was adapted to allow the making of a preliminary "non-detriment" assessment of the industry with particular reference to harvest regime. It must be emphasised that this project did not set out to conduct an exhaustive resource assessment, but concentrated on assessing the general circumstances of the harvest and trade in *P. sidoides* and to identify critical biological and environmental factors exacerbating harvest impact. The following **methodology** (typically adopting procedures for CITES "non-detriment findings") was used, namely:

- Identification of interested and affected parties to ensure that interviews assessed the views and experiences of a representative group of industry participants;
- Confirm during interviews and literature review the existence or lack of formal and/or informal management plans and species threat assessments within government conservation agencies and amongst traders and harvesters;
- Confirm during interviews whether training and support is provided to harvesters to encourage sustainable harvest techniques.
- Conduct socio-economic survey of harvesters to assess factors, such as land tenure arrangements and volume of traditional use, that can be used to identify positive or negative incentives and pressures that would encourage sustainable or non-sustainable harvest;
- Clarify life history of *P. sidoides* to identify characteristics (e.g. longevity and reproductive rate) that make it resilient or susceptible to harvest;
- Assess ecological adaptability to identify characteristics (e.g. ability to grow in wide variety or highly specific soil types) that may make it resilient or susceptible to harvest;
- Establish the plants preferred habitat to identify its suitability for growth under disturbed conditions or as part of mature climax communities;
- Without conducting detailed population surveys obtain available quantitative and qualitative data on population status and distribution;
- Identify the plant part utilised and whether this indicates destructive or sustainable harvest;
- Assess the ability of the plant to regenerate easily or not through the set of seed or through vegetative propagation. It is of importance to distinguish between vegetative regeneration of the plant and actual recovery of the commercially valuable product. It is possible that recovery of the latter may lag behind the former by several years;
- Assess the legal means to protect *P. sidoides* and the existence of ongoing monitoring of harvest in the field and compare this during interviews with the actual situation regarding legal or illegal harvest in the field;

- Identify harvest and post harvest techniques utilised by harvesters and traders to assess wasteful or inappropriate techniques that may be the cause of supplementary harvest to replace spoiled materials;
- Identify the main target species and other species that may be mistakenly harvested to ensure that harvest impact is not assigned to the wrong species;
- Quantify the volume of material harvested for comparison against total population;

For a rapid assessment such as *P. sidoides* the harvest assessment methodology has to be flexible enough to maximise the collection of data directly relevant to measuring harvest impact so that the researcher can make basic management decisions and/or identify future research priorities.

In the case of *P. sidoides*, despite the apparent resilience to harvest it is not known how quickly new commercially valuable tuberous roots form out of the re-growth and too frequent follow-up harvests may compromise the **survival of re-sprouting plants**. Considering the harsh environmental conditions prevalent in habitat, it is provisionally suggested that re-grown plants should not be re-harvested within a period of four to five years and that further research into root re-generation times be conducted to enable revision of this minimum period. In addition, although trade data indicates export volumes in the order of 50,000kg (wet weight) per annum, it is not clear if this matches volumes processed by the main importing countries. It is necessary that a supplementary trade study be conducted in Europe, to identify other international consumers and finally to confirm that trade levels are within sustainable limits.

Resource assessment methods for sustainable collection of Arnica flowers in the Apuseni mountains in Romania

HORAȚIU EMIL POPA[1]

The Apuseni Mountains are located in western Romania and are among the most important source regions of *Arnica montana* in Romania. The WWF-UK / WWF DCP / USAMV project „The Conservation of the Eastern European medicinal plants: *Arnica montana* in Romania" (hereafter called 'Arnica Project') is funded by the DARWIN Initiative and has developed a model for sustainable *Arnica* harvesting and trade (www.arnica-montana.ro). The major **threats to *Arnica*** and its habitats are the change of traditional mountain meadow management into more intensively managed agricultural systems and over-harvesting of *Arnica*.

Both species conservation and economical sustainability rely on appropriate **resource assessment methods**, aiming to provide reliable data to determine the optimum maximum sustainable yield of *Arnica* and set annual quotas for its harvesting in the project area, the commune of Gîrda de Sus. Therefore, all *Arnica* habitats were inventoried, the number of flower-heads monitored, the 'generative : vegetative' ratio determined, and the density of flowering *Arnica* plants and their flowering rates analyzed. In addition, the project studies the biodiversity of the *Arnica* meadows and investigated their management through interviews with farmers.

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Out of 8,741 hectares (total surface of the commune of Gîrda de Sus), about 1,600 hectares of open land were surveyed. During three flowering seasons in 2002 (MICHLER 2005), 2004 and 2005, 597 *Arnica* polygons with a total surface of 547 hectares were identified in 32 days of walking through the area. The most important tools for the mapping process were the 1:5000 topographical maps. The borders of the polygons were drawn on the maps and then, using GIS software, the polygons were digitized.

The number of *Arnica* stems was counted in random transects of 30m x 2m for 38 polygons in 2004, 130 polygons in 2005 and 98 polygons in 2006. 9.3 transects were counted on average per polygon during the 2005 field season. The number of flower heads per stem was also analyzed, resulting in an average of two flower heads per stem. Also, knowing the average number of the flowering individuals per square meter, allows to estimate the total number of flower heads.

After data analysis and related statistical calculations, an **annual harvesting quota** of six tonnes of fresh *Arnica* flower heads was determined as sustainable within the commune of Gîrda de Sus (BARBARA MICHLER, pers. comm.). The descriptive statistics of flowering individuals per square meter consist in the calculation of mean, average, maximum and standard deviation.. In 90% of the habitats, the flowering individuals have a density between 0.02 and 2.9 flowering individuals per m^2 (all descriptive statistics were provided by BARBARA MICHLER, internal report, unpublished).

The overall **cost of the resource assessment** for the three field seasons is estimated at 22,000 US$. This calculation includes the costs of the inventorying, the monitoring, the biodiversity research, the soil study research and the meadows management interviews and does not include the costs of a 4x4 car, of IT equipment and software and transport costs. It does also not include the salaries of specialists for analyzing the data and for producing technical reports. Over the long term, the recurring costs of resource assessments of the same area are costs for salaries for field work and data interpretation, accommodation, meals and transport. If more local people are involved in monitoring accommodation costs could be reduced. According to the accepted error of the assessment, a lower number of transects per square hectare could be established, which would offer a possibility to reduce the working days and the costs for accommodation and meals which are in average 11.5 US$ for a person per day.

The questions on how precise this resource assessment method is and if the costs of the assessment can be sustained by a local company who will not benefit from external project funds, still needs to be discussed.

The data obtained from resource assessments and the subsequent data analyses are valuable information for the development of a **management plan** for *Arnica* habitats and for *Arnica* collection. This management plan is hoped to be included in the general management plan of the Apuseni Natural Park established in the region.

To guarantee the long-term sustainability of *Arnica* (and potentially also other MAPs) in the region, an ethical buyer of the product was found, who will also indirectly have an eye on adequate resource assessment in the future. Third party certification is an additional tool of external resource control; an assessment to obtain organic certification (EEC 2092/91) and ISSC-MAP (International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants) pilot assessment were carried out by IMO (Institute for Marketecology) in summer 2006.

Reference

MICHLER, B. (2005): Leitprojekt "Heilpflanzen". – In: RUSDEA, E., REIF, A., POVARA, I. & KONOLD, W. (eds.): Perspektiven für eine traditionelle Kulturlandschaft in Osteuropa. Ergebnisse eines inter- und transdisziplinären, partizipativen Forschungsprojektes im Apuseni-Gebirge in Rumänien. pp. 378-380. Institut für Landespflege, Freiburg (Culterra 34).

Determining the potential production area (PPA) and effective productivity area (EPA) of medicinal plant resources in Bulgaria

SLAVCHO SAVEV[1]

The study aims at the assessment of the species composition of MAPs in the Western Balkan Mountains range and to assess their **total and effective potential productivity area**. Several habitat types were studied: pure beech forests with two subtypes: wet and drier beech formations; wet habitats along the rivers; forest meadows, clearings and pastures; and cutting yards and forest roads. An inventory of MAPs is performed for each habitat type. The plant inventory has been done in three stages: mapping, assessment of productivity, and assessment of stock.

Forest maps have been used as a basis and route sampling method was applied to determine the map units where the target species occur. The relationship among the basic ecological variables of stands and the presence of target species was determined by means of regression statistical analysis. The total area resulted of the analysis was considered as **potential productivity area** (PPA).

Determining the effective productivity area (EPA) was performed by means of experimental plots; in each plot the following characteristics were assessed:

- Coverage of the target species;
- Area covered by the populations of the target species;
- Productivity (g/m^2 and kg/ha);
- Growing stock (kg/ha or t/ha).

These characteristics were used to determine the **effective productivity areas** (EPA). Only areas where enough stock for exploitation was available were considered as EPA. Exploitation stock should meet the following criteria:

- Economical effectiveness of the harvesting;
- Accessibility to the localities;
- Possibility for application of **criteria for sustainable use.**

These criteria are:

(1) Possibility for application of rotations of harvesting. It is determined according to the period of full regeneration of the population. If such regeneration continues, for example, 5 years, then the rotation period of harvesting is 5 years (each year 1/5 of the stock is harvested).

(2) Possibility for proper determining of the period for regeneration of the population after the harvesting.

(3) Possibility to determine the annual harvest on a territory that will not destroy the population of the target species. This parameter is determined as a ratio of exploitation stock and the rotation period.

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Resource assessment methods for sustainable collection of Devil's Claw (*Harpagophytum procumbens* DC.) in Namibia

MARIANNE STROHBACH[1]

Harpagophytum procumbens is a geophyte restricted to sandy areas of the semi-arid Kalahari basin of southern Africa. It survives unfavourable seasons by storing water and assimilates in its **tuberous root system** – the latter consisting of a central main tuber extending into a deep taproot, and secondary tubers, which form on roots growing horizontally off the main tuber, often close to the soil surface. The plant emerges during favourable conditions in spring from the main tuber, and the prostrate-growing shoots die off completely either at the end of the growing season, or when conditions become excessively arid before.

The **secondary tubers** have been used for centuries as a panacea by the San people, and since scientific confirmation of their medicinal value in the 1960s have been harvested extensively for the production of analgesic and anti-inflammatory medicine. Recently, harvesting of the closely related *Harpagophytum zeyheri*, which is distributed in the northern, higher-rainfall outliers of the Kalahari basin, has also increased. **Annual exports** of sliced and dried secondary tuber of both species range between 500 and 800 t, but have already exceeded 1000 t. The majority of this material comes from Namibia, supporting an estimated 10 000 of the poorest households in the country.

In an effort to investigate and demonstrate that harvesting practices can be sustainable in the long term, **annual resource assessments** were undertaken with target communities to set annual harvesting quotas.

Initial methods determining harvesting quotas consisted of plant counts along **randomly walked transects**, extrapolating densities to the total estimated area indicated by community members and multiplying the estimated number of plants with an assumed tuber regeneration weight. **Detailed population studies** on permanent observation sites over a five-year period, carried out in the central Omaheke Region in eastern Namibia, yielded information on typical plant distribution patterns, harvesting impact on age-state distribution within populations, as well as secondary tuber (re)generation rates related to rainfall and harvesting practice. Observed **phenological patterns** enabled an optimal timing of annual resource assessments and harvesting periods. It could also be confirmed that by following a **four-year rotational harvest system** as well as leaving the main tuber intact ensured the continued survival of the population, while overgrazing and bush-encroachment lead to a decline in plant productivity and numbers.

Several survey methods developed for sampling plant densities were tried out in the study area; of these the **Variable Area Transect (VAT) method** proved to be the most rapid, easily understood and yet relatively accurate resource survey method, which, with a few modifications, could also be used by trained community members. The VAT method consists of a fixed-width transect that is investigated from a random point until a set number of individuals has been found. We adapted the method to carry on counting plants in 100-step segments. Depending on the distribution of *Harpagophytum* in the area, the 100 steps will be walked in a random fashion, or in a continuous belt until no more plants can be found. This gives us a better indication as to the actual local distribution of *Harpagophytum* and hence the extrapolation of recorded densities to a specific harvesting area is more accurate.

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In addition, repeatedly practising and evaluating the survey method with harvesters and other community members showed that besides ecologically based issues, resource assessment methods also need to take into consideration **community knowledge** of the plant's life-cycle and ecological requirements, the management of the total available resource (past and present), overall lifestyle and income-generating opportunities of communities as well as the need for a **trusting relationship** between ecologist and harvesting community to ensure a long-term sustainability of harvesting *Harpagophytum* tubers.

Resource Assessment methods for sustainble collection of Ratanhia (*Krameria lappacea*) in Peru

MAXIMILIAN WEIGEND and NICOLAS DOSTERT[1]

In the past few years botconsult GmbH in collaboration with WELEDA GmbH and GTZ has established methods for the sustainable wild harvest of Ratanhia [*Krameria lappacea* (Dombey) Burdet & Simpson] roots in a designated collection area near San Antonio south of the city of Arequipa (Depto. Arequipa, Peru).

The biology and life cycle of *Krameria lappacea* are complex, involving a hemiparasitic life form and very slow growth, with plants taking approximately 7 to 10 years to reach maturity, a size warranting a harvest of the root system. A commercial cultivation of the species appears not feasible. Also, due to the far-reaching root system, its strong lignification and the extremely hard soils **partial harvest of individual plants is not practicable.** Sustainable harvest levels therefore had to be established on the basis of an **estimate of the total number of plants** present in the protected area and their annual regrowth (establishment/recruitment). A maximum harvest level was arbitrarily set at 35% of the annual regrowth. Re-assessment of the status of the population will have to be carried out every second or third year to test for changes in population size or structure and adjust harvest level accordingly, if necessary.

Additional studies have been carried out towards a "Plan Nacional de Manejo Sostenible" for *Krameria lappacea* in Peru in additional Departments of the country to estimate possible sustainable harvest levels on a wider scale and the degree of depletion of this resource at a national level. Population sizes were studied by making a census for repeated 10 x 10 m squares in various populations and counting the number of plants in four age groups plus the excavation holes from harvest (as a proxy for the number of plants that have already been harvested in a given area). Totals of population sizes were used to calculate the **"standing crop"** (total number of plant individuals per age group/ha and total weight of dried *Krameria* roots in kg/ha) and **annual recruitment** (absolute resource regeneration per year in kg/ha). The research shows that while the species as such is still very widespread and locally abundant, it already is commercially extinct (i.e., a commercial harvest is no longer viable) in the Department Lima and parts of the Department Ancash. On the other hand, there are very extensive populations of *Krameria lappacea* in some parts of Depto Ancash reaching 20 to over 40 times the density of San Antonio. Future commercial exploitation should concentrate on these large and healthy populations.

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The importance of taxonomic accuracy in resource assessment

MAXIMILIAN WEIGEND[1]

"Management plans" for sustainability purposes are focussed on a given botanical resource in a clearly delimited geographical region. However, very little if any attention is given to the **correct identification of the plant material** involved and no botanical vouchers are routinely deposited in scientific collections, so that the real identity of the plant material harvested is frequently entirely untraceable and commonly incorrect. Many botanicals on the international market represent wild **mixtures belonging to various species**, which were either mixed at some stage of the post harvest treatment or originate already from mixed collections in the field. Some of the taxa collected may be rare in nature and should not be collected at all and may even be protected by local or national laws.

These problems abound particularly in many plant groups which are taxonomically difficult, even to taxonomists, e.g., many Lamiaceae such as *Thymus* (thyme), *Mentha* (mint), *Minthostachys* (muña) or other plant groups such as *Gentianella* (gentians). However, even common and seemingly well-known plants species such as *Crataegus* (hawthorn) and *Urtica* (stinging nettle) frequently have poorly known and locally endemic subspecies. Different taxa will usually differ in their ecology, abundance, distribution and pharmacological value. Correct identification is of paramount importance for resource assessment, since the actual population sizes and sustainable levels of harvest have to be identified for the resource collected and it has additional ramifications for both conservation and quality management.

The quality of plant identifications depends on several variables: The expertise of the botanist carrying them out, the quality of the literature and reference material at his disposal, and the availability of useful voucher material and data on the plant resource to be collected.

For the purposes of an efficient resource management I propose the following **procedure** to deal with the problem of taxonomic identity:

- Herbarium vouchers are prepared from a representative set of populations in the collection area and labelled according to the standard procedure.
- Vouchers are identified by a knowledgable biologist.
- Vouchers are permanently deposited in a public herbarium (e.g., the National History Museum of the country concerned)
- Area management plan includes the following information:
  - scientific name of the plant;
  - voucher data of the plant material deposited (collector, date, locality, where deposited);
  - name of the scientist who identified the plant;
  - literature used for determination;
  - other, readily confused species in the collection area (*if any*) and differential characters.

This procedure, while appearing tedious to a non-scientist, assures maximum security for the parties concerned in resource management and involves very little costs. Phytochemical analysis, which are routinely carried out as part of the quality control, are then also automatically vouchered and can be readily verified.

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75 years of VILAR scientific work to explore medicinal plant resources of Russia: approaches, methods and results

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The All-Russia (former All-Soviet-Union) Institute of Medicinal and Aromatic Plants (VILAR) is a center of expertise in the field of medicinal plant research in Russia. Since its creation in 1931, **numerous studies** have been carried out on biodiversity of the Russian flora in order to find new biologically active substances and plant raw material resources used for drug substances production.

All steps of plant drug development from target plant identification and raw material resources evaluation to drug production are performed in the Institute. One of the fundamental tasks of the Institute has always been constitution, enrichment and preservation of herbal funds, enlargement of the botanical garden medicinal plant and seed collections.

In the process of wild-growing medicinal plant (WGMP) investigation, **different approaches of natural resources evaluation** are used: ecologico-geographical, coenotical, cartographical and others. Two main methods have been worked out for resource assessment: evaluation of given populations and the method of key areas.

About **600 expeditions** have been organized on a large spectrum of medicinal plants distributed in all climatic zones; taiga, broad-leaved forests, forest-steppe, steppe and high-altitude belt areas displaying the highest biodiversity.

Excessive exploitation of certain plant species (for example, *Rhodiola rosea*, *Rhaponticum carthamoides*) raised the question of their conservation. Monitoring of resources and regeneration after harvesting should be carried out for these species and in situ conservation procedures should be developed.

Based on VILAR's long experience and through developing external collaborations, new goals and perspectives have been formulated:

- Analysis of expedition results on WGMP areas and resources investigation;
- Study of WGMP resources in key regions reflecting physico-geographical, phyto-coenotic, ecological, nature conservation and economic specificity of medicinal plant species growth (reserves, specially protected natural areas, agricultural regions);
- Development of the geo-informational system "Medicinal flora geography of Russia" and establishment of the electronic atlas "Medicinal plant areas and resources of Russia";
- Creation of a modern system of standardized and legal documentation for sustainable use, control, exploitation and preservation of WGMP resources.

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Assessment for Maximum Sustainable Yield of Medicinal Aromatic Plants (MAPs)

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Anexo 8:

Working draft

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

INTERNATIONAL STANDARD
FOR
SUSTAINABLE WILD COLLECTION OF MEDICINAL AND AROMATIC PLANTS
(ISSC-MAP)

WORKING DRAFT (JUNE 2006)

Medicinal Plant Specialist Group (MPSG)
Species Survival Commission (SSC)
IUCN – The World Conservation Union

STEERING GROUP
for the development of an
International Standard
for the Sustainable Wild Collection
of Medicinal and Aromatic Plants

WWF

TRAFFIC

IUCN

MEDICINAL
PLANT
SPECIALIST
GROUP

By themselves standards do not guarantee a particular performance threshold. Rather, the process through which they are developed, the technical rigor of the standards themselves, and the consistency and competency with which they are applied determine their value and impact.

(Pierce and Laird 2003)

This document has been prepared by the Medicinal Plant Specialist Group (MPSG) of the Species Survival Commission (SSC), IUCN – The International Conservation Union, on behalf of a Steering Group consisting of the Bundesamt für Naturschutz (BfN), MPSG, and WWF Germany and TRAFFIC. The Steering Group has been brought together by BfN Germany to develop a standard for the sustainable wild collection of medicinal and aromatic plants. This work is supported through linked projects jointly funded by BfN, WWF Germany, and IUCN-Canada.

This document, and other documents related to this project, are available on the project download website: http://www.floraweb.de/map-pro/.

Comments on the *International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants* (ISSC-MAP), Working Draft (June 2006) are welcome. Please direct inquiries and comments to: MAP-Standards-Criteria@wwf.de.

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1. INTRODUCTION

This working draft of the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) has been prepared by the Medicinal Plant Specialist Group (MPSG) of the Species Survival Commission (SSC), IUCN – The International Conservation Union, in collaboration with a Steering Group consisting of the MPSG, Bundesamt für Naturschutz (BfN), WWF Germany, and TRAFFIC Germany. The ISSC-MAP is designed to help users, collectors, and managers of wild-collected medicinal and aromatic plant (MAP) resources to understand and comply with the conditions under which sustainable collection of these resources can take place. An international advisory group of experts from diverse backgrounds has provided guidance in drafting the ISSC-MAP. The application of this draft standard will be tested in field implementation trials addressing a range of potential and existing management situations for wild-collected MAP resources.

The ISSC-MAP builds on recent efforts to define a framework for the sustainable use of biological diversity. The United Nations Convention on Biological Diversity (CBD) (UNEP 2001) provides both global and national contexts for these efforts. Under the CBD, specific guidance for the ecological, socio-economic, and equity basis for conservation and sustainable use of biodiversity has been articulated in the *Ecosystem Approach* (Secretariat of the CBD 2000), the *Global Strategy for Plant Conservation* (Secretariat of the CBD 2002), the *Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization* (Secretariat of the CBD 2002), and the *Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity* (Secretariat of the CBD 2004).

The ISSC-MAP responds to the need to use biodiversity resources to improve human well-being by contributing to the objectives and targets defined by the Millennium Development Goals (UN 2005), and to the Johannesburg Plan of Implementation adopted by the World Summit on Sustainable Development (Secretariat of the CBD 2002).

More specifically focusing on medicinal plants, the ISSC-MAP is designed to follow and, more importantly, to elaborate the recommendations of the 1993 WHO/IUCN/WWF *Guidelines on the Conservation of Medicinal Plants* (WHO, IUCN & WWF 1993) and the *WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants* (WHO 2003). These guidelines provide general recommendations for the development of a global framework of practice standards for MAP. Of these documents, only the 1993 *Guidelines* directly address ecological and socio-economic/equity issues related to sustainable wild harvest, and these are now out of date. WHO, IUCN, WWF and TRAFFIC are currently working together to revise these *Guidelines* through an international consultation process and with the intent to incorporate broader guidance and principles related to sustainable use of biological diversity, access and benefit sharing, and fair business practices. Publication of these revised and updated *Guidelines* is anticipated in 2007.

The ISSC-MAP will bridge the gap between existing broad conservation guidelines, and management plans developed for specific local conditions. Adopting the principles and applying the criteria that make up the ISSC-MAP will help private companies, government agencies, research centres, and communities to identify and follow good practices for the following six key elements of sustainable wild collection of medicinal and aromatic plants (MAP):

1. Maintaining wild MAP resources
2. Preventing negative environmental impacts
3. Complying with laws, regulations, and agreements
4. Respecting customary rights
5. Applying responsible management practices
6. Applying responsible business practices

The process to elaborate a standard for the sustainable wild collection of MAP is funded by the German Federal Agency for Nature Conservation / Bundesamt für Naturschutz (BfN) in association with The World Conservation Union (IUCN), WWF Germany, and TRAFFIC. This document and other documents related to this project are available on the Project download website: http://www.floraweb.de/map-pro/.

The ISSC-MAP is an evolving document. This working draft is intended to be tested and revised based on experience gained in field implementation trials, in partnership with interested organizations, during 2006 - 2008, as well as through continuing consultation with an advisory group broadly representative of potential users of the ISSC-MAP.

2. BACKGROUND: WHY IS THE ISSC-MAP BEING DEVELOPED?

Medicinal and aromatic plants (MAP)[1] have been an important resource for human health care from prehistoric times to the present day. According to the World Health Organization (WHO), the majority of the world's human population, especially in developing countries, depends on traditional medicine based on MAP (WHO 2002). Between 50,000 and 70,000 plant species are known to be used in traditional and modern medicinal systems throughout the world (Schippmann et al. 2006). About 3,000 MAP species are traded internationally (Lange and Schippmann 1997), while an even larger number of MAP species are found in local, national, and regional trade.

Relatively few MAP species are cultivated, however. The great majority of MAP species in trade are wild-collected (Lange and Schippmann 1997; Srivastava et al. 1996; Xiao Pen-gen 1991). This trend is likely to continue over the long term due to numerous factors, including:

- Little is known about the growth and reproduction requirements of most MAP species, which are derived from many taxonomic groups for which there is little or no experience of cultivation.
- The time, research, and experience leading to domestication and cultivation are costly, and relatively few MAP species have the large and reliable markets required to support these inputs.
- In many communities where wild collection of MAP is an important source of income, land for cultivation of non-food crops is limited.

Moreover, cultivation may provide fewer environmental, social, and economic benefits than wild collection of some MAP species. Wild collection of MAP secures valuable

[1] Definitions of use of plant species often overlap. In this document, the term "medicinal and aromatic plants (MAP)" includes plants used to produce pharmaceuticals, dietary supplement products and natural health products, beauty aids, cosmetics, and personal care products, as well as some products marketed in the culinary/food sector.

income for many rural households, especially in developing countries, and is an important factor in the source countries' local economies (Schippmann et al. in press). Wild collection can provide incentives for conservation and sustainable use of forests and other important plant areas.

However, over-harvesting, land conversion, and habitat loss increasingly threaten a considerable portion (approximately 15,000 species, or 21 per cent) of the world's MAP species and populations (Schippmann et al. in press). For these reasons, approaches to wild MAP collection that engage local, regional, and international collection enterprises and markets in the work of conservation and sustainable use of MAP resources are urgently needed.

There are many challenges to meet in developing and applying a standard set of principles and good practices leading to support sustainable wild collection of MAP resources. These challenges include:

- Circumstances of ecology, habitat, and pressures on resource are unique for each species, requiring management plans that are specific to each MAP collection operation and area.
- Little research on harvesting techniques has been directed toward understanding how to collect wild MAP species sustainably.
- Maximum quotas for wild-collection of MAP species are often based on overly simple and untested assumptions about the relationship between available supply and regeneration of MAP resources.
- Products, uses, and markets based on MAP species are numerous and diverse, with similarly numerous and diverse entry points for practices supporting sustainable use.
- There is a wide proliferation of labels and claims, such as organic and fair trade, which imply but do not provide a means of verifying sustainable wild collection.
- Long and complex source-to-market supply chains make tracing a product back to its source extremely difficult.

Existing principles and guidelines for conservation and sustainable use of medicinal plants address primarily the national and international political level, but only indirectly provide the medicinal plant industry and other stakeholders, including collectors, with specific guidance on sustainable sourcing practices. For example, the revised *Guidelines on the Conservation of Medicinal Plants* (WHO/IUCN/WWF/TRAFFIC forthcoming) and the *WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants* (WHO 2003) provide general recommendations addressed primarily to governments and other political stakeholders, NGOs, IGOs and businesses world-wide. These guidelines call for, but do not provide, concrete principles and criteria for the conservation and sustainable use of medicinal plants. The ISSC-MAP provides a practical interface between the general recommendations set out in these *Guidelines*, and management plans that must be developed for particular species and specific situations.

Other existing or proposed standards for the sustainable collection of non-timber forest products (NTFP) provide useful models for MAP. Models for sustainable harvest of NTFP that may be particularly useful for MAP include the certification system of the Forest Stewardship Council (FSC), the International Federation of Organic Agricultural Movements (IFOAM), and Fairtrade Labelling Organizations

International (FLO).[2] Other important models include natural resource co-management agreements with indigenous communities, and access and benefit sharing arrangements between genetic resource users and providers.

The ISSC-MAP working draft builds on existing principles, guidelines, and standards, but expands and extends these to provide principles and criteria more relevant to the sustainable wild collection of MAP resources. Implementing the ISSC-MAP will benefit ecological resources or area managers, industry, and local collectors by providing a reputable standard of good practice for sustainable wild collection against which local performance can be designed and monitored with criteria and verified with indicators relevant to MAP resources. Harmonization with appropriate ecosystem, fair trade, production, product quality, and other relevant standards is considered an important avenue for developing and implementing this standard.

The ISSC-MAP is designed to be applicable to the wide array of geographic, ecological, cultural, economic, and trade conditions in which wild-collection of MAP resources occurs. It primarily addresses wild collection of medicinal and aromatic plant materials for commercial, rather than subsistence or local use, purposes. The standard focuses on best ecological practices but also aims to support responsible social standards and business practices that affect collectors and collection operations, because these elements in turn affect the management of collected species and collection areas.

3. PROCESS: HOW IS THE ISSC-MAP BEING DEVELOPED?

The process to elaborate an international standard for the sustainable wild collection of medicinal and aromatic plants (ISSC-MAP) is a joint initiative of the German Bundesamt für Naturschutz (BfN), WWF/TRAFFIC Germany, IUCN Canada, and the IUCN Medicinal Plant Specialist Group (MPSG). Together, these organizations have formed a steering group to oversee the development of the standard. An international, interdisciplinary advisory group has been formed to involve relevant stakeholders from ecological, socio-economic and fair-trade sectors in the process of developing and testing a standard for sustainable wild collection of MAP.[3] The advisory group brings together the medicinal plant / herbal products industry, small-scale collection enterprises, non-government organizations, conservation and certification organizations. The members' specific expertise and advice on the content of the standard, the development of practical guidance, and the opportunities to harmonize the development of this standard with other relevant frameworks supports the implementation of the ISSC-MAP.

A first draft of this standard was completed in November 2004 for discussion with members of the advisory group (Leaman 2004). The first draft consisted of four separate practice standards[4]: I. Ecosystem and MAP resource management; II. Wild collection of MAP resources; III Domestication, cultivation, and enhanced in situ production of MAP resources; and IV. Rights, responsibilities, and equitable relations of stakeholders. The first draft was presented to the World Conservation Forum of

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[2] For a summary and analysis of efforts that have been made in the past to consider the relevance and application of various models aimed at certification of sustainable wild collection see: Shanley, Pierce, Laird, & Guillen 2002.
[3] A current list of members of the Advisory Group is available on the project website: http://www.floraweb.de/map-pro/.
[4] The first draft MAP standard was loosely modelled on the structure of the Marine Aquarium Council (MAC) "Core Standards and Best Practice Guidance for the Marine Aquarium Trade" (MAC 2002), and on the Working Draft ABS Management Tool currently under development by the State Secretariat for Economic Affairs (SECO), Government of Switzerland (SECO 2005).

the 3rd IUCN World Conservation Congress in Bangkok in November 2004. A first expert workshop, convened on the Isle of Vilm in December 2004, provided a discussion forum for the members of the Advisory Group on the first draft document and other process related issues.

A second draft, distributed to the Advisory Group in April 2005, condensed the original four practice standards into a single standard with ten principles, related criteria, and proposed indicators (Leaman & Salvador 2005). The relevance and practicality of the second draft standard was tested August – October 2005 in five existing MAP field projects. The projects were selected from different geographical regions, and offering a range of socio-economic and resource management circumstances:

- A private company, *Anđelic d.o.o.* in Bosnia-Herzegovina (financed by BfN/ INA, and SIPPO)
- A non-profit initiative, *Iracambi Medicinal Plants Project* in Brazil (financed by Manfred-Hermsen-Stiftung)
- A state-owned and managed protected area of *Wanglang National Nature Reserve & Baima State Forest* in China (financed by WWF Germany)
- A community-based *agro-artesanal producers' association (AAPPSME)* in Ecuador (financed by UNCTAD, with additional support from Manfred-Hermsen-Stiftung)
- A non-profit *Sustainably Harvested Devil's Claw* project in Namibia (financed by Salus Haus, Germany)

Results from the field consultations have been summarized by Salvador (2005), and were evaluated during a second expert workshop on the Isle of Vilm in December 2005[5]. The current working draft of the ISSC-MAP incorporates comments from the Advisory Group, results of the field consultation phase, and discussions during the 2nd Vilm workshop.

Participants in the 2nd Vilm workshop identified a range of potential implementation strategies for the ISSC-MAP (Figure 1). Implementation of the ISSC-MAP must address a number of additional challenges, including:

- Awareness by potential ISSC-MAP users of the impacts of wild collection on MAP resources and perception of the need for a standard
- Participation of potential ISSC-MAP users in the process of developing and implementing the standard
- Credibility of the overseers of the standard
- Accountability of the users of the standard
- Willingness of industry and consumers to support additional costs associated with applying the standard

A study of implementation strategies and opportunities for the ISSC-MAP was commissioned by WWF Germany early in 2006 (Kathe and Gallia 2006). Principal strategies examined include:

- Integration with existing standards and mechanisms (e.g., CITES non-detriment findings for species listed on Appendix II).

[5] Descriptions and summaries of the field consultation projects and the testing methodology are available at www.floraweb.de/map-pro, as are the minutes of the Vilm workshops.

- Partnership / harmonization with existing or developing standards and mechanisms (e.g., organic and fair-trade certification schemes, BioTrade principles and criteria).
- Stand-alone mechanism (e.g., verification / certification by one or more members of the ISSC-MAP steering group).

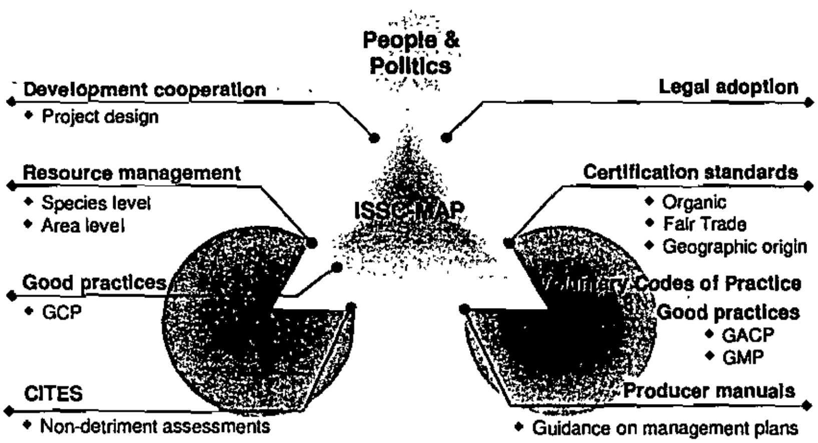

Figure 1. Potential implementation strategies for the ISSC-MAP

Opportunities for implementation of the ISSC-MAP in South-eastern Europe were discussed during an international workshop convened in Bosnia and Herzegovina in May 2006. A preliminary implementation trial, focusing on community-managed collection areas for medicinal plants in India, will be undertaken in 2006 by the Foundation for Revitalization of Local Health Traditions (FRLHT) with support from Plantlife International. An extended pilot implementation phase is planned for 2007-2008.

4. STRUCTURE AND CONTENT OF THE ISSC-MAP

The **purpose** of the ISSC-MAP is to ensure the long-term survival of MAP populations in their habitats, while respecting the traditions, cultures and livelihoods of all stakeholders.

The **objectives** of this standard are:

- To provide a framework of principles and criteria that can be applied to the management of MAP species and their ecosystems;
- To provide guidance for management planning;
- To serve as a basis for monitoring and reporting; and

- To recommend requirements for certification of sustainable wild collection of MAP resources.

The current working draft of the ISSC-MAP follows a functional hierarchy of components according to the division outlined in Table 1. These definitions are based on a general framework recommended for the formulation of sustainable forest management standards (Lammerts van Bueren and Blom 1997).

Table 1. Functional differentiation of standard components

Element	Description
Standard	Set of rules developed for conceptualisation, implementation, and/or evaluation of good management practices.
Principle	A fundamental law or rule, serving as a basis for reasoning and action. Principles are explicit elements of a goal.
Criterion	A state or aspect of a process or system, which should be in place as a result of adherence to a principle. The way criteria are formulated should give rise to a verdict on the degree of compliance in an actual situation.
Indicator	A quantitative or qualitative parameter which can be assessed in relation to a criterion. It describes in an objectively verifiable and unambiguous way features of the system, or elements of prevailing policy and management conditions and human driven processes indicative of the state of the eco- and social system.
Method of control (verifier)	The source of information for the indicator or for the reference value for the indicator.

The current working draft of the ISSC-MAP has six principles and 18 criteria, addressing ecological, social, and economic requirements for sustainable wild collection of MAP. These are listed in Table 2. The proposed indicators are elaborated in Annex 1.

Table 2. ISSC-MAP Principles and Criteria

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. **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.

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.

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.

2.2 Habitat (landscape level) management

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

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.

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.

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.

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.

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.

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.

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.

5.4 Documentation

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

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.

6.2 Traceability

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

6.3 Financial viability

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

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.

6.5 Worker safety and compensation

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

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Annex 1. ISSC-MAP Proposed Indicators

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence: Collection manager	Competence: Consultant	Competence: Certifier	Category[6]
Section I	**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.							
Criterion 1.1	**Conservation status of target MAP species** The conservation status of target MAP species and populations is assessed and regularly reviewed.	1.1.1	Current conservation status of target MAP species is assessed according to the IUCN Red List categories and criteria (version 3.1, 2001) and regularly reviewed.	• IUCN Red List programme, Red List database, and/or Red List Authority for medicinal plants + • Conservation status reports	X X	 X		1
		1.1.2	For species determined to be Data deficient (DD) or not evaluated (NE) according to the IUCN Red List categories and criteria, sufficient information is gathered to complete and / or review a previous conservation status assessment (according to 1.1.1).	• Documents of gathered information • Written field verification report on the species population • Resource assessment • Red List data required - checklist	X X X X	 X X X		2→1
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.	1.2.1	Endangered or critically endangered species (according to the IUCN Red List) are not wild collected for commercial purposes.	• List of collected plants	X			1
		1.2.2	Management strategies are defined and implemented to reduce identified threats to species considered "vulnerable" according to the IUCN Red List.	• List of collected plants • Management plan	X X			1
		1.2.3	MAP species targeted for collection and their geographic sources are accurately and adequately identified with voucher specimens from the collection site.	• Handbooks, manuals, and other aids to species identification • Voucher specimens with taxonomic names, as well as local and trade names • Map showing collection location or GPS coordinates included on voucher + • Quality standards • Documented instructions of the buyer	X X X X X	 X		2→1
		1.2.4	Maps of collection sites identify target populations.	• Maps of each collection area	X			1

[6] Priority categories have been proposed by the Institute for Marketecology (IMO) in work undertaken to revise the indicators for the current Working Draft (June 2006) ISSC-MAP:
1: Major must = minimum requirement
2: Minor must = should requirement
3: Recommendation
The MPSG has proposed a higher priority for some of the indicators, indicated by "→".

Criterion	Number	Indicator	Form of Indicator / Method of control	Competence			Category[8]
				Collection manager	Consultant	Certifier	
	1.2.5	Internal collection instructions define collection methods for each target MAP species / part of plant based on appropriate sources of information and knowledge of biological characteristics of the species.	• Collection instructions/ Internal Collection Rules • Species- and site-specific monographs for collectors + • Information gathering documents • Published research, on-site research and observations, local knowledge and collectors' experience. • Consultation with relevant specialist/ resource management authorities	X X X X	X		1
	1.2.6	Collection instructions are regularly surveyed and adjusted on the basis of observation of its impacts on targeted MAP species.	• Written monitoring reports • Analysis of information collected	X X	X X		1
	1.2.7	Waste of target MAP resources caused by poor collection practices is minimized.	• Collection instructions/ Internal Collection Rules • Visual / physical verification of area by inspector	X		X	2→1
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.	1.3.1	Baseline information is available on target species' population size, distribution, and structure (age classes) in the collection area.	• Assessment reports, scoping inventories, information gathering documents. • Information from relevant studiesConsultation with relevant specialist/ resource management authorities	X X X	X X		2→1
	1.3.2	Maximum allowed collection quantities are defined in the internal collection instructions for each species/ part of plant and for each collection area.	• Resource assessment • (including regeneration rate assessment) • Confirmation of sustainability of a certain harvest quantity issued by an independent expert / relevant authority • Collection permit issued by resource management authority listing all plants with respective maximum quantities • Historical data registers or monitoring reports on stable production with present collection activities + • Collection instructions / Internal Collection Rules • Species- and site-specific monographs for collectors	X X X X X	X X		1
	1.3.3	Collection quantities are defined using reliable and practical measurements (e.g., volume, weight, number).	• Collection instructions / Internal Collection Rules • Species- and site-specific monographs for collectors	X X	X		1

Criterion	Number	Indicator	Form of Indicator / Method of control	Competence			Category[8]
				Collection manager	Consultant	Certifier	
	1.3.4	When appropriate and adequate knowledge / information is not available, a data collection programme is undertaken and any ongoing collection takes a precautionary approach (collected quantities below potential production).	• Data collection programme • Information gathering documents. • Documented observation and visual appraisal • Overall risk assessment	X X		X X	1
	1.3.5	The proportion of mature, reproducing individuals to retain in the target populations for collection is determined to maintain a baseline population density and a baseline structural and genetic diversity.	• Assessment reports • Information from relevant studies • Consultation with relevant specialist/ resource management authorities	X X X	X X X		
	1.3.6	Minimum and maximum age / size class allowed for collection is defined for the target species and collection site in the internal collection instructions.	• Assessment reports • Consultation with relevant specialist/ resource management authorities + • Collection instructions / Internal Collection Rules • Species- and site-specific monographs for collectors	X X X X	X X X		2
	1.3.7	The age / size-classes are defined using reliable and practical characters (e.g., plant diameter / DBH, height, fruiting and flowering, local collectors' knowledge).	• Assessment reports • Species- and site-specific monographs for collectors	 X	X X		2→1
	1.3.8	Maximum allowed frequency of collection of the target species, defined in the collection instructions, does not exceed the rate of replacement of adult individuals or plant part collected in the collection region.	• Assessment reports / Declaration of relevant specialist/ resource management authorities • Collection instructions / Internal Collection Rules • Species- and site-specific monographs for collectors	X X X	X X		
	1.3.9	Periods allowed for collection are determined using reliable and practical indicators (e.g., seasonality, precipitation cycles, flowering and fruiting times) and are based on information about the reproductive cycles of target MAP species.	• Assessment reports / Declaration of relevant specialist/ resource management authorities • Species- and site-specific monographs for collectors	X X	X X		2→1
	1.3. 10	Consolidated data on collected quantities are available (why not "recorded" like in the following indicator (species/area/year) and confirm compliance with collection instructions.	• Collection/ purchase records	X			2
	1.3. 11	Collection quantities, periods and frequency of collection are recorded and confirm compliance with collection instructions.	• Collection/ purchase records	X			1

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence			Category[5]
					Collection manager	Consultant	Certifier	
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.							
Criterion 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.	2.1.1	Existing species and habitat conservation strategies relevant to the collection area are recognized and included in the management plan (according to Criterion 5.1.6, 5.1.7).	• Management plan	X			2→1
		2.1.2	Knowledge of special functions in the ecosystem / dependent relationships between target MAP and other species is documented and incorporated into management and monitoring (according to Criterion 5.1 and 5.2).	• Management plan	X	X		3
Criterion 2.2	**Habitat (landscape level) management** Management activities supporting wild MAP collection do not adversely affect ecosystem diversity, processes, and functions.	2.2.1	The habitat management practices applied in the collection area are described.	• Information from the owner/ responsible manager	X			2→1
		2.2.2	Negative impacts of MAP collection practices and management activities on the collection area are identified in the management plan (according to Criterion 5.1).	• Management plan	X	X		2→1
		2.2.3	Implemented collection methods & tools are appropriate: damage to the plant/plant population is minimised.	• Consultation with relevant specialist/ resource management authorities • Visual / physical verification of area by inspector	X	X	X X	1
		2.2.4	Collection methods do not create negative ecosystem-level impacts in the collection area (according to 2.2.1).	• Consultation with relevant specialist/ resource management authorities • Visual / physical verification of area by inspector	X	X	X X	1
		2.2.5	Other activities in the area representing potential threats on sustainability of species and habitat are identified (e.g. other collectors in the same area).	• Reports on other activities in the area • Reports on other companies / groups collecting in the same area • Consultation with other operations/ management authorities working in or adjacent to the collection area	X X X			1
		2.2.6	The management plan (acc. Criterion 5.1) includes strategies to prevent or reduce negative impacts on other species and the collection area (according to 2.2.1).	• Management plan • Agreements with other companies in the area	X X			2→1
		2.2.7	Changes in ecosystem structure, function, and services are monitored and reported (according to Criterion 5.2).	• Written monitoring reports	X			1

Criterion	Number	Indicator	Form of indicator / Method of control	Competence: Collection manager	Competence: Consultant	Competence: Certifier	Category[§]
	2.2.8	No prohibited inputs (according to organic standards) are used in the collection area.	• Official confirmation from regional forest office or similar (land owner, responsible manger) • Visual / physical verification of area by inspector • Overall risk assessment of the area	X		X X	1
	2.2.9	Landscape-level and intensive management practices promoting MAP resources (e.g. overstory reduction, enrichment planting) do not negatively affect sensitive species or the ecosystem structure, diversity processes and functions in the collection area.	• Written monitoring reports • Field notes / documented observations and visual appraisal • Consultation with relevant specialist/ resource management authorities	X		X	2
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.							
Criterion 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.	3.1.1	The area where wild collection is carried out is clearly defined and its boundaries established.	• Current versions of maps at an adequate scale for all the collection areas (also community/ collector-generated maps and surveys)	X			1
	3.1.2	The ownership, tenure, or use rights of the collection area are known over a time-scale that is long enough to fulfil the stated MAP resource management objectives.	• Relevant documents that identify the responsible managers /ownership include: Land title / deed, lease agreement, resource management agreement, collection permit, letter from a solicitor / lawyer, land registry records	X			2
	3.1.3	There is a regulatory system in place protecting the MAP management area from illegal collection activities, settlement, and other unauthorized activities.	• Documented Regulatory system/ Policy from the responsible manager or authority / owner	X			2
	3.1.4	Mechanisms of control effectively insure the functioning of the regulatory system.	• Regulatory system • Interview with collectors • Information from the responsible manager or authority / owner • Monitoring reports	X X X		X	2
	3.1.5	The collectors/ collection managers have a clear right to use and manage the MAP resources.	• Collection permits • Contracts or agreements	X X			2

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence			Category[8]
					Collection manager	Consultant	Certifier	
Criterion 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.	3.2.1	Relevant legal, regulatory, and administrative requirements and responsibilities are known and understood by resource managers.	• Relevant legal, regulatory, and administrative documents (including contracts, collection permits, export permits,etc.) + • National/ local lists of protected species found in or likely to be found in the collection area • National/local lists or maps of protected areas within or overlapping with the collection area • Communication with relevant authorities / local conservation organizations	X X X X			1
		3.2.2	Management plans, procedures, work instructions and contracts meet relevant legal, regulatory, and administrative requirements.	• Contracts + • Management plans, procedures, work instructions + • Collection permits + • Maps indicating location of any protected areas within or adjacent to collection area + • Export permits (e.g. CITES Appendix II species)	X X X X X			1
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.							
Criterion 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.	4.1.1	Knowledge of legal or customary rights, traditional uses and cultural and religious significance of MAP and other species and their habitats is available	• Documentation on traditional MAP and collection area uses so as on cultural and religious significance • Information gathering documents • Information from local groups/ indigenous peoples • Consultation with relevant authorities and specialists	X X X			2
		4.1.2	Traditional uses / access rights are included in the resource / collection area management plan (according to criterion 5.1)	• Management plan	X	X		2→1
		4.1.3	Collection of MAP resources respects the cultural and religious significance of MAP and other species and their habitats (according to 4.1.1).	• Agreements with local groups / indigenous peoples • Maps indicating location and boundaries of these areas	X X			1

Criterion	Number	Indicator	Form of Indicator / Method of control	Competence: Collection manager	Competence: Consultant	Competence: Certifier	Category*
	4.1.4	Potential impacts of MAP collection activities on traditional use, access rights, and cultural heritage in the collection area (on the basis of indicator 4.1.1) are defined (including the influx of collectors).	• Risk analysis of potential impacts	X			2→1
	4.1.5	Measures are taken to avoid loss or damage affecting the legal or customary rights, resources, health security or livelihoods of local communities and indigenous peoples (on the basis of indicator 4.1.1).	• Management plan	X			2→1
	4.1.6	Fair compensation is provided in the case of such loss or damage.	• Evidence (e.g. document records) of consultation / conflict resolution	X			2→1
	4.1.7	Availability, accessibility, and quality of medicinal plant resources for local and traditional use (on the basis of indicator 4.1.1) are not undermined or diminished by commercial collection.	• Records on consultations with local communities and indigenous people concerning availability, accessibility and quality of medicinal plant resources	X			2→1
	4.1.8	Appropriate and effective mechanisms are used to resolve grievances.	• Evidence (e.g. document records) of consultation / conflict resolution with local communities and indigenous peoples concerning MAP collection activities	X			2→1
Criterion 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.	4.2.1	Agreements with local communities and indigenous people exist.	• Agreement record/document	X			2
	4.2.2	Agreements are in compliance with relevant national laws and regulations concerning access and benefit sharing.	• National legislation / regulations	X			1
	4.2.3	Concerning the use of traditional knowledge: Informed consent is given by the source community, and mutually agreed terms are reached for access to this knowledge and the equitable distribution of benefits arising from its use.	• Agreement documents	X			2→1
	4.2.4	Evidence exists of prior informed consent (PIC) and mutually agreed terms (MAT) with respect to genetic resource access, management responsibility, and delegation of control to other agencies.	• Contracts and agreements include evidence of prior informed consent (PIC); statement of mutually agreed terms (MAT)	X			2→1
	4.2.5	Resource access and benefit sharing agreements reflect available scientific, local, industry, and other relevant sources of knowledge / information concerning the current and anticipated value of the resource.	• Agreement document • Records, reports or other evidence reflecting the resource value	X X			2→1

Criterion		Number	Indicator	Form of indicator / Method of control	Competence: Collection manager	Competence: Consultant	Competence: Certifier	Category*
		4.2.6	Mechanisms for sharing benefits are perceived as fair by beneficiaries.	• Declaration of the beneficiaries	X			2→1
		4.2.7	Agreements allow for new information and changing local conditions affecting these communities.	• Agreement document	X			2→1
		4.2.8	Collection and processing of wild-collected MAP products are conducted in a manner that strengthens and diversifies the local economy.	• Evidence of reasonable provision for local employment • Local ownership of and investment in MAP wild collection operations	X X			1
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.							
Criterion 5.1	**Species / area management plan** A species / area management plan defines adaptive, practical management processes and Good Collection Practices.	5.1.1	A management plan for sustainable collection exists.	• Management plan	X			1
		5.1.2	The management plan includes: a) Plant and habitat conservation strategies b) Internal quality standard according to indicator 6.1.2 c) Documented procedures required by this standard (e.g. monitoring, measurements and analysis of impacts of collection practices) d) Documents needed by the wild collection company/organization to ensure the effective planning, operation and control of its processes e) Records and documents required by this standard.	• Management plan	X			1
		5.1.3	The management plan is specific to the collection area (site) and to the MAP species collected.	• Management plan	X			1
		5.1.4	The management plan is reviewed at regular intervals on a timeframe specified in the plan to ensure its continuing suitability, adequacy, and effectiveness in meeting the objectives of this standard.	• Summaries of management plan revision	X			1
		5.1.5	Records from management plan reviews are maintained.	• Summaries of management plan revision	X			2→1
		5.1.6	The management plan takes into consideration any management plan that refers to the collection area and that is produced by the appropriate resource management authority.	• Management plan • Consultation with other operations / management authorities working in or adjacent to the collection area	X X			1

Criterion	Number	Indicator	Form of Indicator / Method of control	Competence			Category[8]
				Collection manager	Consultant	Certifier	
	5.1.7	Overlapping and adjacent protected areas and areas with special management objectives are identified.	• Management plan • Consultation with other operations / management authorities working in or adjacent to the collection area • Maps	X X X			1
	5.1.8	Maps are available to indicate locations of extraction trails or roads, conservation areas and main infrastructure at a scale that is useful for supervision of management activities and to facilitate on-site monitoring.	• Maps	X			1
	5.1.9	All major sources of potential contamination are clearly indicated on the map and excluded from collection.	• Maps • Internal Collection Rules/ Good Collection Practices • Visual / physical verification of area by inspector •	X X		X	1
	5.1.10	Written internal instructions exist for each collection area on: a) collection sites, b) collection methods, c) maximum collection quantities, d) maximum allowed collection frequency and e) periods to avoid and concentrate collection activities.	• Internal Collection instructions/ Good Collection Practices • Species- and site-specific monographs for collectors	X X			1
	5.1. 11	Collection Instructions/ Good Collection Practices and Management plan are in compliance with criterion 1.3 of this standard.	• Internal Collection Instruction/ Good Collection Practices • Species- and site-specific monographs for collectors	X X			1
	5.1. 12	Collection instructions are revised and updated according to new species and site-specific information and observations.	• Updated collection instructions / Species- and site-specific monographs for collectors	X			1
Criterion 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.	5.2.1	Assessment and regular monitoring of the target MAP resources and habitats, and of social / cultural and economic issues related to MAP collection are performed, documented, and incorporated into the management plan (according to criterion 5.1).	• Assessment reports, scoping inventories, information gathering, written monitoring reports and analysis of results • Management plan	X X	X		1
	5.2.2	Collection instructions specify observations required to monitor collection impacts.	• Internal Collection Instruction/ Good Collection Practices • Monitoring reports	X X			2→1
	5.2.3	Periodic regeneration surveys are conducted within the management area using repeatable, comparable survey methods.	• Document on survey method + • Written monitoring reports	X X			2

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence			Category*
					Collection manager	Consultant	Certifier	
		5.2.4	Population size, distribution, and structure (age/size-class distribution) as recorded in the regeneration survey remain equal to or above baseline values and reflect a healthy population.	• Assessment reports, scoping inventories, information gathering, written monitoring reports and analysis of results • Documented observations and visual / physical verification of area •	X X		X	1
		5.2.5	Periodic monitoring within the management area confirms that availability, viability and quality of the target resource / part of plant remain stable or increase.	• Written monitoring reports, scoping inventories, information gathering, and analysis of results + • Visual / physical verification of area by inspector •	X		X	1
		5.2.6	Inventory, assessment, and monitoring are conducted using tools and procedures within the reasonable (existing or achievable) skills and capacity of the collectors / field managers.	• Assessment reports, scoping inventories, information gathering, written monitoring reports and analysis of results • Field notes / documented observations and visual appraisal •	X		X	2→1
Criterion 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.	5.3.1	Groups, organizations, enterprises, individuals, agencies, etc. having an interest in the targeted MAP resources, collection area or the potential impacts, are identified in the management plan (according to criterion 5.1).	• Management plan	X			2
		5.3.2	Regular consultations are maintained with people and groups directly affected by MAP collection and resource management operations.	Evidence of ongoing and effective communication with and participation of affected communities, e.g.: • Early notification / opportunity for involvement • Definition of roles and responsibilities • Facilitation of participation • Records, plans, schedules of meetings with contracting parties and other stakeholders • Records of decisions taken as a result of such consultations.	X			1
		5.3.3	Collectors' organizations and communities affected by MAP collection activities are actively involved in the development and implementation of MAP resource management.					1
		5.3.4	Resource conflicts with adjoining landowners / managers, or other resource users, are resolved or addressed in a systematic and effective manner.					2
Criterion 5.4	**Documentation** Procedures for collecting, managing, and sharing information required for effective collection management are established and carried out.	5.4.1	Information on collection protocols and practices, transport and storage is maintained.	• Internal collection rules / GCP • Internal Handling Rules • Plant Monographs • Summaries of management plan revisions.	X X X X			1
		5.4.2	Records are established and maintained to provide evidence of conformity to requirements and of the effective operation of the management plan.	• Records of collection purchase and monitoring • Storage, handling, processing and transport records	X X			1

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence: Collection manager	Competence: Consultant	Competence: Certifier	Category*
		5.4.3	Systems of communication are established and maintained with the involvement of local communities and other stakeholders.	• Records, plans, schedules of meetings with contracting parties and other stakeholders	X			2
		5.4.4	Summaries of the main elements of the management plan, related annual operating plans and assessment reports are available to stakeholders.	• Summary of Management plan • Annual operating plans • Assessment reports	X X X			1
		5.4.5	The documentation and level of detail associated with the management plan and the planning process is appropriate to: • The size and complexity of ownership / tenure of the collection area and MAP resources • The scale and intensity of the collection operation • The likely impact of the collection activities on the MAP resources and habitat.	• Management plan • Risk assessment of inspector	X		X	2→1
rinciple 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.							
riterion 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.	6.1.1	Collection managers identify and implement market needs (e.g., through buyer order instructions / specification sheets).	• Buyer instructions • Specifications sheets • Information gathering documents	X X X			2
		6.1.2	Internal documentation which defines minimum product quality and hygiene requirements is based on the respective market requirements.	• Collection instructions/ Internal Collection Rules • Internal quality standard	X X			2
		6.1.3	Only plants which fulfil the quality requirements are collected.	• Collection instructions/ Internal Collection Rules	X			1
		6.1.4	The buyer of MAP resources agrees with the collection manager on quantities (e.g., how much of which plant / plant part) before the collection season starts.	• Documented agreements with buyers	X			3
		6.1.5	Collection managers review the buyer instructions with respect to the resource management plan before taking action on the order.	• Documented agreement with buyers • Management plan	X X			2
		6.1.7	Internal handling instructions describe the procedures for correct post-collection handling by the collectors, after purchase from the collectors, and during transport in order to minimise contamination / quality loss.	• Internal Handling Instructions	X			1

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence			Category*
					Collection manager	Consultant	Certifier	
Criterion 6.2	**Traceability** Storage and handling of MAP resources is managed to support traceability to the collection area.	6.2.1	Proper collection and post-collection identification, labelling, and record keeping procedures are followed.	• Collection / Purchase records and receipts • Purchase Summary • Processing records • Stock records • Labels/identification • Sales records •	X X X X X X			1
		6.2.2	Records and proper identification allow each batch of goods to be traced back to the area where it was collected.	• Collection / Purchase records and receipts indicate collection area and date • Purchase Summary • Processing records • Stock records • Labels/identification • Sales records + • Verification of traceability by inspector	X X X X X X		X	1
		6.2.3	Invoices, bills of lading, certificates of origin and other applicable documentation related to shipping or transport specify the management status of the products.	• Invoices • Bills of lading • Certification of origin • Shipping/transport documents	X X X X			2
		6.2.4	Collectors do not sell to unrecognised traders.	• Collectors contract • Interviews with collectors	X		X	1
Criterion 6.3	**Financial viability** Mechanisms are encouraged to ensure the financial viability of systems of sustainable wild collection of MAP resources.	6.3.1	There is a financial plan for the MAP collection operation which includes resource management and conservation as internal costs.	• Financial plan	X			2
		6.3.2	The revenue received from wild collection of MAP resources is sufficient to cover the costs of resource management activities in the long term, including conservation investments required to meet this standard.	• Financial analysis	X			2→1
Criterion 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.	6.4.1	Appropriate courses, manuals, and other training materials are incorporated into the management operation.	• Internal documents describing the content of collectors training	X			2
		6.4.2	All collectors, purchasing and resource management staff are trained in sustainability issues and know the internal rules.	• Training records	X			1
		6.4.3	Collectors' registers are available in order to make sure that all collectors are well trained and know the rules for collection.	• Collectors list with dates of training	X			1
		6.4.4	Only registered and trained collectors are allowed to collect.	• Collectors list • Purchase records and receipts	X X			1
		6.4.5	Training is regularly repeated and its effect surveyed.	• Training records • Monitoring of collectors/purchase managers	X X			2

Criterion		Number	Indicator	Form of Indicator / Method of control	Competence			Category[8]
					Collection manager	Consultant	Certifier	
		6.4.6	For all new plants the collectors are informed and trained again in detail.	• Training records	X			1
		6.4.7	Training follows the principles laid down in the internal collection and handling rules.	• Internal documents describing the content of collectors training	X			1
Criterion 6.5	**Worker safety and compensation** MAP collection management provides adequate work-related health, safety, and financial compensation to collectors and other workers.	6.5.1	Benefits for staff and contractors are consistent with (not lower than) prevailing standards for benefits such as health, retirement, worker's compensation, food and housing.	• Evidence of implementation of health and safety legislation / codes of practice • Relevant records are maintained and up to date (e.g., accident records, site risk assessments)	X X			1
		6.5.2	Payment is at least equivalent to the prevailing standard (e.g., sector average, union negotiated rate, legal minimum wage).	• Interview with collectors • Purchase records and receipts	 X		X	1
		6.5.3	Payment is equitable for men and women (equal pay for equal work).	• Purchase records • Purchase receipts	X X			1
		6.5.4	Workers have the right to organize and voluntarily negotiate with employers.	• Interviews: Staff and contractors are aware of relevant requirements	X		X	2

Annex 2. Glossary

Acronyms and Abbreviations

BfN	Bundesamt für Naturschutz / German Federal Agency for Nature Conservation
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
FSC	Forest Stewardship Council
GACP	Good Agricultural and Collection Practices
GAP	Good Agricultural Practices
IGO	International Government Organization
IFOAM	International Federation of Organic Agricultural Movements
ISSC-MAP	International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants
NGO	Non-government Organization
MAP	Medicinal and aromatic plant
MPSG	Medicinal Plant Specialist Group of the IUCN-The World Conservation Union
NTFP	Non-timber Forest Product
WHO	World Health Organization
WWF	World Wild Fund for Nature

Term	Definition	Source
Adaptive management	An integrated, multidisciplinary approach for confronting uncertainty in natural resources issues. It is adaptive because it acknowledges that managed resources will always change as a result of human intervention, surprises are inevitable, and that new uncertainties will emerge. Active learning is the way in which the uncertainty is winnowed. Adaptive management acknowledges that policies must satisfy social objectives, but also must be continually modified and flexible for adaptation to these surprises. Adaptive management therefore views policy as hypotheses- that is, most policies are really questions masquerading as answers...and management actions become treatments in an experimental sense.	Holling 1978; Walters 1986
Biological diversity	The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.	CBD 1992
Botanicals	A subset of NTFPs that includes herbal medicines, personal care products, and functional foods.	Pierce and Laird 2003
Chain of custody	The channel through which products are distributed from their origin in the forest to their end-use.	FSC 2000
	A tracking system that enables certifiers to trace each forest product from its origin through harvesting, processing, storage and sale.	Shanley et al. 2002
Collectable yield / harvestable yield	Maximum available quantity for collection.	See Peters 1996
Consensus	General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process seeking to take into account the views of interested parties, particularly those directly affected, and to reconcile any conflicting arguments. Need not imply unanimity.	ISEAL 2004
Criterion	A state or aspect ... which should be in place as a result of adherence to a principle. The way criteria are formulated should give rise to a verdict on the degree of compliance in an actual situation.	Lammerts van Bueren and Blom 1997.

Term	Definition	Source
	A standard on which judgement or decision may be based; a characterizing mark or trait.	*Encyclopædia Britannica* 2002
	A means of judging whether or not a principle has been fulfilled. A criterion adds meaning and operationality to a principle without itself being a direct yardstick of performance.	Shanley et al. 2002.
	Indicates what a standard measures.	ISEAL 2004
	A means of judging whether or not a Principle (of forest stewardship) has been fulfilled.	FSC 2000
Customary rights	Rights that result from a long series of habitual or customary actions, constantly repeated, which have, by such repetition and by uninterrupted acquiescence, acquired the force of a law within a geographical or sociological unit.	FSC 2000
Ecosystem	A community of all plants and animals and their physical environment, functioning together as an interdependent unit.	FSC 2000
Endangered species	Any species that is in danger of extinction throughout all or a significant portion of its range.	FSC 2000
Ethical	Conforming to accepted professional standards of conduct.	*Encyclopaedia Britannica* 2002
Ex-situ conservation	The conservation of components of biological diversity outside their natural habitats.	CBD 1992
Extent of collection	Extent: the range over which something extends: scope. Scope: extent of treatment, activity, or influence: range of operation Scale: a distinctive relative size, extent, or degree < projects done on a large scale. Rate: a fixed ratio between two things; a reckoned value; a quantity, amount, or degree of something measured per unit of something else Intensity: the magnitude of a quantity (as force or energy) per unit (as of area, charge, mass, or time). Frequency: the number of repetitions of a periodic process in a unit of time Volume: the amount of space occupied by a three-dimensional object as measured in cubic units; the amount of a substance occupying a	*Encyclopoedia Britannica* 2002

Term	Definition	Source
	particular volume. Quantity: a determinate or estimated amount Level: the magnitude of a quantity considered in relation to an arbitrary reference value; broadly = magnitude, intensity. Yield (sustainable annual): to bear or bring forth as a natural product, esp. as a result of cultivation; product, esp. the amount or quantity produced or returned.	
Guideline	An indication or outline of policy or conduct.	*Encyclopædia Britannica* 2002
Habitat	The place or type of site where an organism or population naturally occurs.	CBD 1992
Harmonization	Harmonization is the process by which the content of two or more standards is brought into increasing conformity. Activities that support harmonization include, but are not limited to the use of common criteria and indicators, statements of common objectives, adoption of common structures for presentation of standards, and development and adoption of a single international standard.	ISEAL 2004
	A quantitative or qualitative parameter which can be assessed in relation to a criterion.	Lammerts van Bueren and Blom 1997.
Indicator	Qualitative or quantitative parameter that can be assessed in relation to a criterion. It describes in an objectively verifiable way the features of the ecosystem or a related social system. Minimum or maximum allowable value of an in indicator is known as threshold value (i.e., a way of quantifying or qualifying or measuring performance).... An indicator is assumed to include a performance value and is therefore called a performance indicator.	Shanley et al. 2002
	How criteria are measured.	ISEAL 2004
In-situ conservation	The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.	CBD 1992
Medicinal and aromatic plants	"Medicinal" and "aromatic" are terms describing properties of chemistry and use that can be ascribed to plants. Medicinal plants prevent, alleviating, or curing disease. This	Leaman et al, 1999

Term	Definition	Source
	group can be defined narrowly, to include only those plants already known to be used in this way in some system of medicine, traditional or modern, or it can be defined broadly to include potential, as yet undiscovered uses of this nature. Aromatic plants contain fragrant, essential oils valued as perfumes, herbs, spices, and as medicines. Many "medicinal" plants are thus also "aromatic" (and vice versa), just as medicinal and aromatic uses overlap within particular taxa with other important categories of plant use, such as foods and beverages. The coincidence of highly desirable qualities within particular taxa makes these groups all the more important as plant genetic resources. The degree of overlap between medicinal and aromatic properties and uses has supported the treatment of medicinal and aromatic plants as a single category, particularly from the point of view of commercial harvest, trade, and agriculture.	
Non-timber forest products	All forest products except timber, including other materials obtained from trees such as resins and leaves, as well as any other plant and animal products.	FSC 2004
	All biotic products other than timber that can be harvested for subsistence and/or for trade. NTFPs may come from primary and natural forests, secondary forests, and forest plantations, as defined by FSC regional Working Groups.	Brown et al., 2002
Organic agriculture = biological agriculture = ecological agriculture	A whole system approach based upon a set of processes resulting in a sustainable ecosystem, safe food, good nutrition, animal welfare and social justice. Organic production therefore is more than a system of production that includes or excludes certain inputs.	IFOAM 2004
Precautionary principle; precautionary approach	An approach to uncertainty that provides for action to avoid serious or irreversible environmental harm in advance of scientific certainty of such harm.	Cooney 2004
Principle	A fundamental law or rule, serving as a basis for reasoning and action. Principles are explicit elements of a goal.	Lammerts van Bueren and Blom 1997.
	A comprehensive and fundamental law, doctrine, or assumption.	*Encyclopædia Britannica* 2002

Term	Definition	Source
	A fundamental truth or law as the basis of reasoning or action; an essential rule or element.	Shanley et al. 2002
	An essential rule or element.	FSC 2000
Protected area	A geographically defined area that is designated or regulated and managed to achieve specific conservation objectives.	CBD 1992
Standard	A definite rule, principle, or measure established by authority.	*Encyclopædia Britannica* 2002
	Principles + criteria = standard.	FSC 2000
	Practice standard = core commitment (fixed requirements / the outcome or condition to be achieved in all applicable circumstances, applicable to all) + guidance (flexible, to be respected in intent and are available to be adopted according to the specific circumstances, levels, and sectors), documentation and reporting (to bring transparency to the application of the commitments and guidance).	SECO 2005
	Document that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method.	ISEAL 2004
Sustainable use	The use of components of biological diversity in such a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.	CBD 1992
Sustainable yield	Appropriate definition needed	See Peters 1996
Tenure	Socially defined agreements held by individuals or groups, recognized by legal statutes or customary practice, regarding the "bundle of rights and duties" of ownership, holding, access and/or usage of a particular land unit or the associated resources there within (such as individual trees, plant species, water, minerals, etc).	FSC 2000
Threatened species	Any species that is likely to become endangered within the foreseeable future	FSC 2000

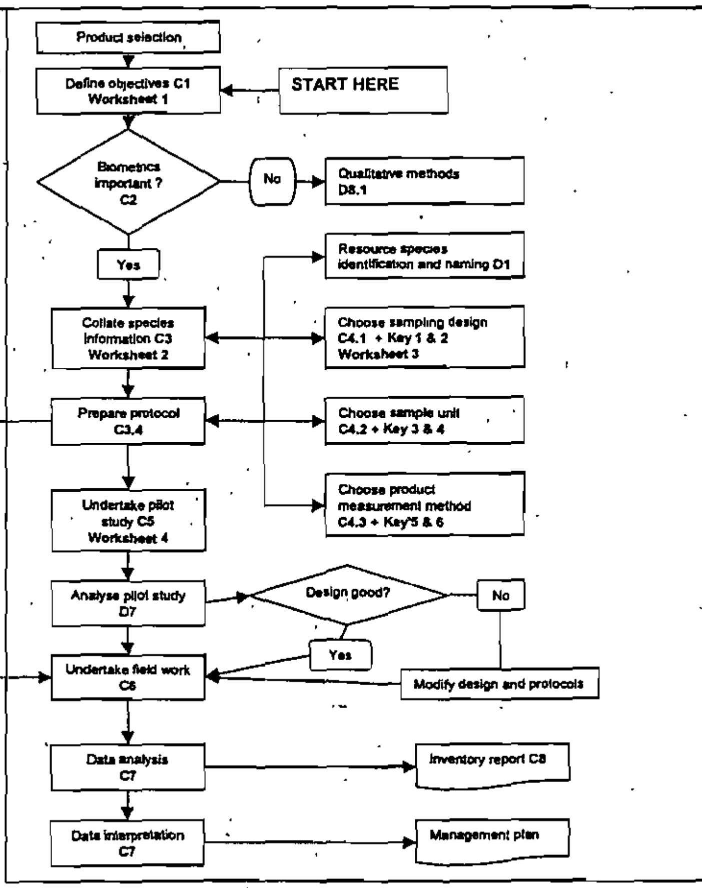
	throughout all or a significant portion of its range.	
Traceability	Appropriate definition needed	
Traditional / local / indigenous	Appropriate definition needed	
Use rights	Rights for the use of forest resources that can be defined by local custom, mutual agreements, or prescribed by other entities holding access rights. These rights may restrict the use of particular resources to specific levels of consumption or particular harvesting techniques.	FSC 2000
Verifier	Describes the way an indicator is measured in the field (i.e., data points or information that enhance the specificity or the ease of assessment of an indicator). The intention in this process in not to prescribe a minimum set of verifiers, but to allow room for verifiers that are specific to region, product, class, operation size, etc. Verifiers add meaning, precision and usually also site-specificity to an indicator. Numerical parameters might be assigned to a verifier on a case-and-site-specific basis.	Shanley et al. 2002
Viable population	Appropriate definition needed. *Viability of a species in a given geographic region is often expressed as its risk of extinction or decline, expected time to extinction, or chance of recovery.*	See Akçakaya and Sjögren-Gulve 2000
Wild collection	Appropriate definition needed. *Practice of gathering a non-cultivated native or naturalized resource from its natural habitat (which may be forest, meadow, pasture, agricultural field, desert, or any other environment in which non-cultivated species are present.*	

Anexo 9:
Material entregado por Dr. H. Tremp

Decision table for determining required level of rigour

Factor	Rigour required	
	Higher	Lower
Number of objectives	Many	Few
Type of objectives	Broad	Narrow
User group understanding	Critical	Not critical
Scientific defensibility	Yes	No
Political defensibility	Yes	No
Need for continuity i.e. data suitable for use in monitoring	Critical	Not critical

FAO NWFP Assessment Guidelines



Local community managing a resource

Good working relations with NGO/forest department

Motivation to improve sustainability

Participatory experiments are quite challenging, in terms of time and ideas. They require dedication from local people and from technical partners. We recommend that the partnerships have been tried and tested through other participatory activities, before trying this.

Collective decision to improve sustainability of harvest

Before planning any experiments, the resource users and their partners need to understand the resource, what is in it, who uses it and how the quality and quantity of resource is changing. They will also need to discuss their perceptions of why this change is happening. These perceived causes will be tested through the experiments.

Participatory appraisal

The resource

The people

A stakeholder analysis helps to work out who should be involved. All the people who use the resource, or who affect its quantity and quality, need to be included in some way. For example, herders from the next village who affect forest regeneration may need to agree to respect the experiments. Or traders may need to be consulted, to ensure they understand what the harvesters are doing.

It is helpful to use participatory mapping, group discussions, transects, systems diagrams and other PRA tools at this stage

Select research issues + species

Form a research team

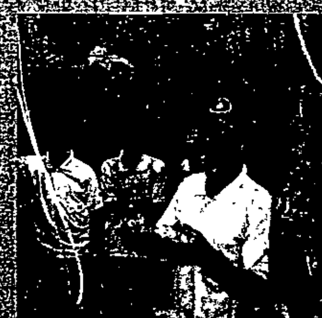
The research team is the core group of stakeholders who make a commitment to plan and conduct the experiments, and to share the results with the wider group of stakeholders. They usually consist of volunteers from the community which owns or manages the resource together with technical support from outside agencies.

Users it is important to separate the influences on resource quality / quantity that are under the control of the users, from those that are not under their control. It is not feasible to plan experiments if the main effects on the resource are beyond the users' control, for example if fires are started by outsiders, or water has been diverted to a dam

Base line survey of the research species

Community survey + participatory mapping

Scientific survey + GIS



Hypotheses need to be in an explicit form "If management is changed from BAU to the alternative, yields and/or regeneration will increase/stabilise because..."

Rigorous Experimental Design

for each selected species

Define Business As Usual (BAU)

***Business As Usual (BAU)** is a formalised description of what most people do most of the time, when they are harvesting. It has to be standardised to permit rigorous*

scientific principles:
*1. **Replication** – multiple plots to ensure results are not just due to chance*
*2. **Control** – un-harvested plots for comparison*
*3. **Randomisation** – plot location and allocation is not affected by the biases of participants*

requires sharing and negotiation Among team members.

Select Indicators

*The '**indicator**' is the variable that is measured in order to tell us about the variable that we are interested in. For example, we may want to know how root biomass changes during the experiments. It is difficult to measure this directly without killing the plant, so the research team has to find a more easily measured indicator. See example 2 on the back page of this paper.*

Establish plots

1. BAU
2. Treatment
3. Control

Community Training
To ensure the experiments are rigorous, community members need to learn how to measure variables.

Plot data collection

Because the experiments are rigorous, the results can be analysed statistically.

FEEDBACK

Casual observation

Systematic observation

Statistically analysed data

Different people are convinced by different kinds of data. For some, their regular observations of the forest and the experimental plots will stimulate them to change management. For others (particularly foresters and other scientific stakeholders) the more quantitative data will be more important. What is essential in the participatory process is to share and compare the different kinds of data. Sometimes this will show that local perceptions are mistaken, and that management changes are needed to make harvests more sustainable. In other cases the statistical analysis will show that more qualitative observations are in fact correct, and that the expensive quantitative approach is not needed in this case.

*Users need to monitor the effect of the revised management plan. This knowledge can then **feedback** to earlier stages of the process, generating new hypotheses to be tested.*

Sharing and interpreting the results

Adapting the management plan

Dissemination

Community researchers can become very enthusiastic about experiments. In India they developed 'community-to-community training' (CTCT) with support from foresters, to promote the method to others.

Wider community

NGO staff

Other communities

Foresters

Policy makers

Traders

Because the process is scientific it is convincing to foresters and policy makers so results may be supported and used widely.

Participatory science for sustainable forest harvesting

Community-based experiments provide reliable information for adaptive management of non-timber products in forests and pastures

This paper outlines the process used to work with communities who harvest medicinal plants and other non-timber products (NTFPs), and want to enhance the sustainability of this harvest. The process is participatory at each stage, incorporating local knowledge and rigorous scientific methodology. The results can therefore influence both community resource management and policy at higher levels.

The methodology is particularly relevant where a defined group of resource users is entitled to make and enforce the rules about resource use In partnership with outside agencies, they can try new ways of managing the resource, and monitor the effects to test whether they are more sustainable.

Continuous experimentation and monitoring of resource management is known as adaptive management. When communities do this in partnership with outside agencies, it becomes adaptive co-management. The experimental process described here helps communities to achieve adaptive co-management.

Why do communities need information about sustainability of harvest?

To test the sustainability of existing practices, or to compare them with alternative practices, locally specific information is needed about the effects of harvesting on the plants, their reproduction and their habitats.

Unlike timber, usually little is known about the life cycle, productivity and management of NTFPs. Even proven scientific knowledge about such species may not relate exactly to the ecological or cultural conditions of the community.

Whilst the people in the community may have been harvesting those species for centuries, increasing human populations and commercialisation lead to decline in numbers of useful species, and quality of their habitats. Moves away from traditional harvesting practices further exacerbate the decline.

Why does this process use both local and scientific knowledge?

Different people have different kinds of knowledge, which can be combined to work towards sustainability.

Resource users' knowledge about the resource is context-specific and evolves through new experiences. Some of this knowledge may be dormant or subconscious, or overridden by concerns about resource access and security. So it may be necessary to help the resource users to become more aware of their knowledge, and to share memories and observations about resource use and change.

This local knowledge complements scientific knowledge, which is more universal and standardised. Conventional science may have useful facts to contribute, but in this case it is also particularly strong in terms of the methodology used to test theories and produce new information.

What makes information relevant and reliable?

Different people have different ways of trusting knowledge: The approach presented here aims for an acceptable balance between locally relevant, and scientifically reliable, information. Another word for relevance is 'validity'.

If results are valid, they are telling us what is true in the context in which we want to apply them So if we want to generalise, we need to know which communities and forests / pastures the results will apply to. If results are reliable, they will be the same every time we repeat the research.

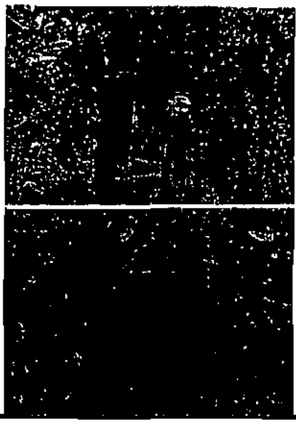
The research process outlined here helps to ensure validity by thinking through alternatives and testing them, and helps to ensure reliability by applying scientific principles to the design.

What kinds of factors can be tested using this approach?

Only factors that are under the direct control of the communities can be addressed using this approach. In most cases this is restricted to the immediate influences on the harvest, which are often (but not always) under the control of the resource users. These include: frequency, intensity, quality and method of harvest. The wider influences, which also affect the sustainability of the harvest, include: institutional, political, economic, social and ecological factors. In discussion with the community it is important that the wider context is understood so that it is clear which factors are under their control, and whether it is worth trying to change these.

The process

The diagram in the centre of this paper shows the steps in the process. At the heart of this is the basic research cycle: assess situation, define hypothesis, design experiment, collect data, analyse data, reassess situation. However it is made both more complex and richer by the fact that it is participatory. Attention needs to be paid to the different people involved, their motivations, knowledge, and interactions So there is a focus on establishing a research team consisting of the most relevant people, and on sharing experiences and knowledge before deciding on the focus of the experiments. By keeping relevant people involved, the techniques tested by the experiments, and the interpretation of the results, will be more useful to them.



Examples

We developed the methodology by combining the expertise of ForestAction (Nepal), Foundation for the Revitalisation of Local Health Traditions (FRLHT) (India) and the Environmental Change Institute (University of Oxford, UK) with that of four forest-managing communities in India and Nepal. The following examples illustrate ways in which the process was used.

1. Changing the management of cinnamon

Agumbe is a village in the Western Ghats of India, surrounded by lush dipterocarp forest. Under Indian forest policy community members are entitled to collaborate with the Karnataka State Forest Department in Joint Forest Management. A village forest committee therefore exists, and had good previous experience of working with FRLHT. They were therefore enthusiastic about working together again in developing scientific tests to improve their NTFP management.

Through a participatory appraisal they prioritised *Cinnamomum macrocarpum* (cinnamon) as a species which was suffering from destructive harvesting practices. Discussions with the harvesters and some of the older people in the village led to the realisation that harvesting practice had changed. Instead of plucking the mature leaves from the tips of the branches, people had started pulling down whole branches to make it easier to reach the leaves.

The 'task team' (research committee) worked out a description of Business As Usual (BAU), which they wanted to compare with a less destructive approach in the experimental plots.

BAU: Currently, we collect all the leaves, and do this by cutting the branches and twigs.

Hypothesis: If instead of BAU we collect only mature leaves, and pluck them individually, this will improve both regeneration and yield.

The task team set up replicated plots in the forest, carefully marked with the plot number and treatment, and put up notice boards to inform others about the experiment. They also had to make sure that the harvesters, who came from outside the village, had been informed about the different harvesting techniques.

Everyone in the village was very aware of the plots and curious about the results. After two years, they found that the health of the trees was indeed improved under the 'new' treatment, but it was too soon to draw conclusions about regeneration. The experiments continue, but meanwhile the village forest committee has changed its management guidelines about cinnamon, with the full support of the forest department.

2.Finding indicators to help with the estimate of root yields

The process diagram emphasises the importance of indicators. It is not always possible to measure directly the yield or regeneration of a species. For example if the yield is belowground, we will destroy the plant by measuring it. In this case we have to develop indicators that can be measured as a proxy for other variables which are of interest, but harder to measure regularly.

Asparagus racemosus root is used in Ayurvedic medicine for treating diarrhoea and dysentery. Sundari is a community of people who have all migrated in the last 20 years from the middle hills or high hills of Nepal, and are learning about their new environment. They therefore have a very open attitude to new forest management methods, and have worked with the NGO ForestAction in a very dynamic way.

Sundari Forest Users Group chose this plant (commonly known as kurilo) as a species that was under pressure from increasing commercialisation. They wanted to test out different management strategies, but it was not clear how they would know which management was best, if they had to destroy the plants during the measurements.
They had to find an indicator which was strongly correlated with the root size, but which could be easily measured. This would allow the community to assess the health of the population without adversely affecting its capacity to regenerate.

They therefore formulated 'indicator hypotheses' which they tested statistically:
Indicator hypotheses for kurilo

1. Tuber weight is correlated to the height of the plant
2. Tuber weight is correlated to the root collar diameter of the plant
3. Tuber weight is correlated to the to the crown diameter of the plant.

Experimentation showed that the second hypothesis (root collar diameter) was a very good indicator of tuber size. Now community members only need to measure root collar diameter to find out which management treatment is best for kurilo yields.

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Environmental Change Institute
UNIVERSITY OF OXFORD

FRLHT

ForestAction

FORESTRY RESEARCH PROGRAMME

Anexo 10:

Material entregado por Dr. H. Parzies

The Convention on Biological Diversity Around the World

Selection Criteria

Government:
Chile

Party to:	**Convention**	**Cartagena Protocol**
Since:	9 September 1994 *(by Ratification)*	Non Party
Signature Date:	13 June 1992	24 May 2000

National Biodiversity Strategy and Action Plan

- (English)
- (English)
- (Spanish)
- (Spanish)

National Reports

- First National Report
  - (Spanish)
  - (Spanish)
- Third National Report
  - (Spanish)
  - (Spanish)

National Biodiversity Links

- Comisión Nacional del Medio Ambiente

National Focal Points

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NATIONAL BIODIVERSITY STRATEGY of the REPUBLIC OF CHILE

GOBIERNO DE CHILE
COMISIÓN NACIONAL DE MEDIO AMBIENTE

PROGRAMA DE LAS NACIONES UNIDAS PARA EL DESARROLLO

DECEMBER 2003

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