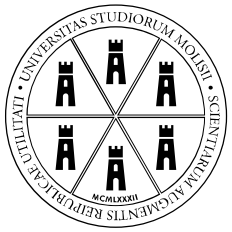
Giornata di Studio
MONITORAGGIO VEGETAZIONALE, FAUNISTICO E DI FUNZIONALITÀ ECOSISTEMICA E INVENTARIAZIONE FORESTALE
Venerdì 22 giugno 2012

Esperienze di monitoraggio della biodiversità negli inventari forestali

a scala internazionale, nazionale e locale



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Perchè monitorare la biodiversità?

- La **Convention on Biological Diversity** (CBD) definisce un piano strategico con l'obiettivo di: "ridurre significativamente la perdita di biodiversità entro il 2010" (UNEP, 2002)
- La **European Environmental Agency** (EEA) su mandato della Commissione Europea recepisce il pano strategico e avvia l'iniziativa SEBI2010 (Streamlining European Biodiversity Indicators)
- A partire dal 1990 **Forest Europe** (la Conferenza Interministeriale sullo Stato delle Forese in Europa – MCPFE) adotta quattro risoluzione per la valutazione del livello di sostenibilità della gestione forestale
- Il **Montréal Process** ha finalità simili in dodici Paesi temperati e boreali extra-Europei

Che cos'è la biodiversità?

"the diversity of life in all its forms and all its levels of organization" (Hunter 1990)

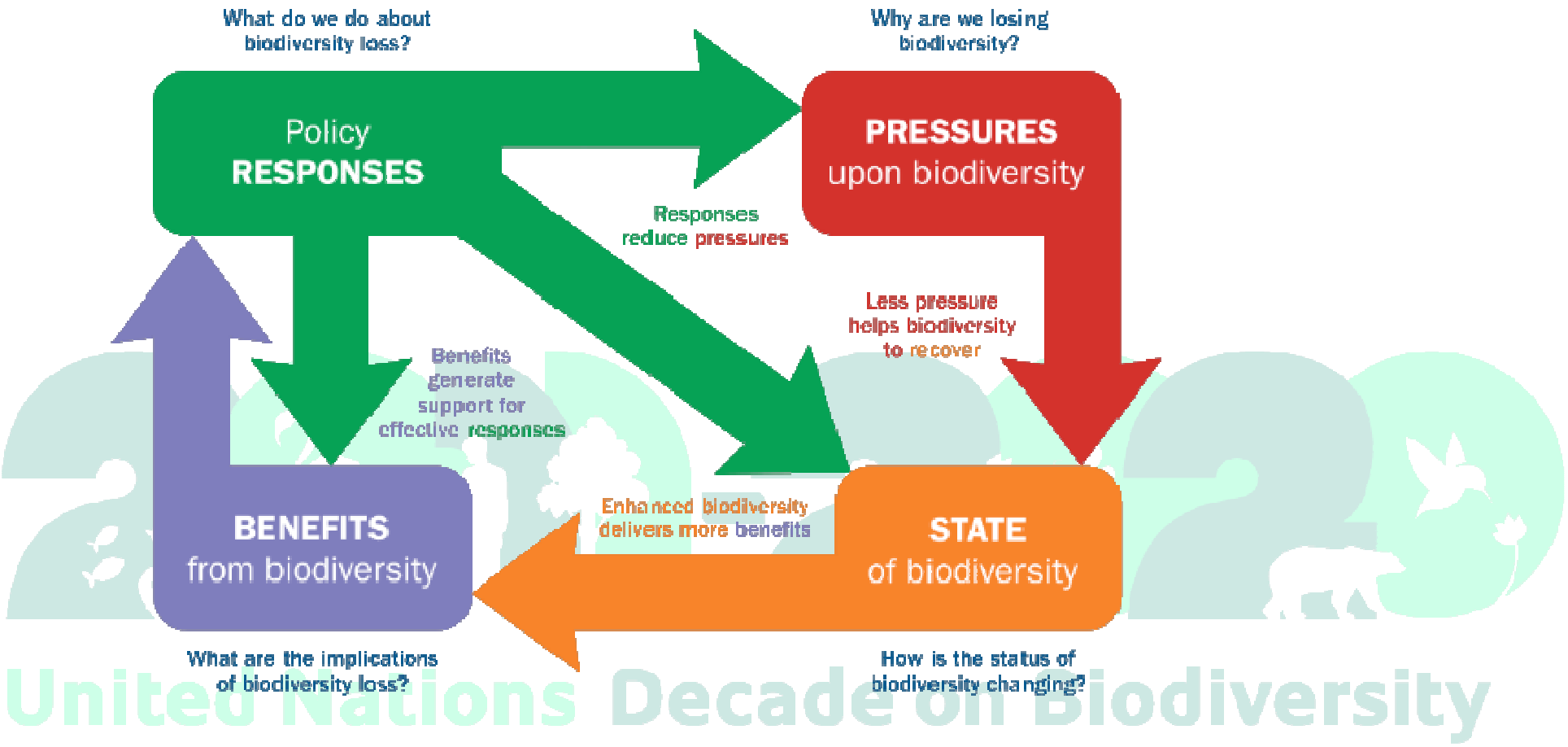
- Per poter monitorare la biodiversità nell'ambito di un sistema di rilevamento statisticamente rigoroso è essenziale DEFINIRE che cosa s'intenda per biodiversità
- Il concetto di biodiversità è ancora controverso ed oggetto di dibattitto (multidimensionale, multiscala)
- Monitorare la biodiversità nel tempo su ampie superfici considorandone tutti gli aspetti e le scale è economicamente insostenibile

α, β, γ diversity (Whittaker, 1972)
compositional, functional, structural diversity (Noss, 1990)
genetic, species, ecosystem diversity (Leveque, 1994; Gaston & Spicer, 2004)

Indicatori di biodiversità

relazione con gli ambienti forestali

CBD, BIP indicators



The Partners

1	Trends in extent, condition and vulnerability of ecosystems, biomes and habitats	6 indicators
2	Trends in abundance, distribution and extinction risk of species	3 indicators
3	Trends in genetic diversity of species	2 indicators
4	Trends in pressures from unsustainable agriculture, forestry, fisheries and aquaculture	8 indicators
5	Trends in pressures from habitat conversion, pollution, invasive species, climate change, overexploitation and underlying drivers	7 indicators
6	Trends in distribution, condition and sustainability of ecosystem services for equitable human well-being	4 indicators
7	Trends in awareness, attitudes and public engagement in support of biological diversity and ecosystem services	0 indicators
8	Trends in integration of biodiversity, ecosystem services and benefits sharing into planning, policy formulation and implementation and incentives	3 indicators
9	Trends in access and equity of benefit sharing of genetic resources	0 indicators
10	Trends in accessibility of scientific/technical/traditional knowledge and its application	1 indicator
11	Trends in coverage, condition, representativeness and effectiveness of protected areas and other area-based approaches	3 indicators
12	Trends in mobilisation of financial resources	1 indicator

12 components of biodiversity

Biodiversity Indicators Partnership

27 indicatori

Red List index
Extent of forests & forest types
Extent of marine habitats
Area of forest under sustainable forest management: degradation & deforestation
Forest fragmentation
River fragmentation & flow regulation
Living planet index
Wild bird index
Ex-situ crop collection
Genetic diversity of terrestrial domesticated animals
Ecological footprint
Status of species in trade
Wild commodities Index
Marine Trophic Index
Proportion of fish stocks in safe biological limits
Water quality Index for Biodiversity
Trends in invasive alien species
Nitrogen deposition
Biodiversity for food & medicine
Health & wellbeing of communities directly dependant on ecosystem goods & services
Nutrition indicators for biodiversity
Area of agricultural ecosystems under sustainable management
Status and trends of linguistic diversity and numbers of speakers of indigenous languages
Management effectiveness of protected areas
Coverage of protected areas
Protected area overlay with biodiversity
Official development assistance in support of the Conventions

SEBI2010 EEA

FOCAL AREA	INDICATOR
STATUS AND TRENDS OF THE COMPONENTS OF BIOLOGICAL DIVERSITY	01. Abundance and distribution of selected species
	02. Red List Index for European species
	03. Species of European Interest
	04. Ecosystem coverage
	05. Habitats of European Interest
	06. Livestock genetic diversity
	07. Nationally designated protected areas
	08. Sites designated under the EU Habitats and Birds Directives
THREATS TO BIODIVERSITY	09. Critical load exceedance for nitrogen
	10. Invasive alien species in Europe
	11. Occurrence of temperature-sensitive species
ECOSYSTEM INTEGRITY AND ECOSYSTEM GOODS AND SERVICES	12. Marine Trophic Index of European seas
	13. Fragmentation of natural and semi-natural areas
	14. Fragmentation of river systems
	15. Nutrients in transitional, coastal and marine waters
	16. Freshwater quality
SUSTAINABLE USE	17. Forest: growing stock, increment and fellings
	18. Forest: deadwood
	19. Agriculture: nitrogen balance
	20. Agriculture: area under management practices potentially supporting biodiversity
	21. Fisheries: European commercial fish stocks
	22. Aquaculture: effluent water quality from finfish farms
	23. Ecological Footprint of European countries
STATUS OF ACCESS AND BENEFITS SHARING	24. Patent applications based on genetic resources
STATUS OF RESOURCE TRANSFERS AND USE	25. Financing Biodiversity Management
PUBLIC OPINION	26. Public Awareness

COUNTDOWN 2010

1	Trends in extent, condition and vulnerability of ecosystems, biomes and habitats	Red List Index
		Extent of forests & forest types
		Extent of marine habitats
		Area of forest under sustainable forest management: degradation & deforestation
		Forest fragmentation
		River fragmentation & flow regulation
2	Trends in abundance, distribution and extinction risk of species	Red List Index
		Living planet index
		Wild bird index
3	Trends in genetic diversity of species	Ex-situ crop collection
		Genetic diversity of terrestrial domesticated animals
4	Trends in pressures from unsustainable agriculture, forestry, fisheries and aquaculture	Ecological footprint
		Status of species in trade
		Wild commodities index
		Red list index
		Living planet index
		Wild bird index
		Marine Trophic Index
		Proportion of fish stocks in safe biological limits
5	Trends in pressures from habitat conversion, pollution, invasive species, climate change, overexploitation and underlying drivers	Wild commodities index
		Red list index
		Living planet index
		Wild Bird Index
		Water quality Index for Biodiversity
		Trends in invasive alien species
		Nitrogen deposition
6	Trends in distribution, condition and sustainability of ecosystem services for equitable human well-being	Red List Index
		Biodiversity for food & medicine
		Health & wellbeing of communities directly dependant on ecosystem goods & services
		Nutrition indicators for biodiversity
7	Trends in awareness, attitudes and public engagement in support of biological diversity and ecosystem services	
8	Trends in integration of biodiversity, ecosystem services and benefits sharing into planning, policy formulation and implementation and incentives	Trends in invasive alien species
		Area of forest under sustainable management
		Area of agricultural ecosystems under sustainable management
9	Trends in access and equity of benefit sharing of genetic resources	
10	Trends in accessibility of scientific/technical/traditional knowledge and its application	Status and trends of linguistic diversity and numbers of speakers of indigenous languages
11	Trends in coverage, condition, representativeness and effectiveness of protected areas and other area-based approaches	Management effectiveness of protected areas
		Coverage of protected areas
		Protected area overlays with biodiversity
12	Trends in mobilisation of financial resources	Official development assistance in support of the Conventions

MCPFE Forest Europe
35 quantitative indicators

Criterion 1:
Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles

1.1 Forest area
Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area

1.2 Growing stock
Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply

1.3 Age structure and/or diameter distribution
Age structure and/or diameter distribution of forest and other wooded land, classified by forest type and by availability for wood supply

1.4 Carbon stock
Carbon stock of woody biomass and of soils on forest and other wooded land

Criterion 2:
Maintenance of Forest Ecosystem Health and Vitality

2.1 Deposition of air pollutants
Deposition of air pollutants on forest and other wooded land, classified by N, S and base cations

2.2 Soil condition
Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types

2.3 Defoliation
Defoliation of one or more main tree species on forest and other wooded land in each of the defoliation classes "moderate", "severe" and "dead"

2.4 Forest damage
Forest and other wooded land with damage, classified by primary damaging agent (abiotic, biotic and human induced) and by forest type

Criterion 3:
Maintenance and Encouragement of Productive Functions of Forests (Wood and Non-Wood)

3.1 Increment and fellings
Balance between net annual increment and annual fellings of wood on forest available for wood supply

3.2 Roundwood
Value and quantity of marketed roundwood

3.3 Non-wood goods
Value and quantity of marketed non-wood goods from forest and other wooded land

3.4 Services
Value of marketed services on forest and other wooded land

3.5 Forests under management plans
Proportion of forest and other wooded land under a management plan or equivalent

Criterion 4:
Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems

4.1 Tree species composition
Area of forest and other wooded land, classified by number of tree species occurring and by forest type

4.2 Regeneration
Area of regeneration within even-aged stands and uneven-aged stands, classified by regeneration type

4.3 Naturalness
Area of forest and other wooded land, classified by "undisturbed by man", by "semi-natural" or by "plantations", each by forest type

4.4 Introduced tree species
Area of forest and other wooded land dominated by introduced tree species

4.5 Deadwood
Volume of standing deadwood and of lying dead-wood

Forest Europe growing life

MCPFE Forest Europe
35 quantitative indicators

4.6 Genetic resources
Area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ gene conservation) and area managed for seed production

4.7 Landscape pattern
Landscape-level spatial pattern of forest cover

4.8 Threatened forest species
Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species

4.9 Protected forests
Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE Assessment Guidelines

Criterion 5: Maintenance and Appropriate Enhancement of Protective Functions in Forest Management (notably Soil and Water)

5.1 Protective forests – soil, water and other ecosystem functions
Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class "Protective Functions"

5.2 Protective forests – infrastructure and managed natural resources
Area of forest and other wooded land designated to protect infrastructure and managed natural resources against natural hazards, part of MCPFE Class "Protective Functions"

Criterion 6: Maintenance of Other Socio-Economic Functions and Conditions

6.1 Forest holdings
Number of forest holdings, classified by ownership categories and size classes

6.2 Contribution of forest sector to GDP
Contribution of forestry and manufacturing of wood and paper products to gross domestic product

6.3 Net revenue
Net revenue of forest enterprises

6.4 Expenditures for services
Total expenditures for long-term sustainable services from forests

6.5 Forest sector workforce
Number of persons employed and labour input in the forest sector, classified by gender and age group, education and job characteristics

6.6 Occupational safety and health
Frequency of occupational accidents and occupational diseases in forestry

6.7 Wood consumption
Consumption per head of wood and products derived from wood

6.8 Trade in wood
Imports and exports of wood and products derived from wood

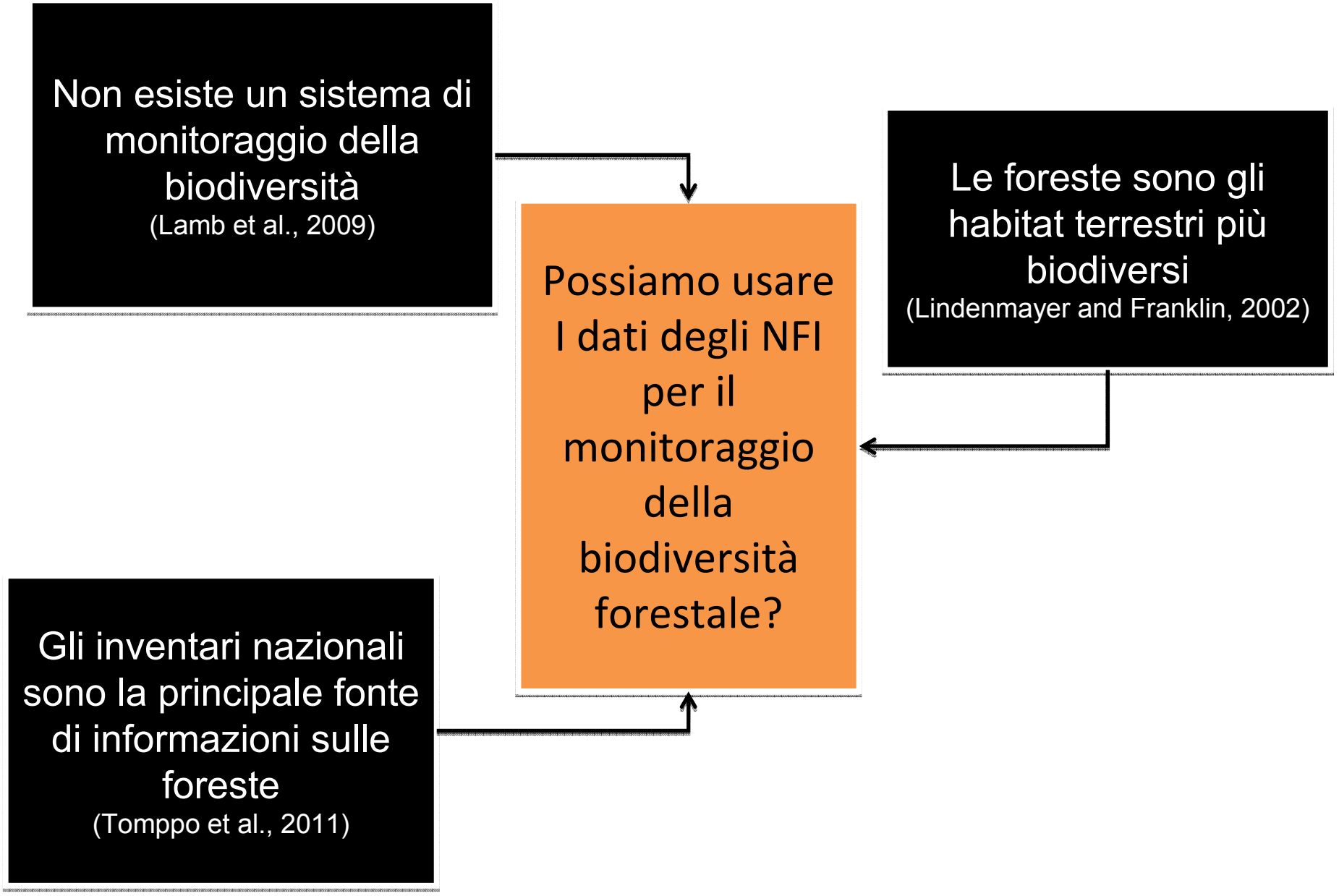
6.9 Energy from wood resources
Share of wood energy in total energy consumption, classified by origin of wood

6.10 Accessibility for recreation
Area of forest and other wooded land where public has a right of access for recreational purposes and indication of intensity of use

6.11 Cultural and spiritual values
Number of sites within forest and other wooded land

Forest Europe growing life

Quali dati per calcolare gli indicatori di biodiversità?



Gli inventari forestali nazionali

PRO

Solidità statistica

Lunghe serie temporali (aree boreali e USA 1920-1930)

Vasta diffusione globale

CONTRO

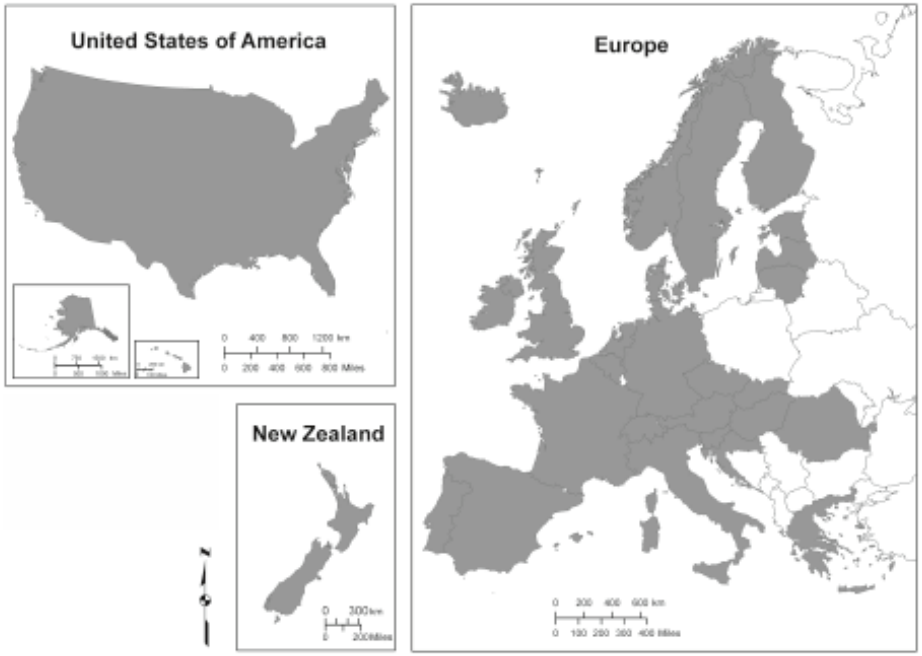
Mancanza di armonizzazione

Non ottimizzati per il monitoraggio della biodiversità

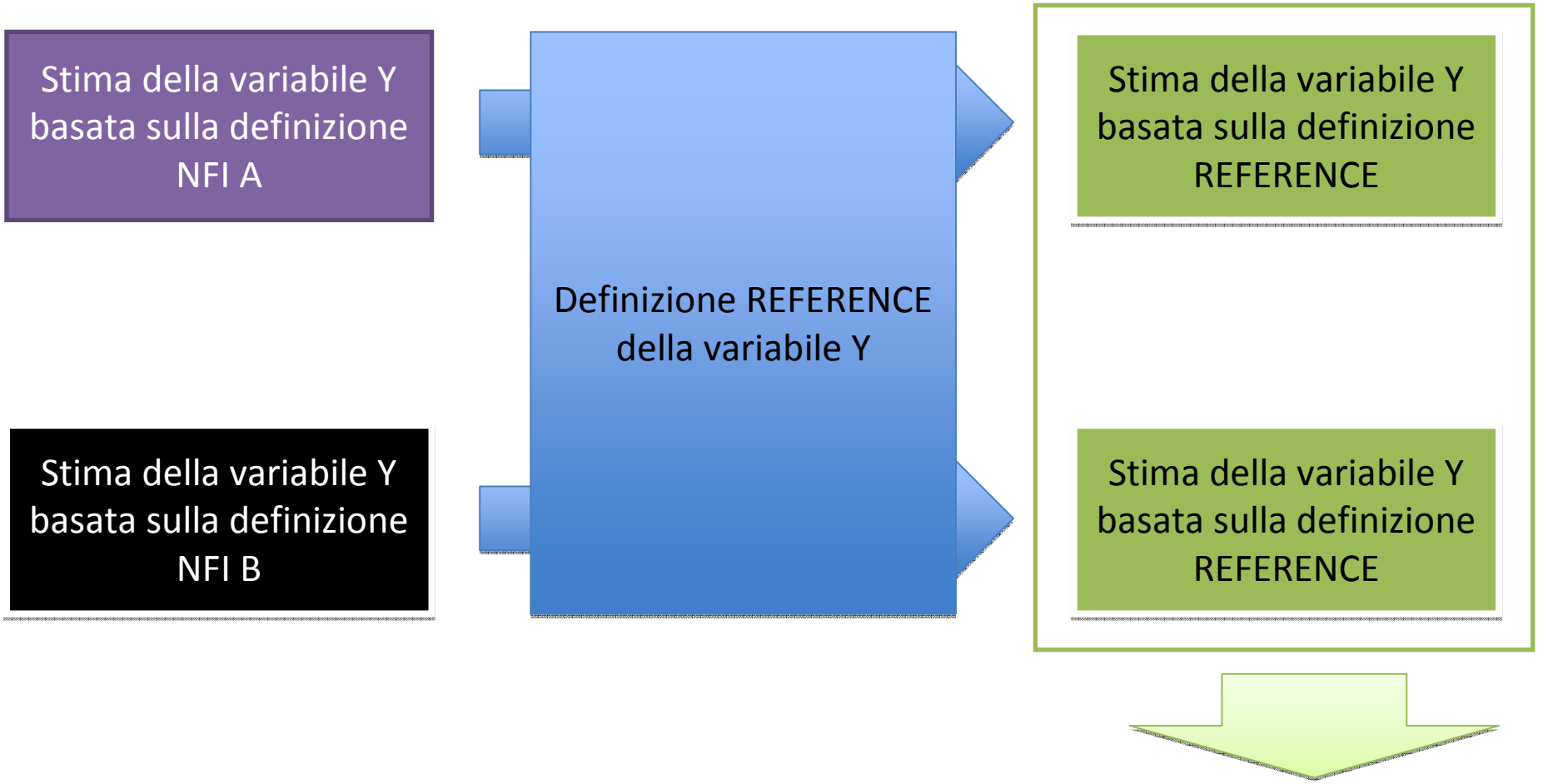
Azione COST E43

Harmonization of NFIs: techniques for common reporting

- Partecipazione degli NFI di 27 Paesi EU + USA e NZ + istituzioni internazionali (FAO, MCPFE, EEA, JRC)
- Armonizzazione vs. standardizzazione
- Messa a punto di *reference definitions* e *bridging functions*
- Linee guida per i futuri inventari



Tecniche di armonizzazione



Scientific papers

Springer books

44 NFI variables in 18 categories pre-selected

First on-line questionnaire

Essential features identified: forest category, deadwood, ground vegetation, naturalness, stand structure, forest age, regeneration

Second questionnaire

NFI methods described

Definition of references

Development of bridging functions

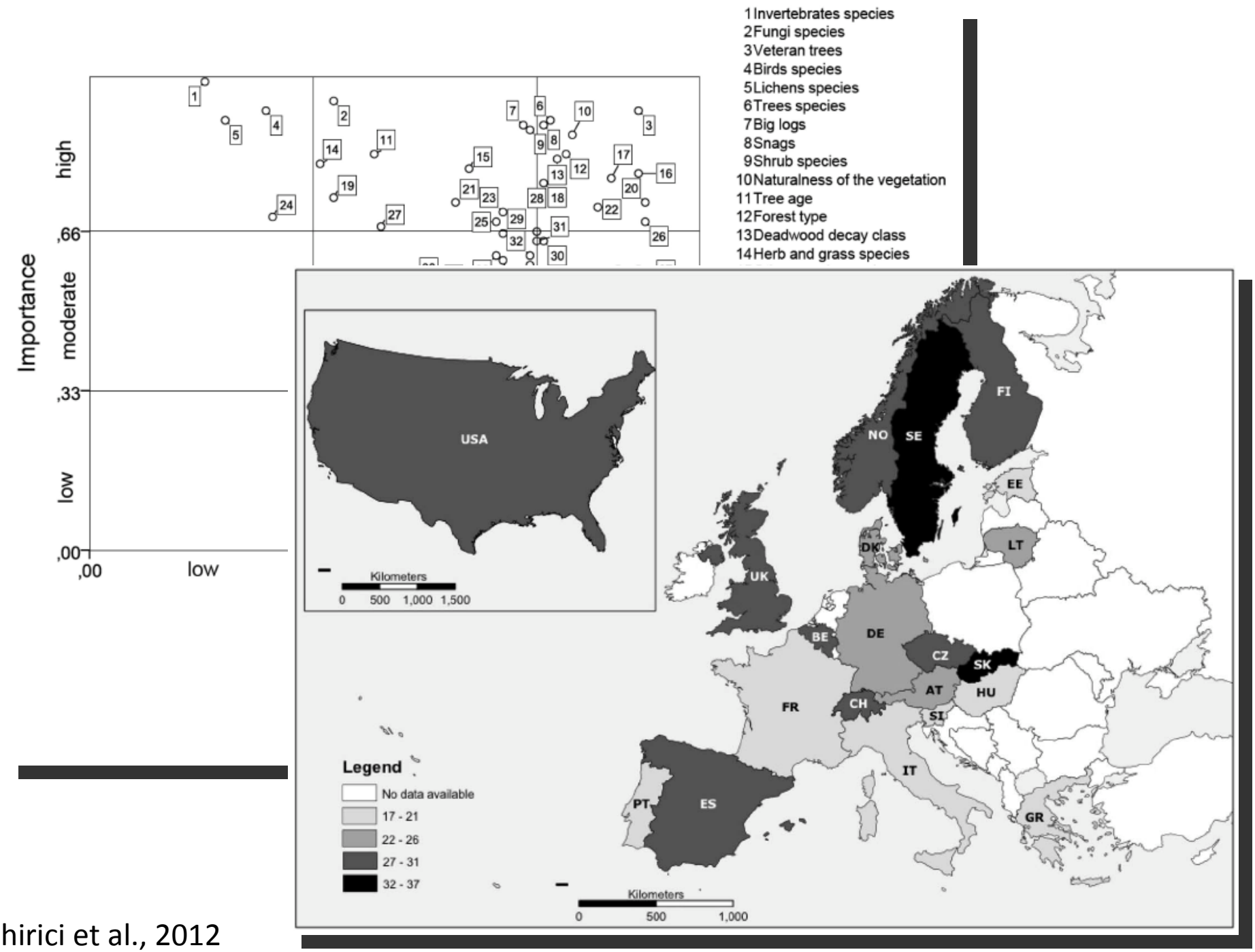
Test of bridging functions with real NFI data

cost E43

Selected essential features where further investigated by sub-working groups in order to acquire methods and definitions currently used by the NFIs

FOREST CATEGORY
DEADWOOD
FOREST STRUCTURE
GROUND VEGETATION
NATURALNESS
FOREST AGE
REGENERATION

A second questionnaire was distributed to the countries regarding (for each essential feature):
spatial and temporal characteristics of the sampling designs, local definitions adopted, field procedures and related inventorying protocols and methods used for the calculation of the estimations



Chirici et al., 2012

WG3 of COST Action E43									
Essential features	Indicators		CBD, BIP indicators		Forest Europe		SEBI2010		Montréal Process
Forest category	**1.1 Forest category**		1.10.1	Extent of forest and forest types	1.1	Forest area	4 Ecosystem coverage 5 Habitats of European interest	1.1.a	Area and percentage of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure
Deadwood	**2.1 Deadwood volume by decay class, tree species, horizontal/ vertical position**				4.5	Deadwood	18 Forest: deadwood		
Forest structure	**3.1 Relative abundance of native tree species in terms of basal area**		1.40.1	Red List Index and Sampled Red List Index	4.1	Tree species composition	2 Red List Index from European species	1.2.a	Number of native forest-associated species
	3.2 Number of native tree species				4.4	Introduced tree Species	3 Species of European interest		
	3.3 Proportion of plots with 1, 2, 3, and more native tree species				4.8	Threatened forest species	10 Invasive alien species in Europe 11 Occurrence of temperature-sensitive species	1.2.b	Number and status of native forest-associated species at risk, as determined by legislation or scientific assessment
	3.4 Largest diameter trees								
	3.5 SD of the tree heights								
	3.6 Number of vertical layers								
	3.7 Frequency distribution of SD classes of dbh								

WG3 of COST Action E43					
Essential features	Indicators	CBD, BIP indicators	Forest Europe	SEBI2010	Montréal Process
Forest age	**4.1 Dominant age: mean age of the 100 trees with the largest dbh on a per ha basis** **4.2 Mean age** **4.3 Weighted mean age** **4.4 Old trees: proportion of trees older than half of their natural life span**		1.3 Age structure and/or diameter distribution		
Naturalness	**5.1 Naturalness**		4.3 Naturalness		
Regeneration	**6.1 Regeneration (investigated but no indicators proposed)**		4.2 Regeneration		
Not investigated		4.30.1 Forest fragmentation 2.10.1 Area of forest under sustainable management: certification 2.10.2 Area of forest under sustainable management: degradation and deforestation	4.7 Landscape pattern 3.5 Forests under management plans	13 Fragmentation of natural and seminatural areas	1.1.c Fragmentation of forests
			1.2 Growing stock 3.1 Increment and fellings	17 Forest: growing stock, increment and fellings	2.b Total growing stock and annual increment of both merchantable and nonmerchantable tree species in forests available for wood production 2.d Annual harvest of wood products as a percentage of net growth or sustained yield

FOREST CATEGORY	
DEADWOOD	
FOREST STRUCTURE	
NATURALNESS	
FOREST AGE	
GROUND VEGETATION	
REGENERATION	

Attuale capacità degli inventari forestali nazionali di produrre stime armonizzate di indicatori di biodiversità forestale

Forest Ecology and Management 262 (2011) 2061–2069

Contents lists available at SciVerse ScienceDirect

Forest Ecology and Management

ELSEVIER

journal homepage: www.elsevier.com/locate/forec

Review

Contribution of large-scale forest inventories to biodiversity and monitoring

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ARTICLE INFO

Article history:
Received 25 May 2011
Received in revised form 19 August 2011
Accepted 28 August 2011

Keywords:
Forest biodiversity indicators
Probabilistic sampling
Forest types
Landscape metrics

ABSTRACT

Statistically-designed inventories and biodiversity monitoring p
ical conservation and natural resources management. Mandated
tunities to identify and satisfy natural resources management in
end in itself but rather is the beginning of a process that should
versity conservation. Forest inventories are currently evolving
and are broadening their scope in several directions: (i) expan
non-traditional attributes such as trees outside the forest and
and carbon sequestration estimation; (iii) assessment of forest
variables such as biodiversity attributes that are not directly rela
vesting.

There is an on-going debate regarding the role of forest inv
monitoring. This paper presents a review on the topic that ai
the current contribution of forest inventories to the assessme
conditions on a large scale. Specific objectives are fourfold: (i) to
indicators that can be estimated from data collected in the fram
the implications of different sampling methods on the estimatio
possibilities for harmonized estimation of biodiversity indicato
tory data; (iii) to show the added value for forest biodiversity m
tors into ecologically meaningful forest type units; and (iv) to e
sample data for estimating landscape biodiversity metrics.

Contents

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doi:10.1016/j.foreco.2011.08.044

National Forest Inventory Contributions to Forest Biodiversity Monitoring

Gherardo Chirici, Ronald E. McRoberts, Susanne Winter, Roberta Bertini, Urs-Beat Brändli, Iciar Alberdi Asensio, Annemarie Bastrup-Birk, Jacques Rondeux, Nadia Barsoum, and Marco Marchetti

Abstract: Forests are the most biodiverse terrestrial ecosystems. National forest inventories (NFIs) are the main source of information on the status and trends of forests, but they have traditionally been designed to assess land coverage and the production value of forests rather than forest biodiversity. The primary international processes dealing with biodiversity and sustainable forest management, the Convention on Biological Diversity (CBD), Forest Europe, Streamlining European Biodiversity Indicators 2010 of the European Environmental Agency, and the Montréal Process, all include indicators related to forest biodiversity. The scope of this article is to review and present possibilities offered by NFIs to harmonize estimation of indicators useful for international forest biodiversity monitoring and reporting. We summarize key findings from Working Group 3 of Action E43 ("Harmonisation of National Forest Inventories in Europe: Techniques for Common Reporting") of the European program Cooperation in Science and Technology (COST). We discuss definitions and techniques for harmonizing estimates of possible biodiversity indicators based on data from NFIs in Europe and the United States. We compare these possible indicators with indicators selected by international processes. The results demonstrate that NFIs can report comparable or harmonized estimates of indicators for multiple biodiversity features (forest categories, deadwood, forest age, forest structure, and forest naturalness), but for others (ground vegetation and regeneration) NFIs should invest more in harmonization efforts. On the basis of these key findings, we recommend that NFIs should represent a main component of a future global biodiversity monitoring network as urgently requested by the CBD. For. Sci. 58(3):257–268.

Keywords: COST Action E43, international references, harmonization, biodiversity indicator, naturalness, forest type, deadwood, forest age, regeneration

Forest ecosystems have the potential to harbor greater levels of biological diversity than any other terrestrial ecosystem (Lindenmayer and Franklin 2002). This biodiversity includes vertebrates such as mammals and birds, invertebrates, and microbes (Chapman 2009). Many forest species depend on forest habitats for only parts of their life cycles, whereas others are completely forest-dependent. Some trees and other plant species may be considered foundational in the sense that their loss would be particularly devastating because of the cascade of species extinctions that would follow (Gaston and Spicer 2004, Ellison et al. 2005).

Human-induced environmental effects such as climate change, introduction of invasive species, intensive cuttings, and pollution pose serious threats to forest biodiversity. As a result, biodiversity in all three of its main components, genes, species, and ecosystems, is declining (Convention on Biological Diversity [CBD] 2010a). For these reasons, international agreements that focus on halting the loss of forest biodiversity and on monitoring the maintenance of ecosystems integrity have been established.

The CBD set as a target "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level" (United Nations Environment Program [UNEP] 2002). As expected (Pereira and Cooper 2006), this target was not met (CBD 2010a). During the tenth Conference of the Parties (COP) held in Aichi, Japan, in 2010, the CBD adopted Decision X/2 for the implementation of the strategic plan for biodiversity 2011/2020 and established the 20 Aichi targets. Aichi

Manuscript received January 13, 2012; accepted March 21, 2012; published online May 3, 2012; http://dx.doi.org/10.5849/forsci.12-003.

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Acknowledgments: This article was prepared within the framework of the activities of Working Group 3: "Contribution Of Field Data Acquired in NFI for Forest Biodiversity Assessment" led by Gherardo Chirici and Susanne Winter of COST Action E43 "Harmonisation of National Forest Inventories in Europe: Techniques for Common Reporting" (chaired by Prof. Erkki Tomppo). The online interface and the first questionnaire database system was implemented by Alessandro Mastronardi (GM Studio, Italy). We thank all the people who responded to the questionnaire and participated in the activities of WG3 of COST Action E43 together with the authors: Albertas Kasperavicius for Lithuania, Anna-Lena Axelsson for Sweden, Vivian Kvist Johannsen for Denmark, Attila Kismarczi for Hungary, Catherine Chauvet and Nabila Hamza for France, Christian Sanchez for Belgium, Elmar Hauk for Austria, Sonia Condés and Santiago Saura Martínez de Toda for Spain, Ioicos Ioicou for Cyprus, Jana Beranova for Czech Republic, Jan-Erik Nilsen for Norway, Marko Kovac for Slovenia, Dieter Pelz for Germany, Tiomo Tolm for Estonia, Teocharis Zagas for Greece, Tiina Tonteri and Helena Mäkelä for Finland, Vladimir Cahoan for Slovakia, Paulo Godinho Ferreira for Portugal and Vittorio Tosi, Patrizia Gasparini, Anna Barbati, Piermaria Corona, Nicola Puletti, and Ugo Chiavetta for Italy.

Assessing Forest Naturalness

Ronald E. McRoberts, Susanne Winter, Gherardo Chirici, and Elizabeth LaPoint

Abstract: The concept of naturalness has been proposed and used for describing the ecological value of forest ecosystems, evaluating management efforts to conserve biodiversity, and identifying natural, old-growth forests for purposes of establishing protection areas. Because the concept is not globally familiar, a literature review was conducted to document the ecological basis for the concept. In addition, the necessity for harmonized reporting motivated an investigation of variables that can be used to quantify and assess forest naturalness. National forest inventories (NFIs) are sources of the most comprehensive and extensive data available for assessing naturalness. However, the variety of NFI plot configurations, sampling designs, definitions, and measurement protocols greatly impedes the utility of NFI data for purposes of producing compatible estimates. As a component of a pan-European harmonization project, a three-phase investigation of harmonized approaches to assessing forest naturalness using NFI variables was conducted. Although the project was primarily European in scope, forest inventory data for an American ecoprovince were used because of their availability, comprehensiveness, and consistency. The primary result is that NFI features such as minimum dbh and plot size affect estimates of indicators of naturalness, and accommodation of their differences may be necessary if harmonized estimates of indicators of naturalness across countries are required. FOR. SCI. 58(3):294–309.

Keywords: harmonization, biodiversity indicators, hemeroby

THE CONCEPT OF FOREST NATURALNESS relates to the degree to which forest ecosystems are characterized by natural processes and/or the absence of human influence. Although the concept is increasing in importance in some parts of the world, it is almost completely unfamiliar in other parts of the world. Thus, a review of the naturalness concept and an investigation of methods for harmonized estimation of indicators of naturalness is warranted.

The overall objectives of the study were twofold: to review the forest naturalness concept by documenting the literature on the topic, describing the ecological development of the concept, and addressing the increasing importance of harmonized estimation of indicators of naturalness and to investigate methods for estimating harmonized indicators of forest naturalness using data obtained for national forest inventory (NFI) variables. The sections that follow immediately address the first objective. Specific intermediate objectives for a three-phase study to address the second objective are provided at the end of the Introduction section.

The Forest Naturalness Concept

Ecological Integrity

Historically, the evolution and dispersal of species has been thought to keep pace with environmental changes on a geological time scale (Pickett et al. 1992). However, recent opinions are that the pace of human influence on the environment may fundamentally alter that relationship (Crumpacker 1998). In response, conservation biology has emerged as the application of scientific principles to address the effects of human disturbance on ecological systems (Soulé 1985). This view emphasizes maintenance of the natural integrity of ecosystems and is guided by the principles that biotic diversity, ecological complexity, and succession are results of natural processes, are intrinsically good, and are valuable management objectives (Soulé 1985, Angermeier and Karr 1994, Crumpacker 1998) and that naturally evolved ecosystems are of greater value and quality than disturbed or artificial systems (Liira et al. 2007).

The term *ecological integrity* has been used to ascribe value to older, natural forest stands (Karr 1991, Woodley et al. 1993, Angermeier and Karr 1994, Ohlson et al. 1997, Angermeier 2000). The first reference to integrity in the ecological sense may have been Aldo Leopold's (1949) famous statement, "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." More recently, Cairns (1977) defined integrity as maintenance of the community structure and function characteristic of a particular locale. Angermeier and Karr (1994) stated that integrity refers to a system's wholeness including the presence of all appropriate elements and occurrence of all processes at appropriate rates over spatiotemporal scales. Noss (1990a) asserted that communities have integrity when they are dominated by native species, are relatively stable, and show attributes of healing. Angermeier and Karr (1994) attributed the most influential definition of biological integrity to Frey (1975), who stated that integrity is "the capability of supporting and maintaining a balanced, integrated, adaptive community of

Manuscript received June 15, 2010; accepted June 1, 2011; published online May 3, 2012; http://dx.doi.org/10.5849/forsci.10-075.

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Assessing Deadwood Using Harmonized National Forest Inventory Data

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Abstract: Deadwood plays an important role in forest ecological processes and is fundamental for the maintenance of biological diversity. Further, it is a forest carbon pool whose assessment must be reported for international agreements dealing with protection and forest management sustainability. Despite wide agreement on deadwood monitoring by national forest inventories (NFIs), much work is still necessary to clarify definitions so that estimates can be directly compared or aggregated for international reporting. There is an urgent need for an international consensus on definitions and agreement on harmonization methods. The study addresses two main objectives: to analyze the feasibility of harmonization procedures for deadwood estimates and to evaluate the impact of the harmonization process based on different definitions on final deadwood estimates. Results are reported for an experimental harmonization test using NFI deadwood data from 9,208 sample plots measured in nine European countries and the United States. Harmonization methods were investigated for volume by spatial position (lying or standing), decay classes, and woody species accompanied by accuracy assessments. Estimates of mean plot volume based on harmonized definitions with minimum length/height of 1 m and minimum diameter thresholds of 10, 12, and 20 cm were on average 3, 8, and 30% smaller, respectively, than estimates based on national definitions. Volume differences were less when estimated for various deadwood categories. An accuracy assessment demonstrated that, on average, the harmonization procedures did not substantially alter deadwood observations (root mean square error 23.17%). FOR. SCI. 58(3):269–283.

Keywords: reference definitions, bridging functions, deadwood attributes, biodiversity indicator, carbon pool

DEADWOOD IS ACKNOWLEDGED TO BE A CRITICAL ECOLOGICAL FACTOR that plays a fundamental role in forest ecosystems (e.g., Christensen et al. 2005, Lombardi et al. 2010). It is one of the most relevant components of forest biodiversity, and it represents an important forest carbon pool (Stokland et al. 2004, Woodall et al. 2009). Dead trees, stumps, and fine and coarse woody debris (CWD) are essential to forest ecosystem dynamics by providing food and habitat for taxa such as fungi, arthropods, birds, insects, and epiphytic lichens (Sippola and Renvall 1999, Bowman et al. 2000, Ferris et al. 2000, Siitonen et al. 2000, Similä et al. 2003, Jonsson et al. 2005, Odor et al. 2006, Lonsdale et al. 2008, Winter and Möller 2008). Approximately 20–25% of forest species depend on decaying wood (Boddy 2001, Siitonen 2001), although decayed material is often viewed as a limited habitat resource for some organisms (Hagen and Grove 1999).

Deadwood is also considered to be an important indicator for assessing sustainable forest management and conservation of forest biodiversity (Ferris and Humphrey 1999, Hahn and Christensen 2004, Travaglini et al. 2007, Fischer et al. 2009). Deadwood was recognized as a biodiversity indicator for sustainable forest management by Forest Europe, the former Ministerial Conference on the Protection of Forests in Europe (2003), and the Montréal Process (Montréal Process 2005) and as one of 26 indicators selected for the Streamlining European 2010 Biodiversity Indicators initiative to track temporal biodiversity changes in the context

Manuscript received May 25, 2010; accepted September 27, 2011; published online May 3, 2012; http://dx.doi.org/10.5849/forsci.10-057.

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Acknowledgments: This article is based on the activities carried out in WG3 of COST Action E43 "Harmonisation of National Forest Inventories: Techniques for Common Reporting." We express our thanks to the chair of COST Action E43, Professor Erkki Tomppo, to the members of the steering committee (Klemens Schadauer, Emil Cienciala, Adrian Lanz, and Claude Vidal) and to those who were involved in the activities of WG3: Iciar Alberdi Asensio, Anna-Lena Axelsson, Anna Barbati, Nadia Bazoum, Jana Beranova, Urs-Beat Brändli, Vladimir Caboun, Catherine Cluzeau, Sebastiano Cullotta, Leandras Deltuva, Paulo Godinho-Ferreira, Nabila Hamza, Elmar Hauk, Albertas Kasperavičius, Marko Kovač, Marco Marchetti, Helena Mäkelä, Stefan Neagu, Jan-Erik Nilsen, Dieter Pelz, Tarmo Tolm, Tiina Tonteri, and Theocharis Zagas. For contributing deadwood data for the common DB, we gratefully acknowledge the following: Belgium: Jacques Rondeux and Nicolas Latte, Unit of Forest and Nature Management, University of Liège (Gembloux Agro-Bio Tech); Switzerland: Urs-Beat Brändli and Ulrich Ulmer, Snow and Landscape Research (WSL), Swiss Federal Institute for Forest; Germany: Heino Polley, Johann Heinrich von Thünen-Institut, Eberswalde; Denmark: Annemarie Bastrup-Birk and Thomas Nord-Larsen, Forest and Landscape, University of Copenhagen; Spain: Roberto Vallejo, Ministerio de Medio Ambiente y Medio Rural y Marino, and Iciar Alberdi Asensio and Sonia Condés, E.T.S.I. Montes de Madrid; Finland: Helena Mäkelä, Finnish Forest Research Institute, Metla; Italy: Marco Marchetti, University of Molise; Sweden: Jonas Fridman and Anna-Lena Axelsson, Swedish University of Agricultural Sciences; United States of America: Forest Inventory and Analysis program of the Northern Research Station, US Forest Service. We acknowledge Alessandro Mastronardi (www.gm-studio.net) for the graphical three-dimensional rendering in Figure 2. We thank the associate editor of *Forest Science* and two anonymous reviewers who help us in improving the quality of an earlier draft of this article. This study was partially supported by the Italian Ministry of Research and University within the PRIN 2007 project "Innovative methods for the identification, characterization and management of old-growth forests in the Mediterranean environment."