Table on Criterion 1 Refinements

This table shows recommendations for refinements to the Montreal Process indicators, the rationales for the indicators, and in selected cases, approaches to measurement. These recommendations were reached through discussion and general agreement at three technical workshops coordinated by the USDA Forest Service and the Roundtable on Sustainable Forests in April 2005 to obtain high-quality input from a diverse set of forest stakeholders. Column 1 shows the location of the text in the *Draft Document: Excerpts from the Montreal Process Technical Notes Modified for the Series of C&I Refinement Technical Workshops*. Column 2 presents the original language with any deleted text underlined and struck out; column 3 presents the refined text with any additional text underlined. Column 4 includes any comments made on the refinement.

Summary of Refinements

Throughout Criterion 1, the term "species diversity" is changed to "between species diversity," "genetic diversity" is changed to "within species diversity," and "forest type" is changed to "forested ecosystem type." Definitions of "forested ecosystem type" and "protected area" are added, and two of the three concepts of biodiversity are modified. The rationales for Indicators 1, 5, 6, 7, 8, and 9 and the titles of Indicators 1, 6, 7, and 8 are modified.

Other Cross-cutting Recommendations

In the context of Indicator 5 on fragmentation, the group suggested that an economic indicator on ownership parcelization be included in Criteria 6. In addition, fragmentation should be measured against a reference condition, which might include historic condition, in order to distinguish between natural heterogeneity and human induced fragmentation.

The breakout group on Criterion 1 suggests that language about natural disturbance regimes (e.g., fire, wind, floods) be added either to indicator 16 or as a new indicator. Measuring disturbance is important because these events may adversely affect ecosystems, rather than maintaining forest health or biodiversity. These disturbances may be within the historic range of variation, so they may not be captured by the current indicator language. The new language should allow the indicator to measure the magnitude, frequency, and extent of disturbances.

New Definition: Forested Ecosystem Type

A category of forests that is a dynamic complex of living organisms (plant, animal, fungal and micro-organism communities) and the associated nonliving environment, including disturbance regimes, with which they interact.

New Definition: Protected Area

A geographically defined area that is legally designated and managed to achieve specific conservation objectives. Protected areas range from areas that are protected for conservation values to areas that are managed for commercial production but protected from development.

Modified Term: Forested Ecosystem Type

In Indicator 1 (1.1.a) and throughout Criterion 1, "forest type" is changed to "forested ecosystem type." The change will make the term consistent with the definitions that are accepted in the scientific community and avoid confusion with other definitions of cover type. "Ecosystem" is consistent with the Montreal Process definition.

Breakout Group: Criterion 1 - Indicators 1 - 9:

Participants: Kent Cavender-Bares, The Heinz Center; Dave Cleland, USDA Forest Service; Paul Geissler, U.S. Geological Survey, U.S. Department of the Interior; Jimmy Kagan, Institute for Natural Resources, Oregon State University; Nancy Lankford, USDA Forest Service; Craig Loehle, National Council for Air and Stream Improvement; Susan Morre, Department of Forest Resources, Oregon State University; Donald Outen, Baltimore County Department of Environmental Protection and Resource Management; Wayne Owen, USDA Forest Service

Criterion Lead: Curt Flather, USDA Forest Service

Facilitator: Laurie Schoonhoven, Sustainable Forestry Partnership, Penn State University

Note Taker: Scott Bell, USDA Forest Service, State and Private Forestry

Text in the Montreal Process Technical Notes	Original Language with Recommended Deletions Underlined and Struck Out	Refined Language with Recommended Additions Underlined	Comments on Recommended Change
Criterion 1 Introduction	With regard to forests, biodiversity incorporates three concepts: 1. **Ecosystem diversity** describes the variety of different ecosystems found in a region. A categorisation of the combination of animals, plants, micro-organisms, and the physical environment with which they are associated, is the basis for recognising ecosystems. 2. **Species diversity** describes the number and ~~variety~~ of species in a given area. 3. ~~**Genetic** **diversity** describes the range of genetic characteristics found within a species and among different species.~~	With regard to forests, biodiversity incorporates three concepts: 1. **Ecosystem diversity** describes the variety of different ecosystems found in a region. A categorisation of the combination of animals, plants, micro-organisms, and the physical environment with which they are associated, is the basis for recognising ecosystems. 2. **Between species diversity** describes the number and status of species in a given area. 3. **Within species diversity** describes the abundance and distribution of species. We lack the scientific and financial means to collect direct measures of genetic diversity, although it is important.	The notion of genetic diversity has been a perennial problem, and Indicators 8 and 9 do not directly measure genetic diversity. However, these changes were not unanimously supported because of concerns that they might change the definition of the three subcriteria (ecosystem diversity, species diversity, and genetic diversity) in the glossary of terms for biodiversity. Therefore, these changes should be in the indicator-specific rationale language only.
Ecosystem diversity Subcriterion	**Ecosystem diversity** describes the variety of different ecosystems found in a region. A categorisation of the combination of animals, plants, micro-organisms, and the physical environment with which they are associated, is the basis for recognising ecosystems.	**Ecosystem diversity** describes the variety of different ecosystems found in a region. A categorisation of the combination of animals, plants, micro-organisms, and the physical environment with which they are associated, is the basis for recognising ecosystems.	No changes were suggested for this subcriterion.
Indicator 1 (1.1.a) Title	Extent of area by ~~forest~~ type relative to total area	Extent of area by forested ecosystem type relative to total area	The change will make the indicator language consistent with the rationale and definitions that are accepted in the scientific community. It also will avoid confusion with other definitions of cover type. "Ecosystem" is consistent with the Montreal Process definition.

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Indicator 1 (1.1.a) Rationale	Ecological processes and viable populations of species that are characteristic of forest ecosystems are dependent on a contiguous ecosystem or ecosystems of a certain minimum size. Each forest type is considered to represent a separate ecosystem and is itself composed of a variety of ecosystem components. If sufficient area of each forest type is not maintained, these ecosystems become vulnerable to loss from fires, hurricanes or typhoons, disease, and other disasters.	Ecological processes and viable populations of species that are characteristic of forest ecosystems are dependent on a contiguous ecosystem or ecosystems of a certain minimum size. Forest ecosystems are defined by biota, and environment, and associated processes. Each forest type within ecoregions is considered to represent a separate ecosystem and is itself composed of a variety of ecosystem components. If sufficient area of each forest type is not maintained, these ecosystems become vulnerable to loss from fires, hurricanes or typhoons, disease, and other disasters.	Note: the group suggests the need to establish reference conditions. Canada adopted the following language, "Area and percent of forest ecosystem types relative to historic condition and total forest area". This suggestion is relevant to indicators 1&2.
Indicator 2 (1.1.b) Title	Extent of area by ~~forest~~ type and by age class or successional stage	Extent of area by forested ecosystem type and by age class or successional stage	The change will make the heading consistent with the rationale and definitions that are accepted in the scientific community. It also will avoid confusion with other definitions of cover type. "Ecosystem" is consistent with the Montreal Process definition.

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Indicator 2 (1.1.b) Rationale	Many species are wholly or partly dependent on a particular successional stage. Therefore, all normally occurring successional stages should be present with sufficient area to support these species. Ecological processes and the species associated with those processes within a forest ecosystem or forest type, are often associated with vegetative structure (species composition, age of the vegetation, its diameter and height, and stratification of the canopy layer). It should be noted that some forest types are predominantly composed of uneven-aged stands or otherwise difficult to ascribe to particular age classes. In addition, in terms of human needs, forest type and forest age are important determinants of timber growth and yield, the occurrence of game animals, other non-timber forest products, and the forest's aesthetic and recreational values.	Many species are wholly or partly dependent on a particular successional stage. Therefore, all normally occurring successional stages should be present with sufficient area to support these species. Ecological processes and the species associated with those processes within a forest ecosystem or forest type, are often associated with vegetative structure (species composition, age of the vegetation, its diameter and height, and stratification of the canopy layer). It should be noted that some forest types are predominantly composed of uneven-aged stands or otherwise difficult to ascribe to particular age classes. In addition, in terms of human needs, forest type and forest age are important determinants of timber growth and yield, the occurrence of game animals, other non-timber forest products, and the forest's aesthetic and recreational values.	No changes were suggested for the rationale language.
Indicator 3 (1.1.c) Title	Extent of area by ~~forest~~ type in protected area categories as defined by IUCN or other classification systems	Extent of area by forested ecosystem type in protected area categories as defined by IUCN or other classification systems	The change will make the heading consistent with the rationale and definitions that are accepted in the scientific community. It also will avoid confusion with other definitions of cover type. "Ecosystem" is consistent with the Montreal Process definition.

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Indicator 4 (1.1.d) Title	Extent of areas of ~~forest~~ type in protected areas defined by age class or successional stage	Extent of areas of forested ecosystem type in protected areas defined by age class or successional stage	The change will make the heading consistent with the rationale and definitions that are accepted in the scientific community. It also will avoid confusion with other definitions of cover type. "Ecosystem" is consistent with the Montreal Process definition.
Indicator 4 (1.1.d) Rationale	In its broadest sense, the area and proportion of forest ecosystems reserved in some form of protected condition provides some indication of the emphasis being placed by a society on the preservation of representative ecosystems as a strategy to conserve biodiversity. There are also important forest management questions that can be addressed by maintaining information on a network of comprehensive, adequate and representative forest types within protected areas. Traditionally, protected areas have been set aside for their conservation, scenic and recreational values. The ecosystems they contain might not be representative of the full range of biodiversity in a country. If protected areas are part of the national strategy for conserving ecosystems and species (including rare and endangered species), then some indication of what is protected is required. Over time, forest types within protected areas may change and this change also needs to be monitored.	In its broadest sense, the area and proportion of forest ecosystems reserved in some form of protected condition provides some indication of the emphasis being placed by a society on the preservation of representative ecosystems as a strategy to conserve biodiversity. There are also important forest management questions that can be addressed by maintaining information on a network of comprehensive, adequate and representative forest types within protected areas. Traditionally, protected areas have been set aside for their conservation, scenic and recreational values. The ecosystems they contain might not be representative of the full range of biodiversity in a country. If protected areas are part of the national strategy for conserving ecosystems and species (including rare and endangered species), then some indication of what is protected is required. Over time, forest types within protected areas may change and this change also needs to be monitored.	No changes were suggested for the rationale language.

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Indicator 4 (1.1.d) Rationale (cont)	Management strategies for forest lands administered for commercial use can be influenced by the area of land that has been reserved in protected areas. Adequate account of the ecosystems and species in reserved areas may provide more management options in forests under management for timber production or other purposes.	Management strategies for forest lands administered for commercial use can be influenced by the area of land that has been reserved in protected areas. Adequate account of the ecosystems and species in reserved areas may provide more management options in forests under management for timber production or other purposes.	
Indicator 5 (1.1.e) Title	Fragmentation of forest ~~types~~	Fragmentation of forests	Neither the science nor the data support the analysis by forest type.

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Indicator 5 (1.1.e) Rationale	The fragmentation of a forest into small pieces may disrupt ecological processes and reduce the availability of habitat. Decades of research in this field have identified a definite relationship in the ability of forest habitats of various sizes to retain species once common to that habitat. Some forest fragments are too small to maintain viable breeding populations of some species. Species dependent on the interior regions of extensive forests require an adequate area that is not close to a forest edge. Significant distances between forest patches can interfere with pollination, seed dispersal, wildlife migration, and breeding. Other changes resulting from fragmentation include a potential increase in invasion by exotic species, environmental changes, and predation problems. Ultimately, these changes result in the loss of species. In addition, regional level connectivity of forest cover can facilitate the adaptation of species to climatic changes. ~~Fragmentation information is also useful for analysis of commercial opportunities as small tracts (ownerships) may not be available for resource management.~~	The fragmentation of a forest into small pieces may disrupt ecological processes and reduce the availability of habitat. Decades of research in this field have identified a definite relationship in the ability of forest habitats of various sizes to retain species once common to that habitat. Some forest fragments are too small to maintain viable breeding populations of some species. Species dependent on the interior regions of extensive forests require an adequate area that is not close to a forest edge. Significant distances between forest patches can interfere with pollination, seed dispersal, wildlife migration, and breeding. Other changes resulting from fragmentation include a potential increase in invasion by exotic species, environmental changes, and predation problems. Ultimately, these changes result in the loss of species. In addition, regional level connectivity of forest cover can facilitate the adaptation of species to climatic changes. An important measure of fragmentation is the density of road and human structures, which is also an index to the human impacts of the landscape.	Fragmentation should be measured against a reference condition, which might include historic condition, in order to distinguish between natural heterogeneity and human induced fragmentation. **Notes:** • We suggest an economic indicator on ownership parcelization that would be included in Criteria 6. • Fragmentation should be measured against a reference condition, which might include historic condition, in order to distinguish between natural heterogeneity and human induced fragmentation.
Between Species Diversity Subcriterion	**Species diversity** describes the number and ~~variety~~ of species in a given area.	Between species diversity	

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Indicator 6 (1.2.a) Title	The number of ~~forest dependent~~ species	The number of native forest species	The definition of "forest dependent species" is problematic. Feedback from various sources suggested using "forest occurring species," but the majority of participants in the breakout group preferred the simpler "forest species," which they defined as any species that regularly uses forest ecosystems and their conditions for all or part of its requirements of food, shelter, or reproduction. "Forest species" would be the same concept as "forest occurring" or "forest associated" species. The inclusion of the word "native" is to clarify the original intent of the indicator.
Indicator 6 (1.2.a) Rationale	The maintenance of a species list for a given area as a measure of biodiversity is the most basic and easily understood measure by most of the public. The issue of species diversity is currently expressed in the popular media as the number, or projected loss, of species in an area. Forest managers also use numbers of species as one way of determining biological diversity and species diversity. Trends in species diversity can reflect the invasion of exotic species or a loss of native species, both of which can disrupt forest processes such as pollination or food chain relationships. In addition, the loss of species diversity may cause a reduction in the quality of human life. Valuable economic species may be lost, as well as important medical opportunities, and	The maintenance of a species list for a given area as a measure of biodiversity is the most basic and easily understood measure by most of the public. The issue of species diversity is currently expressed in the popular media as the number, or projected loss, of species in an area. Forest managers also use numbers of species as one way of determining biological diversity and species diversity. Trends in species diversity can reflect the invasion of exotic species or a loss of native species, both of which can disrupt forest processes such as pollination or food chain relationships. In addition, the loss of species diversity may cause a reduction in the quality of human life. Valuable economic species may be lost, as well as important medical opportunities, and	

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	aesthetic values may be diminished. A focus on numbers of species may lead to a preoccupation with those ecosystems that have high numbers of species and less concern about those with low numbers. Ecosystems with naturally low species counts, however, may also be more threatened, in addition to possessing unique species.	aesthetic values may be diminished. A focus on numbers of species may lead to a preoccupation with those ecosystems that have high numbers of species and less concern about those with low numbers. Ecosystems with naturally low species counts, however, may also be more threatened, in addition to possessing unique species. The observed species list should be measured against an expected species list. Some further research is needed to developed methods to do this.	
Indicator 7 (1.2.b) Title	The ~~status~~ (threatened, rare, vulnerable, endangered, or extinct) of forest~~-dependent~~ species at risk~~ of not maintaining viable breeding populations,~~ as determined by legislation or scientific assessment	The percent of forest species at risk (threatened, rare, vulnerable, endangered, or extinct) as determined by legislation or scientific assessment	This clarifying language better reflects what the indicator covers.
Indicator 7 (1.2.b) Rationale	This indicator is a refined measure of the conservation of biodiversity and provides information on the conservation ~~of species that are already of concern~~**.** As the overall size of a given species' population declines, a point is eventually reached where reproduction is insufficient to reverse further decline, which significantly raises the risk of extinction. By tracking the conservation status of species on this list, changes in the status of those species will be available. The loss of those species will be at a cost of unknown proportions. Changes to the lists will also indicate the continuing development of knowledge about such species.	This indicator is a refined measure of the conservation of biodiversity and provides information on the conservation status of species. As the overall size of a given species' population declines, a point is eventually reached where reproduction is insufficient to reverse further decline, which significantly raises the risk of extinction. By tracking the conservation status of species on this list, changes in the status of those species will be available. The loss of those species will be at a cost of unknown proportions. Changes to the lists will also indicate the continuing development of knowledge about such species.	

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Genetic Diversity Subcriterion	~~**Genetic** **diversity** describes the range of genetic characteristics found within a species and among different species.~~	**Within species diversity** describes the abundance and distribution of species. We lack the scientific and financial means to collect direct measures of genetic diversity, although it is important.	Indirect measures of "within species diversity" include geographic range and population trends, which are measured in Indicators 8 and 9. Except for a few species, a direct measure of within species diversity—or genetic diversity—is not technically feasible at this time. Because there is not time or money for direct measures of genetic diversity for multiple species or at a large scale, surrogate measure are being used. ***Geissler clarification:*** Indicators 8 and 9 are direct measures of components of within species diversity but only poor surrogates for genetic diversity. A direct measure of genetic diversity is not technically feasible at this time except for a few species. There is not time or money for direct measures of genetic diversity for multiple species or at a large scale, therefore surrogate measure are being used. The problem is that the geographic distribution and abundance of species are fundamental and frequently available measures of diversity, which do not fit in either species diversity or genetic diversity.

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Indicator 8 (1.3.a) Title	~~Number of forest dependent species~~ that occupy a small portion of their former range	Percent of forest species that occupy a small portion of their former range **Alternative language:** Geographic distribution declines of representative species from diverse habitats monitored across their range	Percentage accounts for the shifting pool of species for which data are available.
Indicator 8 (1.3.a) Rationale	The geographic ranges of species are continuously responding to phenomena such as glaciation, vegetation migration, climate fluctuation, predation or interspecific competition. Today, human activity may be accelerating some forces of change. Species that currently occupy only a small portion of their former range might have lost some of their genetic variation. They are at risk of losing much of their remaining variability due to natural (e.g., fires, hurricanes or typhoons, diseases) or human caused events (e.g., road development, reservoirs) that can decimate local populations. This erosion in genetic variation results in the species being less able to adapt to changes in its environment brought on by humans, climatic change, or the invasion of exotic species. The result is a higher risk of species extinction. The forest ecosystem of which the species is a part will, in turn, itself become less resilient to change. Society should be concerned because a species with a small component of its original genetic material will have less potential for human benefit. The best	Distribution and abundance of species are fundamental and often available measures of a species status. The geographic ranges of species are continuously responding to phenomena such as glaciation, vegetation migration, climate fluctuation, predation or interspecific competition. Today, human activity may be accelerating some forces of change. Species that currently occupy only a small portion of their former range might have lost locally adapted ecotypes and some of their genetic variation. They are at risk of losing much of their remaining variability due to natural (e.g., fires, hurricanes or typhoons, diseases) or human caused events (e.g., road development, reservoirs**,** urban sprawl) that can decimate local populations. This erosion in genetic variation results in the species being less able to adapt to changes in its environment brought on by humans, climatic change, or the invasion of exotic species. The result is a higher risk of species extinction. The forest ecosystem of which the species is a part will, in turn, itself become less resilient to change. Society should be concerned because a species with a small component of its	***Kagan Explanation for Indicator Rationale***: This indicator is an attempt to measure declines in species distributions, or trends in changes of species distributions. Currently in the U.S., information showing range changes or trends is available for only a limited group of species, such as birds and tree species. The indicator allows for a quantification of the percent of species that have sustained significant losses, but is not very sensitive to current trends in species range declines. Gathering information showing the trends in range declines for all vertebrate species and vascular plants would provide a much better picture of current trends.

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	examples of this are food plants and the constant search for different variations of these species to develop higher yielding or pest resistant varieties of the plant. Very few countries have the ability to directly monitor the genetic changes in endemic species. However, we know that loss of genetic diversity results where once widely distributed species are reduced to small or fragmented populations. The high cost of direct measurement of genetic markers makes range mapping an attractive alternative mechanism to identify species where genetic diversity is likely to be declining.	original genetic material will have less potential for human benefit. The best examples of this are food plants and the constant search for different variations of these species to develop higher yielding or pest resistant varieties of the plant. Very few countries have the ability to directly monitor the genetic changes in endemic species. However, we know that loss of genetic diversity results where once widely distributed species are reduced to small or fragmented populations. The high cost of direct measurement of genetic markers makes range mapping an attractive alternative mechanism to identify species where genetic diversity is likely to be declining.	
Indicator 9 (1.3.b) Title	Population levels of representative species from diverse habitats monitored across their range	Population levels of representative species from diverse habitats monitored across their range	No changes were suggested for the indicator language.

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Indicator 9 (1.3.b) Rationale	There are many forest ~~dependent~~ species that rely on some particular forest structure (multistoried tree canopies), forest vegetation associations (e.g., the association of the Koala and certain species of eucalyptus) or ecological process (e.g., the relationship between pyrophilic tree species and frequent wildfires). These species are commonly associated with other species that are also dependent on similar conditions. One of these species could be used to represent all species dependent on similar conditions, as it is not feasible to monitor all species.	Distribution and abundance of species are fundamental and often available measures of a species status. There are many forest species that rely on some particular forest structure (multistoried tree canopies), forest vegetation associations (e.g., the association of the Koala and certain species of eucalyptus) or ecological process (e.g., the relationship between pyrophilic tree species and frequent wildfires). These species are commonly associated with other species that are also dependent on similar conditions. One of these species could be used to represent all species dependent on similar conditions, as it is not feasible to monitor all species.	