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Global Ecological Forest Classification and Forest Protected Area Gap Analysis

Analyses and recommendations in view of the 10% target for forest protection under the Convention on Biological Diversity (CBD)

2nd revised edition, January 2009

ALBERT-LUDWIGS-UNIVERSITÄT FREIBURG
INSTITUTE OF FOREST AND ENVIRONMENTAL POLICY

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Report prepared by:

United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)

World Wide Fund for Nature (WWF) Network

World Resources Institute (WRI)

Institute of Forest and Environmental Policy (IFP)
University of Freiburg

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The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the biodiversity assessment and policy implementation arm of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organization. The Centre has been in operation since 1989, combining scientific research with practical policy advice.

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Preface

Deforestation and forest degradation continue at an alarming rate worldwide and jeopardise the tremendous diversity of species and habitat types present in forests around the globe. They also put at risk the large variety of ecosystem services forests provide to humankind. In view of this global problem, the Convention on Biological Diversity (CBD) at its Ninth Conference of the Parties (COP9) reconfirmed the target of having "*at least 10% of each of the world's forest type effectively conserved*" (decision IX/5, Programme of Work on Forest Biological Diversity). The present study illustrates the major issues related to this target, such as the geographic distribution of the world's remaining forest areas, difficulties related to the world's forest types and WWF ecoregions, and an up-to-date global gap analysis for forest protected areas.

The objectives of this study were developed within a larger project carried out by the Institute of Forest and Environmental Policy (IFP), University of Freiburg, called "Conservation of forest biodiversity under the CBD: Options for a global forest protected area network". Its overall aim was to provide scientific analyses and policy advice with regard to the feasibility, financing and targets for the establishment of a global network of forest protected areas. The project was supported by the German Federal Agency for Nature Conservation (BfN) with funds from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

The present study is a result of the joint efforts of a consortium comprising the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), World Wide Fund for Nature (WWF) Network and World Resources Institute (WRI) in cooperation with IFP. Staff from the WWF network, in collaboration with those from UNEP-WCMC and WRI, prepared the assessment of the feasibility of WWF ecoregions for use as a global guidance for forest types; UNEP-WCMC took the lead on conducting the global gap analyses for forest protected areas.

On behalf of the consortium, IFP is thanked for funding the majority of this work through support provided by BfN / BMU; WWF International also provided additional funding. All partners of the consortium are thanked for contributing their staff time, as well as data sets and analyses for use in this study. Conservation International provided permission to use their GIS layers for High Biodiversity Wilderness Areas and Biodiversity Hotspots.

The study was first presented and distributed at COP9 during the side event "Forest protected areas – Identifying and closing global conservation gaps". This revised edition is based on a modified version of the forest cover data, which corrected some minor inconsistencies in the original datasets regarding the classification of forest type. The new results did not change the conclusions of the first edition, but improved the consistency of the analyses and resulted in only small changes in some of the reported statistics. The second edition was made possible by the tireless efforts of Lauriane Boisrobert, Neil Burgess, Lauren Coad and Christine Schmitt in revising the study on behalf of the broader group.

Contents

Executive Summary

This study, conducted by the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), World Wide Fund for Nature (WWF) Network, World Resources Institute (WRI) and Institute of Forest and Environmental Policy (IFP), assesses the global gaps in forest conservation with reference to the target of the Convention on Biological Diversity (CBD), which calls for the effective conservation of "*at least 10% of each of the world's forest types*" by 2010 (decision VIII/15). The results are expected to guide forest conservation policies and planning at national and international levels. The study addresses four main tasks:

- Update of the 2000 UNEP-WCMC Global Forest Map (GFM) and forest types.
- Evaluation of the utility of WWF ecoregions as a means for tracking progress under the 10% target.
- Assessment of the progress made towards achieving the 10% target for forest protection based on the global forest types, the WWF ecoregion framework and Conservation International's (CI) conservation priority areas.
- Identification of global priority areas for forest conservation.

The GFM was updated using recent satellite data from 2005 and the forest cover was sub-divided into different forest types. The updated GFM was then overlaid onto ecoregions in order to assess the amount of forest cover within each ecoregion and according to forest type. Subsequently, protected area (PA) ecological gap analyses were performed using the latest PA data within the World Database of Protected Areas (WDPA, February 2008). These analyses calculated the amounts of forest cover and forest types protected globally and within each biogeographic realm and WWF ecoregion. Forest protected within IUCN PA management categories I-IV and I-VI was assessed separately to ensure a distinction was made between strictly protected areas and those allowing some form of forest use. A further overlay of forest cover and protected areas with CI's Biodiversity Hotspots and High Biodiversity Wilderness Areas was carried out to establish the level of protection within areas of particular conservation importance.

These analyses produced a wide range of statistics on the PA coverage of the world's forests. A selection of the results are presented and discussed here with the aim of informing the conservation community, scientists and policy-makers on global progress towards achieving the CBD 10% target for forest conservation. It will also facilitate the identification of gaps that need to be filled in order to develop a fully representative global network of forest PAs.

How much of the world is forest and in how many different types?

The updated GFM illustrates predominately natural forest cover divided into 30 forest types. 10 of those are unresolved forest classes that require further work to assign to actual forest types. At the 10% canopy cover threshold, total global forest cover is approximately 39 million km^2 (28.8% of global land cover) with unresolved forest classes covering over 11 million km^2 of land. The Palearctic (e.g., Europe and Russia) and the Neotropics (Latin America) are the global biogeographic realms with the largest areas of remaining forest, highlighting the importance of these regions for forest conservation.

Do WWF ecoregions adequately represent forest cover and forest type?

The overlay of the updated GFM with WWF ecoregions showed that use of the predefined 'forest' and 'non-forest' categories for ecoregions is not an appropriate surrogate for forest cover as both categories of ecoregions contain areas of forest. Therefore the actual area of forest cover, as defined by the updated GFM within all ecoregions needs to be considered when using ecoregions in forest PA gap analyses. Although ecoregions distinguish between

biogeographically different forest areas, they do not fully represent the GFM forest types because many ecoregions contain several forest types. Some important types such as montane forests are not considered under the ecoregion framework.

What is the current status of forest protection at global level?

The results presented in this report clearly suggest that the world's PAs do not adequately conserve the global extent of forest cover. Only 7.7% of the world's forests are currently conserved within PAs in IUCN categories I-IV, which are the most strict conservation categories. Considering those PAs within IUCN categories I-IV, levels of protection are less than 10% for 22 out of 30 global forest types, and 67% of the 742 WWF ecoregions with some forest cover have less than 10% of their forest area conserved. Furthermore, less than 10% of the forest in many renowned high biodiversity areas is protected. If we also consider the PAs with IUCN categories V and VI, then PAs cover 13.5% of the world's forests. While this picture is more encouraging, much depends on the effectiveness of category V and VI PAs in ensuring sustainable use and maintaining core areas. The efficacy of those PAs allowing sustainable use, in their ability to conserve forest, merits further investigation.

Where are the gaps in forest conservation at different biogeographic scales?

Realms and forest types. For PAs within IUCN categories I-IV, the least well protected forests are found in Africa and the northern latitude forest in the Palearctic and Nearctic realms, whilst the forest areas with the highest level of protection are found in Australasia and Latin America (Neotropics). Each realm, including the apparently better protected ones, has a number of GFM forest types that do not meet the 10% target. In addition, a number of forest types are under-represented across several realms even if PAs of all IUCN categories are considered. These include 'Tropical deciduous/semi-deciduous broadleaf forest', 'Temperate deciduous broadleaf forest', and 'Tropical lowland evergreen broadleaf rain forest'.

Realms and ecoregions. Of the 742 WWF ecoregions containing at least some forest cover, 67% have forest cover protected below the 10% threshold at IUCN I-IV. The majority of the least well protected ecoregions are found in the Palearctic region (especially the northern taiga) and in the Afrotropical region (especially the Congo Basin). Even for the better protected realms, areas of low protection are still found in some parts of Australasia (New Guinea and Solomon Islands in particular), Indo-Malay (especially Borneo), and the Neotropics (particularly the Cerrado).

Conservation priority areas. Virtually all CI conservation priority areas contain forest cover. However, forest protection has not reached the 10% target for PAs within IUCN I-IV in 20 out of the 34 CI biodiversity hotspots. As these regions have already lost 70% of their habitat and harbour many narrowly endemic and threatened species, achieving protection of 10% of the remaining forest area is an urgent minimum requirement for conservation purposes. Additionally, the forests in 3 out of the 5 high biodiversity wilderness areas are protected at levels below 10% at IUCN I-IV, including the Congo Basin. Forest protection in these areas should be considered a high priority because together, they harbour a significant proportion of global biodiversity.

How appropriate is the 10% target for forest protection?

It is clear that assessment of the 10% target is highly dependent upon the scale and biogeographic resolution of the analysis. Reporting on this generic target does not provide information on whether PAs adequately capture the distribution of biodiversity within forests, nor does it provide information on conservation effectiveness. In addition, some forest areas have a particularly high biodiversity value, and are likely to require levels of protection above the 10% target. The 10% target should therefore only be viewed as a baseline for forest

protection analysis, while the use of the target needs to be complemented with knowledge of the biological values and ecology of the forest types being considered.

How can progress towards the CBD forest targets best be reported?

Our analyses provide some insights regarding the development of a mechanism that would allow the CBD to track progress towards the achievement of the 10% target for forest types and the establishment of globally representative forest protected area networks.

An interim solution to tracking progress. As long as there are unresolved forest types on the GFM, we recommend that progress towards the CBD target is measured through analysis of the level of protection for forest cover within WWF ecoregions, with recognition that some forest types will not be represented through this approach.

A proposed long term solution to tracking progress. Once a completely resolved GFM is available we believe that a combination of forest types and ecoregions would ultimately provide a better template to measure the CBD target for forests at different geographic scales. At global level, an analysis of forest protection for forest types split by realms can account for the forest types missed out by the ecoregions system. At regional level, i.e. within each ecoregion, the analysis of PA coverage should be broken down by global forest types or finer-scale national classification systems.

What steps need to be taken to establish PAs that adequately represent the world's forest biodiversity?

Close the global gaps in forest conservation. From a global perspective, the current level of forest protection is inadequate. Further protection of forest area, with a focus on certain forest types and ecoregions as presented in this study, is therefore required.

Reconsider the 10% target. The CBD 10% target should be regarded as a minimum political target for forest protection. Especially for forest areas with globally significant biodiversity concentrations and for large wilderness areas, expansion of the protected area coverage above the 10% threshold is recommended.

Further update the GFM. Resolving the currently unresolved GFM forest types could greatly assist the tracking of progress in forest protection globally and regionally.

Conduct systematic conservation planning. Systematic planning is essential in order to ensure that PAs are located in a way that they adequately capture variations in forest species and habitats. Regional planning processes can be facilitated by GFM forest types, the ecoregion framework and national forest classification systems.

Consider PA management effectiveness. Evaluating and monitoring PA management effectiveness is needed to ensure that existing PAs meet their conservation objectives.

Enhance sustainable forest management outside PAs. Although PAs are a major tool for global biodiversity conservation, there is also a strong need for sustainable forest management outside PAs.

List of Acronyms

BfN	German Federal Agency for Nature Conservation
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CBD	Convention on Biological Diversity
CI	Conservation International
EU	European Union
EC-JRC	European Commission, Joint Research Centre
FAO	Food and Agriculture Organization of the United Nations
FRA	Forest Resource Assessment
GFM	Global Forest Map
GIS	Geographic Information System
GLC	Global Land Cover
IFP	Institute of Forest and Environmental Policy
IUCN	International Union for Conservation of Nature
MODIS	Moderate Resolution Imaging Spectroradiometer
NGO	Non-Governmental Organisation
PA	Protected Area
UN	United Nations
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre
WDPA	World Database on Protected Areas
WRI	World Resources Institute
WWF	World Wide Fund for Nature
VCF	Vegetation Continuous Fields

1 Introduction

Forests contain as much as 90% of terrestrial biodiversity, with tropical forests being particularly important in terms of both species richness and their concentration of endemic species (Brooks *et al.* 2006). The world's forests are also globally important carbon stores and sinks (Gullison *et al.* 2007) and provide a wide variety of other ecosystem services for people, such as protection of fisheries, watersheds and soils. Furthermore, forests constitute an important source of raw materials as the rural poor depend on forest products to meet basic livelihood needs and industry needs forests to provide timber and non-timber products.

Approximately 30% of the global land area is currently forested, but mean global deforestation rates amount to 13 million hectares a year (Achard *et al.* 2002). This is related to continuous forest destruction and forest degradation, particularly in tropical countries. Forest biodiversity is also threatened in boreal and temperate forests due to increasingly industrialised forest management.

The UN Convention on Biological Diversity (CBD) considers protected areas as cornerstones for biodiversity conservation and as critical tools for reducing the current rate of loss of species and habitats in all types of ecosystems (2010 biodiversity target, decision VI/26). Recognising the unsatisfactory spatial coverage of protected areas, the expanded Programme of Work on Forest Biodiversity (decision VI/22) calls for Parties to "*assess the representativeness of protected areas relative to forest types*" and to "*establish biologically and geographically representative networks of protected areas*" (programme element 1, goal 3, objective 3). In addition, the framework for monitoring implementation of the achievement of the 2010 target states that "*at least 10% of each of the world's forest types*" should be effectively conserved (decision VIII/15).

Political targets are crucial for guiding global conservation policies. The 10% target for protected area coverage entered the political arena in the 1980s (Svancara *et al.* 2005). Its endorsement by the CBD can be seen as a major achievement in international conservation policy. An advantage of the general 10% target is that it follows the principle of representativeness: From a political perspective all Parties with forests are held responsible for forest conservation, whilst from a biodiversity perspective all forest types are considered.

1.1 Problem statement

Despite the establishment of internationally recognised targets for forest protection, the extent to which forest and forest types are protected globally is not well known. Ecological gap analyses, used to measure the degree to which protected area networks are representative of different attributes of biodiversity, have measured global coverage of protected areas with regard to habitats (Hoekstra *et al.* 2005), species diversity (Rodrigues *et al.* 2004b) and conservation priority areas (Rodrigues *et al.* 2004a). To date though, a comprehensive global gap analysis with particular focus on the CBD 10% target for forest protection has not been conducted.

The assessment of the 10% target for forests requires a globally accepted classification system of forest types as a baseline reference. SBSTTA 11 (UNEP/CBD/SBSTTA/11/INF/2) proposed to use the world's major forest types for this purpose, which are represented by the 2000 Global Forest Map (GFM, UNEP-WCMC 2000). These major forest types are, however, somewhat general, and do not illustrate the ecological variation present within a single forest type across its geographical range. In addition, the 2000 GFM is based on a compilation of relatively outdated data from the 1990s.

Keeping this in mind, biogeographic classification systems may be better suited than the GFM in order to assess global progress towards achieving the 10% target for forests. The WWF ecoregions framework is the most detailed biogeographic classification system at the global level. These ecoregions are defined as "*large units of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions*" (Olson *et al.* 2001) and are mapped using recognised global biogeographic maps, published regional classification systems and expert consultations. The WWF ecoregions framework is widely accepted and is often used for biodiversity analyses (Hoekstra *et al.* 2005; Magin and Chape 2004; Mittermeier *et al.* 2003; Mittermeier *et al.* 2004; Sanderson *et al.* 2002). The WWF framework also distinguishes particular 'forest ecoregions', but the degree to which ecoregions act as a suitable surrogate for the representation of forest coverage has not been investigated.

1.2 Objectives and outline

Knowledge on the current level of forest protection according to forest type and at different biogeographic scales is vital for informed decision making regarding forest conservation nationally as well as globally. It is also a prerequisite for further implementation of the CBD Programmes of Work on Protected Areas and on Forest Biodiversity. The present study therefore has as its objective to accurately assess the global gaps in global forest conservation, based on the officially adopted CBD 10% target for forest protection. The results are expected to guide forest conservation policies and forest conservation planning at national and international levels.

As pointed out previously, a global forest classification system, based on current forest cover and representing biogeographically different forest ecosystems, is not yet in place. Hence, this study reviews two major existing classification systems, i.e., the global forest types and WWF ecoregions, and evaluates the extent to which they are suited to assess the 10% target for forest protection. Subsequently, global gaps in forest conservation are highlighted. The analyses make use of the latest available data on global forest cover (UNEP-WCMC 2000), WWF ecoregions (Olson *et al.* 2001) and Conservation International's (CI) conservation priorities (Mittermeier *et al.* 2003; Mittermeier *et al.* 2004), which have been collated and combined with the 2008 protected areas coverage data in the World Database on Protected Areas (WDPA).

The study addresses four main tasks:

- Update of the 2000 UNEP-WCMC GFM and forest types.
- Evaluation of the utility of the WWF ecoregion framework as a surrogate for the representation of global forest coverage and forest types.
- Global gap analysis for forest protection with reference to the CBD 10% target, based on the global forest types, the WWF ecoregion framework and taking into account CI's Biodiversity Hotspots and High Biodiversity Wilderness Areas.
- Identification of global priority areas for forest conservation.

Recommendations are made regarding:

- The use of different global classification systems for reporting progress toward the CBD 10% target for forest protection.
- The global forest areas, which require additional protection to achieve the 10% target.
- The appropriateness of the 10% target for achieving positive conservation outcomes.
- Further data required for establishing and monitoring forest protected areas, which adequately represent global variations in forest biodiversity.

2 Methodologies

2.1 Updated Global Forest Map

The 2000 version of the UNEP-WCMC GFM (UNEP-WCMC 2000) was updated in order to ensure that the latest and most accurate data for global forest coverage were used in the analyses throughout this study. The update was based on the recent (2005) satellite-derived 500m MODIS Vegetation Continuous Fields Dataset (MODIS05 VCF) (Hansen *et al*. 2006), and the Global Land Cover 2000 (GLC 2000) produced by the European Commission - Joint Research Centre (EC-JRC 2006). The MODIS05 VCF dataset identified areas as forest that had not been considered forest in the original GFM, whereas the GLC 2000 map allowed for identification of areas of non-natural tree cover not suitable for use in this analysis, such as plantations and other non-natural tree cover, as well as shrublands and agricultural areas.

2.2 WWF ecoregion analysis

There are 825 ecoregions within 14 major biomes and 8 biogeographic realms, based largely on the biogeographic realms of Pielou (1979) and Udvardy (1975) (Olson *et al.* 2001). Ecoregions are classified to reflect vegetation cover as it would have been 500 years ago. Depending on the biome they are located in they are defined as 'forest' or 'non-forest' (Table 1).

The updated GFM was overlaid with the WWF terrestrial ecoregions dataset to obtain forest information by ecoregion, and to evaluate whether further refinement of 'forest' ecoregions is required in order to represent all important forest types at the global level. This involved an analysis of whether the ecoregions defined as 'forest' and 'non-forest' actually contained forested areas, and whether ecoregions can accurately distinguish between forest types. The results of this analysis were used to inform the methodology from the gap analysis, and contributed to discussion of the utility of ecoregions in assessing progress towards targets for forest protection.

Table 1: WWF classification of biomes and ecoregions, indicating those biomes which are regarded as 'forest' within the WWF system (Olson *et al.* 2001).

Biome name	Number of ecoregions	Forest
Tropical and subtropical moist broadleaf forest	231	Yes
Tropical and subtropical dry broadleaf forests	54	Yes
Tropical and subtropical coniferous forests	17	Yes
Temperate broadleaf and mixed forests	84	Yes
Temperate coniferous forest	53	Yes
Boreal forests/Taiga	28	Yes
Mediterranean forests, woodlands and shrub	39	Yes
Mangroves	19	Yes
Tropical and subtropical grasslands, savannas, and shrublands	49	No
Temperate grasslands, savannas and shrublands	43	No
Flooded grasslands and savannas	25	No
Montane grasslands and shrublands	50	No
Tundra	37	No
Desert and Xeric shrublands	96	No

2.3 Forest protected area gap analysis

2.3.1 Protected area data

Protected area data were obtained from the February 2008 version of the World Database on Protected Areas (WDPA). It holds spatial and attribute information for 102,290 nationally protected sites, including significant updates for the Congo Basin, South America and Russia as compared to previous versions. Protected areas are not all designated and managed for the same purpose. One of the attributes held for each site within the WDPA is the management category it has been assigned, following the six protected area management categories established by the International Union for Nature Conservation (IUCN) (Table 2). Whilst protected areas of all categories contribute to biodiversity conservation, the categories have different implications for protected area management, which should be taken into account in gap analyses (Dudley and Parish 2006).

Table 2: IUCN protected area management categories (IUCN 1994).

Category	Description
Ia	Protected area managed mainly for science
Ib	Protected area managed mainly for wilderness protection
II	Protected area managed mainly for ecosystem protection and recreation
III	Protected area managed mainly for conservation of specific natural features
IV	Protected area managed mainly for conservation through management intervention
V	Protected area managed mainly for landscape/seascape conservation or recreation
VI	Protected area managed mainly for sustainable use of natural resources

The following groups of IUCN protected area management categories were used to assess the level of protection afforded by protected areas:

- Protected areas with IUCN protected area management categories I-IV (protected areas with strict biodiversity protection; hereafter referred to as 'strict protection').
- Protected areas with IUCN protected area management categories I-VI (hereafter referred to as 'all categories'); protected areas where other forms of land use are allowed including sustainable use by local and indigenous communities.

There are 30,685 sites in the WDPA including, e.g., about African 3,000 forest reserves (Burgess *et al.* 2007), where the IUCN protected area management category was not known at the time of the study. They were excluded from this analysis because their long-term viability as protected areas is as yet uncertain. Once properly reviewed by national authorities and other experts, these areas may become part of subsequent analyses. For limitations and caveats in protected area data, see Section 4.4.

Whilst it should be emphasised that all protected areas have biodiversity conservation as an objective, categories V and VI allow for a wider spectrum of forest uses, which can modify species composition and structure of the original forest vegetation. It is therefore common practice to consider only IUCN categories I-IV in analyses of the conservation of natural forests (e.g., Mittermeier *et al.* 2004; Patry and Ripley 2007), and it is these categories clearly managed for strict protection that are focused upon in this report. This analysis makes no attempt to assess whether the area is managed effectively, and therefore is not an indication of the degree to which forest is actually protected on the ground. However, reporting on the protected areas managed for strict biodiversity protection separate from those managed for sustainable use allows some level of assessment according to the stated management purposes. It also allows identification of areas where the forest protection is

heavily weighted towards strict protection or sustainable use, and facilitates discussion as to the implications of this.

2.3.2 Forest protection gap analyses

Gap analysis of protected areas should ensure that full representation is considered across biological scales (Dudley and Parish 2006), and forest protection was therefore assessed according to forest type and across biogeographic realms and ecoregions. Firstly, the WDPA was overlaid onto the updated GFM to determine the level of protection of the 30 identified forest types. The WDPA and updated GFM were then overlaid with WWF realms and ecoregions to gain results for protection of forest on biogeographic scales. The protection of forest cover was assessed rather than the protection of the realm or ecoregion as a whole, and all ecoregions with forest cover were included in the analysis, rather than only those ecoregions officially defined as 'forest', as informed by the analyses described in Section 2.2.

The above analyses attached no weight to the biodiversity values of the forest area. In order to provide comment on protection of high biodiversity areas, further analyses were undertaken to identify the level of forest protection in CI's biodiversity hotspots and high biodiversity wilderness areas (Mittermeier *et al.* 2003; Mittermeier *et al.* 2004). Hotspots and wilderness areas were selected from a large number of other global biodiversity priority setting schemes, because they follow the ecoregion classification evaluated in this study (Schmitt 2007). They also allow comparison between high biodiversity areas in which much of the habitat has been lost, and those in which a large percentage of the original vegetation remains intact. Hotspots contain a significant proportion of the world's endemic plant species, but have lost >70% of their natural habitat, whereas wilderness areas have >70% of their remaining habitat, and include the most intact forest areas such as the Amazon and Congo Basin rainforests.

The results for each are presented in terms of percentage forest protection under IUCN PA management categories I-IV and I-VI (Section 2.3.1). Areas that have less than 10% protected area coverage are highlighted across each scale of analysis in order to identify gaps in the protected area network.

3 Results and Discussion

3.1 Updated Global Forest Map

The updated GFM is a 500m resolution raster GIS dataset using the latest available satellite imagery to provide an accurate global estimate of forest cover relative to current remote sensing capabilities. By excluding areas of non-natural tree cover, it identifies predominantly natural forest cover. A separation was made between forest cover of 10 to 30% and greater than 30% (Figure 1). This differentiation improves the analysis in that in biomes such as tropical moist forest, where natural forests have a closed canopy, a tree cover of less than 30% indicates severely degraded forests or mosaic of forest and agriculture - in either case a forest significantly altered from a natural state. In addition, at low levels of canopy cover there may be some confusion of shrubs or agroforestry with forests. Meanwhile in drier biomes, the 10% to 30% forest cover class may indicate natural forests. Keeping these two classes of forest cover separate allows flexibility to interpret results at the biome or ecoregion level, and avoids the overestimation of forest cover where natural forests have a canopy cover much greater than 10%.

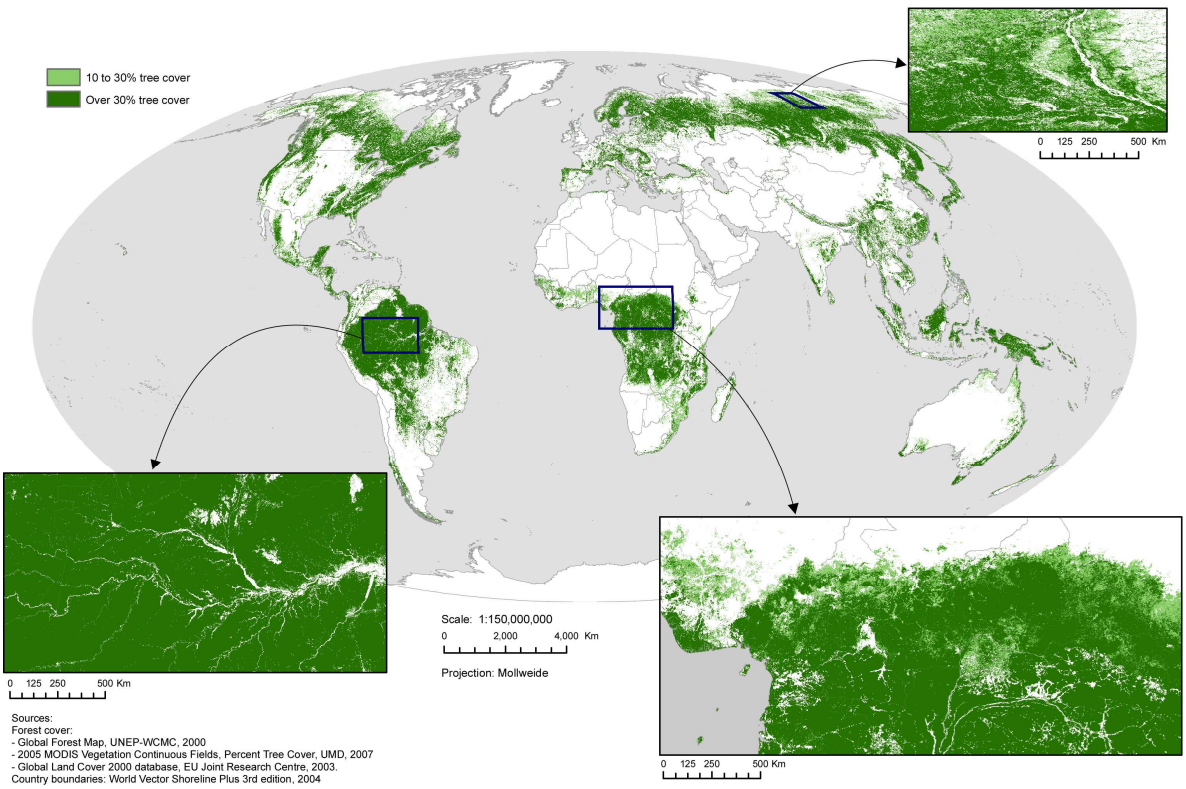

Figure 1: Global forest area as defined by MODIS05 VCF at >10% and > 30% forest cover; the >10% cover definition of forest was used in this report.

The analyses in this study are based on the extent of forest area with > 10% canopy cover, the threshold level used by the UN Food and Agriculture Organization (FAO) for their Forest Resource Assessment (FRA) products, in order to ensure that the results are representative of the most conservative and widely used global forest definition. The estimate of global forest cover provided by the updated GFM is 39.0 million km^2 (28.8%) of the land area

excluding lakes, rocks and ice). This is slightly less than the latest FAO estimate from 2005 of 39.5 million km^2, which is derived mainly from national scale inventories (FAO 2006).

The updated GFM still contains large tracts of unresolved forest type because the forest areas newly identified by MODIS05 VCF could not be integrated with the existing GFM forest types in the timeframe available and were grouped according to the GLC 2000 forest classes. The updated GFM thus distinguishes 30 forest types, in which the GFM 2000 forest types and the GLC 2000 forest classes are treated separately (Table 3). Whilst this was necessary for consistency within the timeframe of the study, the forest types of these two different systems should ideally be harmonised to generate a single set of statistics for forest area of different forest types to be applied globally. The development of such a globally consistent forest map should be considered a priority and this finding is reiterated as one of the major conclusions of this study.

Table 3: Forest types as identified by the updated Global Forest Map (GFM). Unresolved forest types indicate areas of forest that could not be identified to be consistent with the existing GFM forest types in the timeframe available. They are grouped according to Global Land Cover (GLC) classes.

Forest Type	Forest Area (km^2)
GFM 2000 forest types	
Temperate Evergreen needleleaf forest	6,501,321
Tropical Lowland evergreen broadleaf rain forest	6,489,017
Temperate Deciduous broadleaf forest	2,688,989
Temperate Deciduous needleleaf forest	2,624,624
Temperate Sparse trees / parkland	1,939,314
Tropical Deciduous / semi-deciduous broadleaf forest	1,728,779
Temperate Mixed broadleaf / needleleaf forest	1,434,821
Tropical Sparse trees / parkland	1,007,315
Tropical Semi-evergreen moist broadleaf forest	842,975
Tropical Upper montane forest	475,660
Tropical Lower montane forest	448,476
Tropical Freshwater swamp forest	439,556
Temperate Sclerophyllous dry forest	392,058
Tropical Sclerophyllous dry forest	241,265
Temperate Broadleaf evergreen forest	179,706
Tropical Mangrove	118,968
Temperate Freshwater swamp forest	88,502
Tropical Needleleaf forest	32,039
Tropical Thorn forest	10,071
Tropical Mixed needleleaf / broadleaf forest	8,860
GLC 2000 forest classes	
Unresolved Tree Cover, broadleaved, evergreen	2,946,757
Unresolved Tree Cover, broadleaved, deciduous, closed	2,606,302
Unresolved Tree Cover, broadleaved, deciduous, open	1,791,390
Unresolved Tree Cover, needle-leaved, evergreen	1,732,403
Unresolved Mosaic: Tree Cover / Other natural vegetation	845,907
Unresolved Tree Cover, mixed leaf type	626,337
Unresolved Tree Cover, needle-leaved, deciduous	609,236
Unresolved Tree Cover, regularly flooded, fresh water	96,409
Unresolved Tree Cover, burnt	30,836
Unresolved Tree Cover, regularly flooded, saline water	19,779
Total	**38,997,673**

3.2 WWF ecoregion analysis

3.2.1 Forest cover across 'forest' and 'non-forest' ecoregions

An analysis of forest cover across all ecoregions showed that forest is distributed across various ecoregions, including those which are not officially defined as 'forest' (Table 1). 742 ecoregions have some degree of forest cover according to the updated GFM.

Of the 525 'forest' ecoregions, only 489 (or 93%) contain forest (Table 4). This means that 36 of the 'forest' ecoregions no longer contain forest. The discrepancies in forest cover are partly related to ecoregions found on small tropical islands, where forest cover could not be measured due to the lack of satellite data. In addition, it is likely that some other ecoregions have experienced extreme deforestation over the past 500 years (for instance on islands such as the Mascarenes, Madagascar, and Comoros), and do therefore no longer contain forest according to the updated GFM.

In contrast, 84% of 'non-forest' ecoregions did in fact contain areas of forest cover. Many of these ecoregions are within montane grassland-shrubland mosaics and the savanna woodland biome, which covers huge areas of the drier regions, predominantly in the tropics. Although the mean percentage forest cover in 'non-forest' ecoregions was low (13% cover compared to 45% in 'forest' ecoregions), this is still a significant amount of forest. The forest cover can be due to forests along riparian areas or at the limits of ecoregions; or a result of the broad WWF biome classification.

Table 4: Assessment of the forest cover of the ecoregions falling within 'forest' and 'non-forest' biomes (see Table 1).

	Number of ecoregions	Number of ecoregions with forest cover	Percent ecoregions with forest cover
'Forest' ecoregions	525	489	93.1
'Non-forest' ecoregions	300	253	84.3
All ecoregions	**825**	**742**	**89.9**

Our results clearly indicate that the set of ecoregions within 'forest' biomes does not capture all the world's forested areas. It is therefore apparent that the further separation of ecoregions into 'forest' and 'non-forest' is not an accurate indicator of forest coverage. Consequently, all further analyses focus on the 742 ecoregions with forest cover, irrespective of whether they are officially defined as 'forest' ecoregions by WWF. Furthermore, it can be concluded that we need to look at actual forest cover, rather than total area of the ecoregion, for analyses of forest protection.

3.2.2 How well do ecoregions capture forest types?

The overlay of the updated GFM with the WWF terrestrial ecoregions highlighted that most ecoregions contain four to six forest types (Figure 2). Only those forest types recognised by the GFM 2000 (Table 3) were included in the analysis to avoid problems of double counting what is effectively the same forest type (GFM 2000 and GLC 2000). It can be concluded that ecoregions do not adequately capture the variety of global forest types identified by the updated GFM. This holds true especially for tropical ecoregions that may contain a large number of forest types, up to 11 in some cases. Although tropical ecoregions have a finer resolution than the temperate ones, they are still too coarse to represent the large number of forest types that result from the complex vegetation patterns in tropical forests.

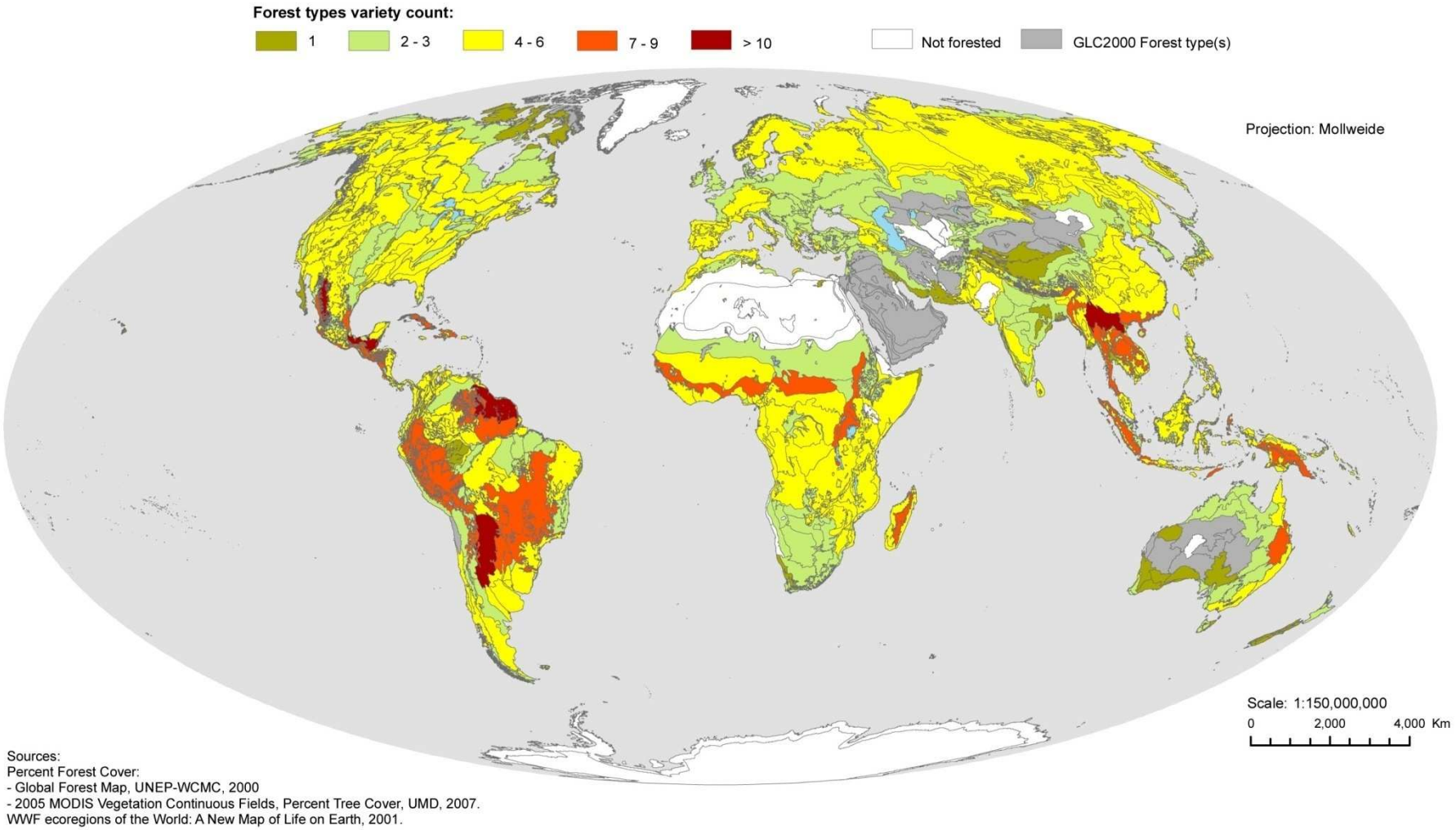

Figure 2: Number of GFM 2000 forest types (see Table 3) within each WWF ecoregion globally.

In addition to this, certain forest types of exceptional biological and hydrological importance, such as montane forests and riparian forest are not identified in the ecoregion framework. Riparian vegetation was explicitly not incorporated into the WWF framework due to its small spatial extent; despite usually being comprised of relatively unique vegetation compared to the surrounding ecoregional vegetation.

It is clear, therefore, that ecoregions cannot be taken to be accurate measures of forest cover in terms of representation of forest types. This finding was to be expected, as the fine scale coverage of the various forest types are hard to separate into the relatively coarse framework of ecoregions. In fact, ecoregions were not intended for use in vegetation classification, but rather to identify similar biogeographic assemblages. This is not only a drawback but also an advantage because the ecoregions can distinguish differences in species assemblages not recognised by the GFM forest types. Africa, for example, has been divided into four separate mangrove ecoregions. As a consequence, global forest cover should be classified by using a combination of forest types and ecoregions. Further discussion of this topic can be found in Section 4.1.

3.3 Forest protection gap analyses

This section aims at assessing the global progress towards achieving the CBD target of conserving "*at least 10% of the world's forest types*" until 2010. There is not yet an ideal way of assessing this target, because the updated GFM contains a large number of unresolved forest types, whilst the ecoregions do not accurately represent the variety of forest types that can be present within a biogeographic region. We therefore decided to assess the protected area coverage for a variety of different spatial units, i.e., for forest types, realms, forest types by realms, ecoregions and global conservation priorities. Although neither methodology is perfectly suited for forest gap analyses, they are the best methods available and together can provide valuable insights into the gaps in global forest conservation.

The purpose of these analyses is to identify forest areas in which the 10% protected area coverage target has been met, and those for which there are gaps. However, it should be noted that there is some debate as to the relevance of the 10% target (Section 4.3), and the results should therefore be viewed with this in mind. Surpassing the 10% target does not necessarily mean that there are no gaps in the protected area network, and although the 10% target provides a representative and global measure of progress, the results presented here show that the level of protection differs depending on which biogeographic units are used for the analyses. It should also be noted that protected areas that have not been assigned an IUCN category have not been reported in this analysis. This provides a level of consistency in that only the designated protected areas that have been assigned a category are included, but does mean that the figures presented here may underestimate the level of forest protection.

3.3.1 Protection of global forest types

Globally, forests are protected at levels below the 10% target when strictly protected areas (categories I-IV) are considered, with total protection of 7.7% of forest area (Table 5). When all management categories are considered (including areas designated for sustainable use), this value nearly doubles to 13.5%. It is interesting to note that approximately half of the world's forest protected areas fall under categories V-VI, where sustainable use of the forest is permitted, and invites discussion as to what is meant by 'protection' when considering biodiversity targets.

Table 5: The area, and percentage coverage of global forest types (described in the updated Global Forest Map), at IUCN categories I-IV and I-VI. Forest types failing to meet the 10% target for protection (at IUCN I–IV) are highlighted in grey.

Forest Type	Forest Area (km^2)	IUCN I-IV Percent Protection	IUCN I-VI Percent Protection
GFM 2000 Forest Type			
Temperate Broadleaf evergreen forest	179,706	28.0	34.2
Tropical Upper montane forest	475,660	18.2	26.1
Tropical Semi-evergreen moist broadleaf forest	842,975	17.7	26.4
Tropical Sclerophyllous dry forest	241,265	16.0	16.5
Tropical Mangrove	118,968	14.2	20.7
Temperate Sclerophyllous dry forest	392,058	13.1	24.1
Tropical Lower montane forest	448,476	12.7	17.5
Tropical Lowland evergreen broadleaf rain forest	6,489,017	10.3	20.8
Tropical Thorn forest	10,071	9.5	22.2
Tropical Deciduous / semi-deciduous broadleaf forest	1,728,779	8.9	12.6
Tropical Needleleaf forest	32,039	8.8	13.3
Tropical Sparse trees / parkland	1,007,315	8.0	11.0
Temperate Evergreen needleleaf forest	6,501,321	7.6	14.1
Tropical Freshwater swamp forest	439,556	6.9	8.6
Temperate Sparse trees / parkland	1,939,314	6.1	8.7
Temperate Deciduous broadleaf forest	2,688,989	5.7	12.8
Temperate Mixed broadleaf / needleleaf forest	1,434,821	4.4	8.5
Temperate Deciduous needleleaf forest	2,624,624	4.3	5.8
Tropical Mixed needleleaf / broadleaf forest	8,860	4.3	6.7
Temperate Freshwater swamp forest	88,502	3.2	8.2
GLC 2000 Forest Class			
Unresolved Tree Cover, regularly flooded, fresh water	96,409	9.0	23.4
Unresolved Mosaic: Tree Cover / Other natural vegetation	845,907	8.6	12.5
Unresolved Tree Cover, broadleaved, evergreen	2,946,757	7.0	12.0
Unresolved Tree Cover, burnt	30,836	7.0	8.1
Unresolved Tree Cover, mixed leaf type	626,337	7.0	11.1
Unresolved Tree Cover, broadleaved, deciduous, open	1,791,390	6.9	9.6
Unresolved Tree Cover, needle-leaved, deciduous	609,236	5.7	9.4
Unresolved Tree Cover, regularly flooded, saline water	19,779	5.7	18.4
Unresolved Tree Cover, needle-leaved, evergreen	1,732,403	3.9	10.7
Unresolved Tree Cover, broadleaved, deciduous, closed	2,606,302	3.6	7.8
Total forest cover	**38,997,673**	**7.7**	**13.5**

Coarse global averages are useful for assessing international achievement of targets, however they often mask discrepancies in terms of representativeness of biodiversity. As forest types differ in terms of their species richness and provision of ecosystem services, the protection coverage of forests needs to be assessed by forest type rather than simple global forest cover. Whilst this study makes no attempt to assign 'value' to these different forest types, it is clearly necessary to distinguish between different types of forest if 'representativeness' of forest protection is to be established.

There is a wide range in the global protection of various forest types by strictly protected areas (IUCN I-IV), with coverage of Temperate freshwater swamp forest protected at only 3.2%, whereas Temperate broadleaf evergreen forest is protected at 28% (Table 5). 22 of the 30 forest types (just over 70%) identified by the updated GFM are under the 10% target when measured according to strict protection, and 10 (33%) are still below the target when all protected area categories are considered. This means that a significant proportion of global forest types have not gained an acceptable level of protection according to the CBD targets, including large tracts of both tropical and temperate forest.

There are clearly some gaps to be addressed in the protection of forest types. Only two temperate forest types meet the 10% target for protected areas within IUCN I-IV, whilst mixed needleleaf / broadleaf forest and freshwater swamp forests in the tropics are also strongly underrepresented. The range of protection again invites discussion as to the relevance of the 10% target in terms of the species diversity that will be protected at 10%. It could be considered, for example, that species within some temperate forest types could be well conserved even at levels below 10%, whereas the protection of some tropical forest types at levels over the 10% target would not be enough to achieve the same purpose. Regardless, these results highlight areas in which protection needs to be strengthened in order to achieve the 10% target of forest protection to ensure full representation. They also highlight the necessity for the production of a global forest map, in which all global forest cover is assigned a resolved forest type, if forest type gap analyses are to fulfil their potential in assessing progress towards forest targets.

3.3.2 Protection of forest types by biogeographic realm

In addition to forest type, there is a need to assess levels of forest protection across a number of regions, as the same forest type can differ in terms of species composition and biophysical conditions according to its geographical location. The WWF realms split the globe into 8 distinct biogeographic realms (7 containing forest), which can be used to investigate the protection of forest cover in different regions of the world (Figure 4 provides geographic representation of realms).

Table 6 describes the protection of forest cover within each of the realms. Five of the realms fail to meet the 10% target under strict protection; three when all categories are considered.

Table 6: Percentage protection of forest cover within each WWF realm (Antarctic not included due to no forest coverage within realm). Realms failing to meet the 10% target for protection (at IUCN I–IV) are highlighted in grey.

Realm	Forest Area ('000 km^2)	% Protected (IUCN I–IV)	% Protected (IUCN I–VI)
Palearctic (Bulk of Eurasia and North Africa)	11,793	5.5	8.8
Afrotropics (Sub-Saharan Africa)	6,794	6.4	9.2
Nearctic (most of North America)	7,293	6.6	15.2
Oceania (Polynesia, Fiji and Micronesia)	6	7.5	8.2
Indo-Malay (South Asian subcontinent and Southeast Asia)	2,571	9.9	13.6
Neotropics (South America and the Caribbean)	8,748	10.6	21.3
Australasia	1,783	13.4	14.8
Rock and ice, and lakes (Areas across all realms)	9	19.6	25.1
Total forest cover	**38,998**	**7.7**	**13.5**

The lowest level of forest protection is found in the Palearctic (including Eurasia and North Africa), with a protected area forest coverage of 5.5% for IUCN categories I-IV, significantly lower than the 10% target forest cover. This is particularly relevant considering that this realm has the largest area of forest coverage, and is still below the 10% target when all categories are considered. Indeed, only two realms (Australasia, Neotropics) achieve the 10% target for both strictly protected and all protected area categories (although the Indo-

Malay realm could be considered to have achieved the target at 9.9%). Australasia has the highest percentage of strictly protected forest at 13.4%. It is interesting to note that over half of the protection in the Nearctic, mostly comprising North America and some parts of Central America, is protected under categories V-VI.

These realms are extremely large geographic areas, and although this is interesting for identifying regions in which protection efforts should be focused, such as in the Afrotropics and the Palearctic, it gives no indication of the level of protection of forest types within each geographic region. Although the Neotropics and Australasia have achieved the 10% target for forest coverage even at IUCN category I-IV, for example, there are still a number of forest types that are under represented (Table 7). Indeed, 70% of forest types occurring in the Neotropics do not meet the 10% target (Annex).

Table 7: Protection of forest types by realm at IUCN categories I-IV (unresolved forest types included).

Realm	Number of forest types	Percent of forest types below 1% protection	Percent of forest types below 10% protection
Nearctic	20	30.0	95.0
Afrotropics	18	11.1	88.9
Palearctic	18	22.2	88.9
Neotropics	27	7.4	70.4
Oceania	3	0.0	66.7
Indo-Malay	24	12.5	54.2
Australasia	21	0.0	38.1

The majority of the geographic realms have a number of forest types protected at levels even below 1% (for IUCN I-IV). Australasia, which has the best protection coverage of its forest types by realms, fails to adequately protect the three forest types most commonly underrepresented across all realms even when all IUCN categories are considered: Tropical deciduous/semi-deciduous broadleaf forest, Temperate deciduous broadleaf forest, and Tropical lowland evergreen broadleaf rain forest (Table 8).

Conversely, there are a number of forest types within the less well protected realms that are protected at levels above the 10% target, such as the Tropical semi-evergreen moist broadleaf forest in the Indo-Malay realm, which is protected at 30% with IUCN categories I-IV (Annex). This information is important for informing the designation of new protected areas of forest, as they should be focused on representative coverage of forest types within realms, rather than achieving the blanket 10% target for the realm as a whole. Identifying areas in which new protected areas should be established based on forest type would be a large step forward towards creating a representative network of forest protection.

As mentioned previously, a larger number of forest types is yet unresolved and this analysis only represents an approximate way of assessing progress towards the 10% target. In addition, as with the global forest protection figures, however, these realms can still be considered coarse scale in biogeographic terms (Dudley and Parish 2006) and further detail can be gained by comparing these results with those from determining forest protection levels at the ecoregion level.

Table 8. Forest types (with forest coverage over 10 km^2 within realm) below the 10% protection target within realm (at IUCN I-IV); for unresolved forest types and forest types above the 10% target see Annex.

Realm	Forest Type	Forest Area (km^2)	Percent Protected IUCN I-IV	Percent Protected IUCN I-VI
Australasia	Tropical Deciduous / semi-deciduous broadleaf forest	16,832	3.7	3.7
	Temperate Deciduous broadleaf forest	1,820	4.3	4.3
	Temperate Evergreen needleleaf forest	9,071	5.4	5.6
	Tropical Lowland evergreen broadleaf rain forest	416,777	6.4	6.9
	Tropical Semi-evergreen moist broadleaf forest	62,281	7.3	7.5
Afrotropics	Tropical Thorn forest	845	0	0
	Tropical Lower montane forest	28,727	0.7	1.2
	Tropical Freshwater swamp forest	181,890	3	3.1
	Tropical Mangrove	28,353	3.7	4.2
	Temperate Sparse trees / parkland	34,756	6	6
	Temperate Deciduous broadleaf forest	34,393	6	6.1
	Tropical Semi-evergreen moist broadleaf forest	18,228	6.6	7.7
	Tropical Deciduous / semi-deciduous broadleaf forest	1,298,644	6.8	10
	Tropical Lowland evergreen broadleaf rain forest	1,525,550	8	9.6
	Tropical Sparse trees / parkland	476,330	9.6	12.7
Indo-Malay	Tropical Sclerophyllous dry forest	491	0	34.5
	Temperate Sparse trees / parkland	14,651	2.3	6.7
	Temperate Deciduous broadleaf forest	131,869	2.7	12.7
	Temperate Sclerophyllous dry forest	5,426	3.8	11.6
	Tropical Freshwater swamp forest	60,348	6.7	8.2
Nearctic	Tropical Sparse trees / parkland	292	0	0
	Tropical Lowland evergreen broadleaf rain forest	91	0	0
	Tropical Mixed needleleaf / broadleaf forest	306	0.2	2.2
	Tropical Deciduous / semi-deciduous broadleaf forest	988	0.2	2.3
	Tropical Upper montane forest	15,869	1	4
	Tropical Lower montane forest	15,591	1.3	10
	Temperate Freshwater swamp forest	88,197	3.2	8.2
	Temperate Deciduous needleleaf forest	10,254	4.4	67.7
	Temperate Deciduous broadleaf forest	957,363	4.4	18.2
	Temperate Mixed broadleaf / needleleaf forest	1,113,195	4.9	8.1
	Temperate Sparse trees / parkland	1,035,764	5.5	7.5
	Temperate Sclerophyllous dry forest	91,249	6.8	45.4
	Temperate Evergreen needleleaf forest	3,077,688	8	19.2
	Tropical Mangrove	146	8.6	8.7
Neotropics	Temperate Sclerophyllous dry forest	35,036	0	2.7
	Temperate Mixed broadleaf / needleleaf forest	6,404	0.1	2.8
	Temperate Deciduous broadleaf forest	41,083	1.1	2.5
	Temperate Sparse trees / parkland	46,851	1.1	4.6
	Temperate Freshwater swamp forest	301	1.5	2
	Tropical Mixed needleleaf / broadleaf forest	8,553	4.5	6.9
	Tropical Sparse trees / parkland	409,445	5.3	8.8
	Temperate Evergreen needleleaf forest	3,584	5.8	31.2
	Tropical Needleleaf forest	26,304	5.8	8.1
	Tropical Thorn forest	4,443	8.6	30.7
	Tropical Freshwater swamp forest	120,323	9.1	14.7
	Tropical Deciduous / semi-deciduous broadleaf forest	129,239	9.7	26
Oceania	Tropical Lowland evergreen broadleaf rain forest	3,239	5.7	6.5
Palearctic	Temperate Mixed broadleaf / needleleaf forest	273,174	0.7	8.4
	Temperate Sclerophyllous dry forest	78,170	2.7	9.2
	Temperate Deciduous needleleaf forest	2,613,864	4.3	5.6
	Temperate Sparse trees / parkland	651,633	5.8	9.8
	Temperate Deciduous broadleaf forest	1,522,106	6.9	9.9
	Temperate Evergreen needleleaf forest	3,318,574	7.1	9.4

3.3.3 Protection of forest by WWF ecoregions

Although it has already been established that forest types are not adequately captured within ecoregions, ecoregions still provide important forest biodiversity information related to biogeographic units. As forest types are not accurately identified on a global forest map (with many forest types still unresolved), it is still relevant to analyse protection of forest on an ecoregion scale. This is particularly true given their aforementioned use in a number of biodiversity analyses and the fact that they are widely accepted biogeographic units with which to undertake this kind of analysis.

Drawing from our previous results, the protected area coverage was calculated for the forest area contained within each ecoregion. The distinction in this report between protection of the forest area within each ecoregion, rather than the percentage protection of the forest ecoregion as a whole, is an important step in utilising ecoregions in forest analyses.

742 ecoregions contain some level of forest cover and have been used in the following analyses. The mean level of protection of forest cover per ecoregion is 10% under strict protection categories and 18% when all categories are considered. On an aggregated scale, the protection of ecoregions reaches the 10% target at IUCN I-IV. However, aggregated statistics rarely show the true picture and can mask significant variation in the range of forest protection within ecoregions. The majority of ecoregions actually fall below 10% protection (Figure 3), and it is likely that a small number of ecoregions with high levels of protection (e.g., the Fiordland temperate forests in southern New Zealand with 98% protection within IUCN categories I-IV), raise this average to a level that is not truly representative. Similarly, some ecoregions with either high or low forest cover protection may actually contain only small forest areas, an issue that has not been controlled for in this analysis.

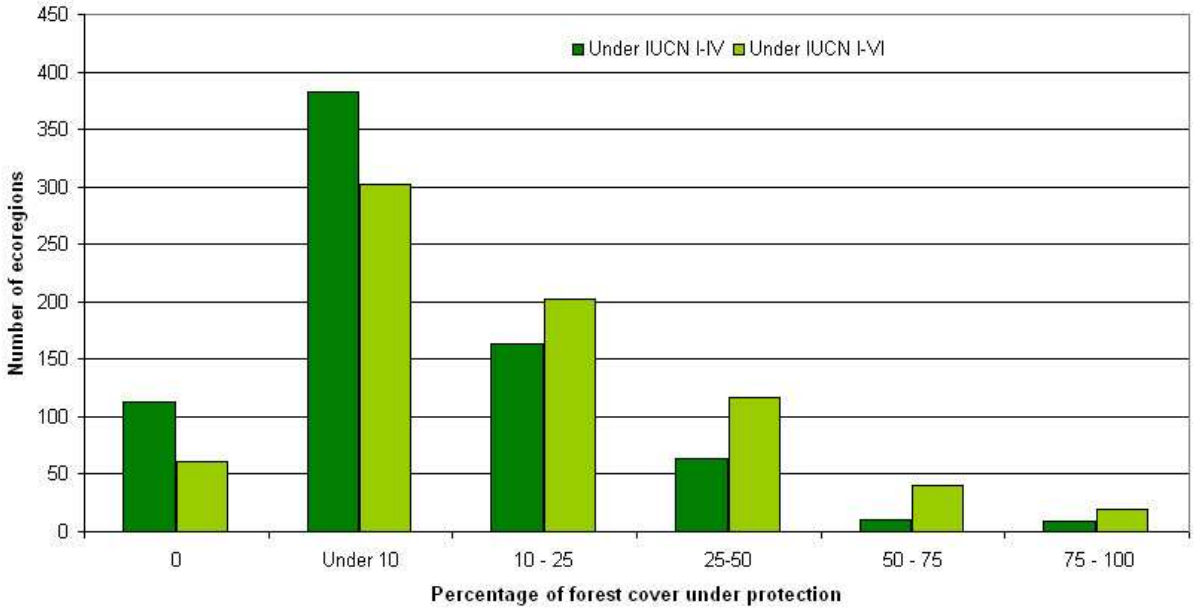

Figure 3: The number of forested ecoregions at different levels of forest cover protection, at IUCN categories I-IV and I-VI.

It is clear that there is a wide range in percentage protection of forest within ecoregions; only 33% of ecoregions reach the 10% target under strict protection, whereas the Fiordland temperate forests are protected at 98%. This can be put in context through analysis of the regional distribution of forest protection within ecoregions (Figure 4), from which it is clear that high levels of ecoregion forest protection (at IUCN I-IV and relative to the 10% target)

are concentrated in a few regions, such as Australia, the Amazon, the Andes, South East Asia, and parts of South West Africa and Alaska. However, the ecoregions with high forest protection in Australia and South West Africa have very low forest cover (< 10%). It is again noteworthy that there is very little protection for northern latitude forest, outside of Alaska.

Ecoregions can also be split according to geographic realm, and it can be seen that, as with forest types, a significant proportion of ecoregions within these realms have their forest cover protected at levels of less than 1% at IUCN I-IV (Table 9). Indeed, there are 113 ecoregions in which the forest cover has no protection at all under categories I–IV. On a general scale, the Afrotropics and Palearctic again appear to require increased attention with large numbers of ecoregions protected at levels below the 10% target at IUCN I-IV; an issue also identified by the global ecoregion protection map (Figure 4). A partial reason for this is that in Africa and some parts of Asia there are thousands of forest reserves managed by Forestry Departments that are of uncertain conservation status and have not been assigned IUCN protected area categories. These reserves were not considered for this analysis; however, their conservation status merits further investigation.

Table 9: Protection of forest cover within ecoregions by realm at IUCN categories I-IV.

Realm	Number of ecoregions with forest cover	% Ecoregions with forest area below 1% protection	% Ecoregions with forest area below 10% protection
Palearctic	178	39.9	82.0
Afrotropics	99	30.3	75.8
Nearctic	114	24.6	70.2
Neotropics	169	24.9	62.1
Indo-Malay	101	10.9	51.5
Oceania	4	25.0	50.0
Australasia	77	22.1	46.8

A number of ecoregions with low levels of forest protection and large forest area have been selected in order to highlight the large areas of biogeographically distinct forest areas within ecoregions that have little or no protection within IUCN categories I-IV (Table 10). Although Australasia is in general the best protected realm, significant areas of rainforest have very little protection even if all IUCN categories are considered. Similarly, subtropical ecoregions of the Indo-Malay, including the Borneo lowland rainforests, and the moist forests in the Neotropics, along with that of the Cerrado and Caatinga ecoregions, have levels of protection below the 10% target (all IUCN categories).

In the Afrotropics, already noted to be in need of increased protected area coverage, the low levels of protection (all IUCN categories considered) for the large tracts of forest within the various Congo ecoregions is striking, as is that of the Miombo woodlands. The fact that the Congo has been identified as a CI high biodiversity wilderness area makes these gaps appear even more relevant. A large number of taiga ecoregions within the Nearctic and Palearctic are also protected at extremely low levels even at IUCN I-VI, including forest stretching over areas up to 3 million km^2 in the Palearctic. Although these areas are not classified as ‘high biodiversity’ they contain large amounts of carbon. It should again be noted, therefore, that there are many different values for forest ecosystems not accounted for in this report.

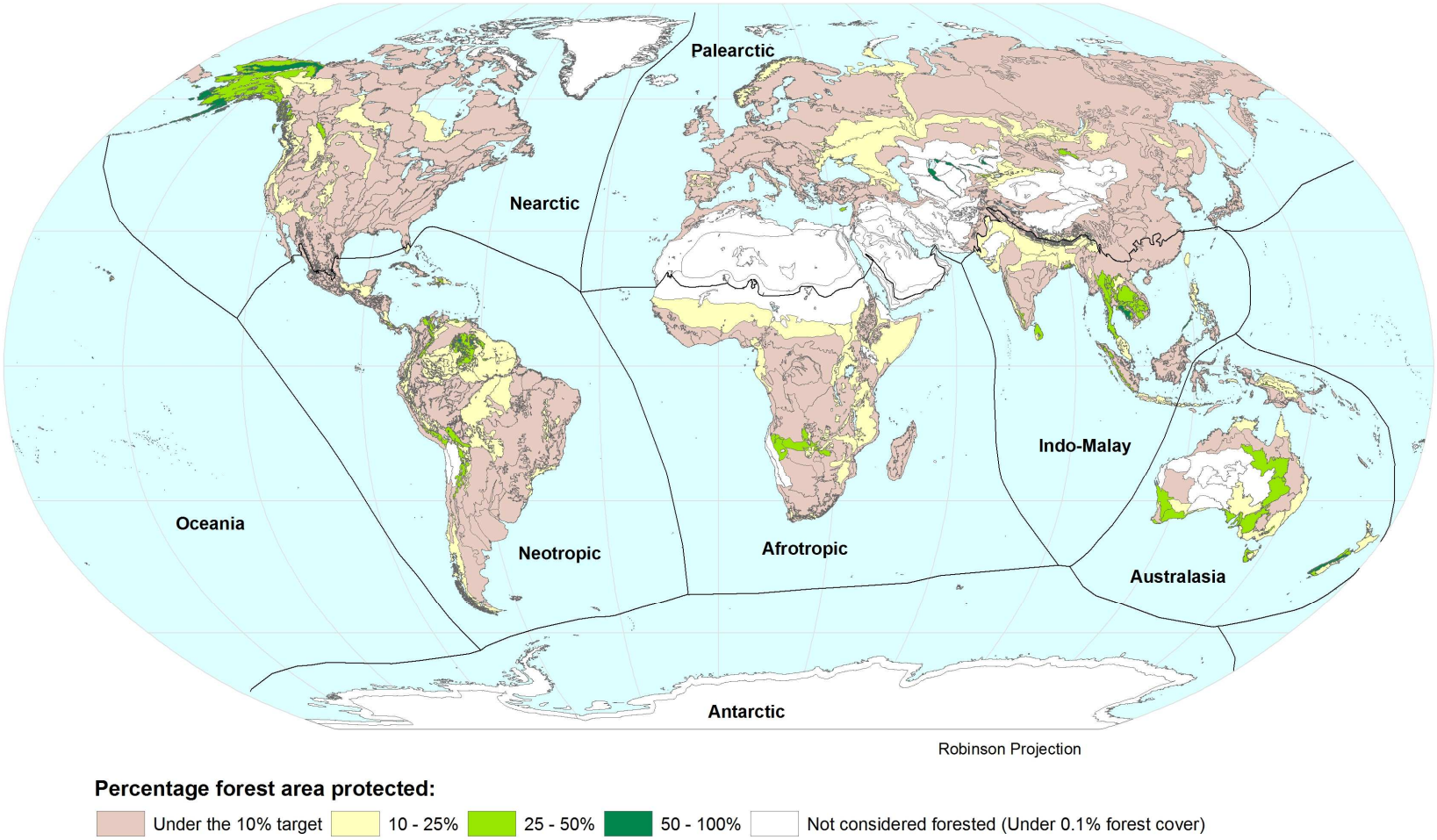

Figure 4: Distribution of the percentage of protected forest area within WWF ecoregions at IUCN management categories I-IV. The highest levels of protection can be seen in parts of the Amazon, SE Asia and Alaska. It is noteworthy that the ecoregions with high forest protection in the Andes, Australia and SW Africa have below 10% forest cover. Notable areas of low protection include the Congo basin in Central Africa and Northern boreal forests. Black lines indicate biogeographic realms.

The complete list of ecoregions that either meet or fall below the 10% target is too detailed to present here, but is available upon request. It should again be noted, however, that those ecoregions currently protected above 10% should not be considered to be adequately protected without further analysis of the utility of the 10% target for that region, and an analysis of how well effectively conserved the forest types are within that particular ecoregion; a task beyond the scope of this report. Indeed, comparison of the ecoregion protection map (Figure 4) with that of forest types contained within ecoregions (Figure 2) highlights the deficiencies in this analysis. It is clear that many of the ecoregions which appear to be exceeding the requirements for forest protection set by the CBD are also ecoregions which contain a large number of forest types; the levels of protection of which cannot be captured through this ecoregion assessment.

It is clear that there are a large number of ecoregions with low percentage protection which require further analysis of the forest types in need of protection in order to inform protected area designation. Conversely, the ecoregions of adequate protection relative to CBD targets also need proper examination to ensure that these levels of protection are representative of all forest types. This analysis could be facilitated by the improvement of the GFM, which would allow further regional assessment of the forest types requiring protection within separate ecoregions; a task too complex to carry out on a global scale.

Table 10: Selected ecoregions with low forest protection (at IUCN I-IV) and with large forest area, separated by realm.

Ecoregion	Forest Area (km^2)	% Forest Area Protected (IUCN I-IV)	% Forest Area Protected (IUCN I-VI)
Australasia			
Solomon Islands rain forests	30,769	0.0	0.6
Southeastern Papuan rain forests	58,335	0.0	0.2
Halmahera rain forests	23,640	0.4	0.4
Einasleigh upland savanna	27,391	4.0	4.5
Southeast Australia temperate savanna	33,671	4.6	5.4
Vogelkop-Aru lowland rain forests	65,616	5.1	5.2
Southern New Guinea freshwater swamp forests	63,824	5.6	5.6
Brigalow tropical savanna	74,251	6.5	6.6
Afrotropics			
Southern Congolian forest-savanna mosaic	409,442	0.0	3.7
Southern Zanzibar-Inhambane coastal forest mosaic	111,729	0.5	1.0
Western Congolian forest-savanna mosaic	258,172	1.0	1.5
Angolan Miombo woodlands	455,421	2.4	2.4
Western Congolian swamp forests	112,330	3.6	3.6
Southern Miombo woodlands	190,968	4.7	9.3
Guinean forest-savanna mosaic	268,507	5.3	5.3
Central Zambezian Miombo woodlands	798,498	5.5	11.4
Northern Congolian forest-savanna mosaic	630,929	6.4	12.9
Indo-Malay			
Jian Nan subtropical evergreen forests	368,691	0.0	6.2
Northern Indochina subtropical forests	161,890	2.2	9.9
Borneo lowland rain forests	256,870	4.5	6.1
Nearctic			
Eastern Canadian Shield taiga	421,599	0.0	0.3
Southeastern mixed forests	249,345	0.2	5.1
Appalachian mixed mesophytic forests	165,115	0.6	14.0
Sierra Madre Occidental pine-oak forests	148,000	0.6	5.8
Piney Woods forests	113,921	0.7	10.1
Northwest Territories taiga	190,827	1.4	4.4
Northern Canadian Shield taiga	234,001	1.8	4.4
Central U.S. hardwood forests	138,513	1.8	13.7
Central Canadian Shield forests	365,495	2.3	2.8
Southeastern conifer forests	130,321	2.7	8.7
New England-Acadian forests	211,403	3.3	6.8
Appalachian-Blue Ridge forests	125,104	3.4	34.5
Midwestern Canadian Shield forests	405,852	3.8	4.4
Eastern Canadian forests	366,995	4.0	4.7
Neotropics			
Iquitos varzeá'	102,641	0.4	19.5
Juruá-Purus moist forests	240,168	0.6	15.8
Xingu-Tocantins-Araguaia moist forests	194,662	0.6	7.4
Humid Chaco	120,378	0.6	4.7
Ucayali moist forests	101,644	0.8	3.5
Purus-Madeira moist forests	166,749	1.0	10.5
Caatinga	169,085	2.1	7.1
Cerrado	334,103	5.1	8.5
Purus varzeá	165,959	5.5	21.7
Mato Grosso seasonal forests	263,404	5.5	6.8
Southwest Amazon moist forests	701,530	5.9	14.0
Paleartic			
Da Hinggan-Dzhagdy Mountains conifer forests	203,905	2.2	14.5
Manchurian mixed forests	312,834	2.6	11.3
Western European broadleaf forests	176,246	2.8	43.8
Trans-Baikal Bald Mountain tundra	111,157	3.1	6.9
East Siberian taiga	3,018,529	3.2	4.3
Scandinavian and Russian taiga	1,678,784	4.9	5.5
West Siberian taiga	1,090,695	6.5	6.5

3.3.4 Protection of global priority areas

So far, analyses have focused on the classification of regions according to factors as forest types and biogeographic units, but no assumption of the 'biodiversity value' of the area has been made. However, global priority areas for conservation do exist, and the results in this section illustrate the degree to which forest is protected within CI biodiversity hotspots and CI high biodiversity wilderness areas. Combining the high biodiversity areas with hotspots accounts for 61.5% of all vascular plants and 43.2% of non-fish vertebrates. Both priority systems follow the WWF ecoregion framework, which allows direct comparison with the previous ecoregional results.

Conservation International Biodiversity Hotspots

CI have defined a number of biodiversity hotspots, i.e., areas where at least 0.5% of the total global plant species are strictly endemic, but less than 30% of the natural habitat remains (Mittermeier *et al.* 2004). Each of these hotspots contains at least some forest cover, with a mean protection of hotspot forest area of 10.2% for strictly protected areas and 15.3% when all categories are considered (Table 11).

Table 11: Protection of forest area within Conservation International's biodiversity hotspots. Hotspots failing to meet the 10% target for protection (at IUCN I-IV) are highlighted in grey.

CI Biodiversity Hotspot	Forest Area ('000 km^2)	% Forest Area Protected (IUCN I-IV)	% Forest Area Protected (IUCN I-VI)
Mountains of Southwest China	125	0.0	13.8
East Melanesian Islands	72	0.0	0.7
Succulent Karoo	0.1	1.9	1.9
Madrean Pine-Oak Woodlands	281	2.1	6.4
Coastal Forests of Eastern Africa	188	2.2	5.7
Irano-Anatolian	2	2.6	8.0
Japan	244	3.3	15.9
Mediterranean Basin	265	4.2	11.8
New Caledonia	6	4.4	4.4
Maputaland-Pondoland-Albany	124	4.7	4.8
Cerrado	366	5.6	8.7
Guinean Forests of West Africa	223	7.0	7.5
Mesoamerica	595	7.3	16.6
Wallacea	195	7.4	8.6
Polynesia-Micronesia	6	7.5	8.2
Madagascar and the Indian Ocean Islands	129	7.6	9.9
Atlantic Forest	246	7.7	15.9
Sundaland	766	9.0	12.7
Tumbes-Choco-Magdalena	77	9.8	12.0
Eastern Afromontane	295	9.8	13.8
Himalaya	211	10.5	14.8
Cape Floristic Region	15	11.1	11.1
California Floristic Province	155	11.7	50.8
Caucasus	90	12.1	13.8
Philippines	83	12.6	17.6
Indo-Burma	742	14.2	19.2
Horn of Africa	2	15.5	18.4
Caribbean Islands	45	15.6	28.4
Chilean Winter Rainfall and Valdivian Forests	134	17.6	19.6
Mountains of Central Asia	11	17.7	18.4
Western Ghats and Sri Lanka	97	17.8	17.8
Tropical Andes	426	18.3	24.0
Southwest Australia	73	26.0	26.1
New Zealand	76	40.7	54.5
Total forest area and mean protection	**6,364**	**10.2**	**15.3**

20 out of 34 hotspots fail to meet the 10% target under strict protection, including the hotspot with the largest area of forest cover, the Sundaland. The entire East Melanesian Islands hotspot has no strict protection at all, and the majority of Africa's hotspots do not reach the 10% target for protection at IUCN I-IV. The hotspot forest areas of the Cerrado, already highlighted as an ecoregion with low protection, are protected below 10% (all IUCN categories), and would thus appear to be a priority for protection in Latin America. Hotspots of Australasia again appear comparatively well protected, with the Tropical Andes also achieving levels of protection over 18% in the stricter IUCN categories.

Conservation International High Biodiversity Wilderness Areas

CI have also identified high biodiversity wilderness areas, i.e., areas of over 750,000 km^2 that are rich in biodiversity, with levels of endemism comparable to the most diverse hotspots (Mittermeier *et al.* 2003). These differ from hotspots in that over 70% over the natural land cover is intact. Five of the high biodiversity wilderness areas contain forest cover, and three fail to meet the 10% target at IUCN I-IV; the North American Deserts, the Congo Forests, and New Guinea (Table 12). Although the Miombo-Mopane wilderness area meets the 10% target, only one of the individual Miombo ecoregions does. This discrepancy is probably related to the fact that the wilderness areas are aggregates of ecoregions and this further underlines that averages at the broader level might blur the reality on the ground.

Table 12: Protection of forest area within Conservation International's high biodiversity wilderness areas. Areas failing to meet the 10% target for protection (at IUCN I-IV) are highlighted in grey.

CI High Biodiversity Wilderness Area	Forest Area ('000 km^2)	% Forest Area Protected (IUCN I-IV)	%Forest Area Protected (IUCN I-VI)
North American Deserts	41	4.2	18.7
Congo Forests	1,572	7.2	8.4
New Guinea	640	9.5	9.9
Amazonia	5,618	11.1	25.0
Miombo-Mopane Woodlands and Savannas	821	14.1	20.2

The low levels of protection within the Congo forest have been highlighted throughout this report, and it is clear that forest protection should be made a priority in this area. This analysis concentrates on wilderness areas that have been labelled 'high biodiversity' and therefore does not include the Taiga forests. However the results shown previously for forest type, realm, and ecoregion protection have also demonstrated that these northern wilderness areas do not even come close to achieving the protection targets.

Although the Amazonia is protected at levels above the 10% target within the stricter categories, the 11% protection could still be considered low given the importance of the area for biodiversity. This again raises the question as to whether the 10% target should be applied to all situations. Indeed, none of the wilderness areas are strictly protected at levels above 15%, and only two of the hotspots above 20%. This does not seem adequate in relation to the high biodiversity values of these areas. In addition, over half of Amazonia is protected under categories V-VI; a pattern also seen for some of the hotspots. Whether or not these high biodiversity areas should have such a skewed proportion of 'sustainable use' protected areas is another topic for discussion.

In summary, a large proportion of globally accepted high biodiversity areas are protected at levels below the 10% target under strict protection; a situation that could be considered even bleaker with reference to the fact that 10% protection is not likely to be enough in these areas that harbour such a significant proportion of global biodiversity. This is particularly the case for hotspots, which have already lost a significant proportion of their forested area.

4 Summary and Conclusions

4.1 Methodology for assessing progress towards forest protection targets

Two potential ways to assess progress towards the CBD 10% target for forest protection were investigated here, as follows:

- Analysis of the percentage protected area cover of forest types in the updated GFM.
- Analysis of the percentage protected area cover of the forested area within WWF ecoregions (forest cover as identified by the updated GFM).

In the following, we discuss the advantages and disadvantages regarding the use of these two methodologies for assessing the 10% target for forest protection.

Global Forest Map and Forest Types

The work undertaken to complete an updated GFM has resulted in a map where 71% of the world's forest cover according to MODIS 05 VCF imagery has been assigned to a forest type. However this still means that 11.3 million km^2 of forest is not assigned (unresolved forest cover), which reduces the utility of the map as a tool for tracking protection of forest types within the framework of the CBD.

The updated GFM is also not a biogeographic classification of the world's forests, but rather identifies 30 broader forest types at the global scale. This means, for example, that although the GFM may map tropical lowland forest cover across the globe, it does not differentiate the variation in species composition of forests in SE Asia, from those of Africa, or those of South America. This again makes the basic map of limited use for tracking the protected area coverage of biogeographically different forest ecosystems. However, it is possible to partly solve this issue by breaking the map of forest types up according to biogeographic realms. This increases the number of resolved forest types from 20 to 85 but that is still not a perfect representation of global variations in forest biodiversity. For example, it is still far fewer than the 742 ecoregions with forest cover that are available if the WWF ecoregions are used as a biogeographic classification of the world.

The updated GFM is based on forest classifications that have been accepted by FAO and are widely used and understood by governments, which could potentially facilitate the acceptance of the updated GFM as a part of the monitoring system for the CBD forest targets. Another positive feature of the updated GFM is that it captures some forest types that are not considered by the ecoregion framework. Particularly important is the fact that the GFM recognises forests on mountains as separate types, which better reflects the distribution of some of the world's important biodiversity features.

Conclusions with regard to the GFM:

- The existence of large areas of unresolved forest types within the updated GFM currently reduces its utility as a tool for tracking levels of protection of different forest types. This would need to be solved before this new map can be properly used for CBD reporting.
- Completing a fully updated GFM, where all forest areas are assigned to a forest type is a significant task, beyond the scope of the current project. This task would involve reviewing each area of 'unresolved' forest cover against regional and national forest datasets, and hence individually assigning these areas to the different forest types. Whilst this is a significant new piece of work, it is fundamental to the work of the CBD and other global conservation processes.

WWF Ecoregions

This report had the specific aim of identifying the degree to which WWF ecoregions are useful in forest analyses and for tracking progress with achieving the CBD target for forest conservation. The first point to be emphasised is that 'forest' and 'non-forest' ecoregions do not reflect the current situation with regard to forest cover, and analyses cannot rely on this delineation but should rather focus on the area of forest cover within all ecoregions. In addition, the ecoregions do not fully track the distribution of major forest types on the updated GFM. For example, several forest types can be present within a single ecoregion, particularly in the tropics, and some forest types such as montane forest areas and riparian forests are not accounted for in the WWF ecoregions framework. Another potential problem with the WWF ecoregions framework is that the work was undertaken by a large NGO, and is perhaps not as widely accepted by governments and UN agencies as the GFM forest types.

However, the ecoregions map has the advantage of being at a finer biogeographic resolution than the updated GFM, and thus tracks species distribution patterns more accurately. As examples, there are between 77 and 172 ecoregions per realm (not including Oceania, data available upon request), which compares with 8 to 19 resolved forest types when split according to realm (Annex). The high resolution of the ecoregions is therefore an advantage for an assessment of the representativeness of the global protected areas in terms of forest biodiversity distribution. Another advantage of the ecoregion approach is that many organisations have used the ecoregion dataset as a basis for a wide variety of regional and global biodiversity analyses. It has thus become an accepted biogeographic framework for the world, across all biomes ('forest' and 'non-forest').

Conclusions with regard to the WWF ecoregions:

- If ecoregions were to be used for analyses of the CBD forest protection target, all forested ecoregions need to be considered, not only those in 'forest' biomes. Moreover, the level of protection needs to be calculated as the percentage of forest area within the ecoregions that is protected. A simple measure of percentage protection of the ecoregion as a whole is not regarded as useful for tracking the CBD forest target.
- Ecoregions are less than perfect as a framework for measuring forest protection globally, because they fail to map mountain and riparian forests and a single ecoregion may also contain a number of forest types according to the updated GFM.
- At the global scale, the assessment of forest protection by ecoregion currently provides finer biogeographic representation than forest types by realm. This is a distinct advantage of the ecoregions system for monitoring the CBD target to develop a globally representative network of forest protected areas.
- At the regional scale, e.g. within ecoregions, it will be necessary to use forest classification systems with higher resolution in order to distinguish between forest types. They could be national forest classification systems or, where these do not yet exist, the GFM forest types.

Finally, we conclude:

- A fully updated GFM would be useful as a framework for tracking progress towards CBD forest protection targets. However, this map would be of limited use for differentiating the species diversity of forest types across the globe. To further divide the forest types according to biological patterns, existing biogeographic classifications might also be overlaid on the forest map; realms for coarse scale analyses (global level), and ecoregions for fine scale analyses. This approach would provide a systematic and flexible global framework based on forest cover, forest type and biogeographic pattern, against which targets of forest protection and representativeness could be assessed.

4.2 Current level of protected area coverage for the world's forests

This report aimed to assess the degree to which the CBD target "*at least 10% of the world's forest types effectively conserved*" (decision VIII/15) has been achieved. In summary, the results for IUCN protected area management categories I-IV, if not mentioned otherwise,are as follows:

Global forest area protected. When considering only those protected areas with an IUCN category of I-IV (strict protection in terms of biodiversity conservation), only 7.7% of the worlds forest cover is protected. If all protected areas with IUCN protected area management categories are included (IUCN I-VI), then 13.5% of the world's forest is protected. However protected areas under IUCN categories V and VI allow some level of sustainable use, which may modify the original species assemblages of natural forests. In addition, several thousand reserves are not regarded as protected areas in this study, because they have not been assigned an IUCN category or information on IUCN category is not available in the WDPA. If we are to measure the level of global forest conservation in a more accurate way, there is a strong need to assign IUCN categories to all existing reserves in the future.

Forest types protected. 22 of the 30 forest types in the updated GFM are protected below the 10% target at IUCN categories I-IV. Only 2 temperate forest types are protected at levels above 10% (IUCN I-IV), although the highest level of protection globally is afforded to Temperate broadleaf evergreen forest (28%). Needleleaf forest types lack adequate protection in both temperate and tropical regions.

Forest protected by realm. Of the seven realms with forest cover, only the forests of Australasia and the Neotropics are protected above the 10% threshold (IUCN I-IV). The realms with the lowest protection for the stricter IUCN categories are Palearctic (5.5%), Afrotropics (6.4%), and Nearctic (6.6%).

Forest types protected within realm. Each realm, including Australasia and the Neotropics, has a number of forest types that do not meet the 10% target for both strictly protected and all protected area categories. In addition, a number of forest types are underrepresented in several realms even at IUCN I-VI: Tropical deciduous / semi-deciduous broadleaf forest, Temperate deciduous broadleaf forest, and Tropical lowland evergreen broadleaf rain forest.

Forest protected by WWF ecoregions. Within the 742 ecoregions with forest cover, only 33% achieve the 10% target for forest protection at IUCN I-IV. Globally the target is best met in parts of Australasia and Latin America (Neotropics), and is being least well met in Africa and northern latitude boreal forests. Within each realm however, there is a significant proportion of ecoregions that are protected at levels of less than 1%.

Forest protected in Conservation International's biodiversity hotspots. Biodiversity hotspots have already lost 70% of their habitat cover. Of the 34 hotspots, all contain forested regions, and of these 20 have less than 10% of their remaining forest habitat protected within the stricter protected area categories. However, even if 10% of the remaining forest is conserved, this is only a small portion of the original habitat area, especially given the high importance of hotspots in terms of narrowly endemic and threatened species.

Forests protected in Conservation International's high biodiversity wilderness areas. Of the five forested high biodiversity wilderness areas, three fall below the 10% target for forest protection at IUCN I-IV. These areas of forest are largely intact and, together with hotspots, harbour the majority of vascular plant species. The forests of the Congo have the most obvious gap regarding protected areas. Forests in New Guinea also fail to meet protection targets.

In conclusion, the most urgent gaps in the global forest protection are:

- Many temperate forest types in general fail to meet the 10% target, especially when only the stricter protected area categories are considered; the Palearctic is the least protected realm and the Nearctic also falls below target protection levels. Considerable areas of Northern Taiga forest are also poorly protected using all IUCN categories, as identified through ecoregion analysis.
- Many forests of the Afrotropics also fail to meet the 10% protection target. In this realm of high biodiversity and complex vegetation types, almost 90% of forest types fall below the 10% protection levels at IUCN I-IV. The majority of hotspots in this region fail to meet protection targets, as does the Congo Basin wilderness area. The protected area gaps within the Afrotropical region are known to leave species of birds, mammals and plants unprotected (Burgess *et al.* 2005; De Klerk *et al.* 2004; Fjeldså *et al.* 2004; Rodrigues *et al.* 2004a; Rodrigues *et al.* 2004b).
- Across the world many WWF ecoregions have been identified as not meeting the 10% protection target even if all IUCN categories are considered. They are also found in the biogeographic realms of generally good protection, but are too numerous to mention individually here. One important example is the Cerrado forest area of Latin America, which is also a biodiversity hotspot.
- Detailed gap analyses for each of these ecoregions is beyond the scope of this report, but further regional scale analysis by forest type would inform the designation of additional forest protected areas. Similarly, for those ecoregions that do appear to meet the target, analysis by forest type would identify whether the forests within these ecoregions are adequately represented by protected areas.

4.3 Utility of the 10% target

The 10% target for forest types provides a representative approach to conservation planning that is easy to understand and can be measured using available data. Achieving the 10% target, however, does not automatically mean that a representative proportion of the world's forest biodiversity will be adequately conserved. This is important in view of other political goals endorsed by the CBD - such as "*a significant reduction of the current rate of biodiversity loss by 2010*".

The 10% target and biodiversity distribution. As a simplistic indicator, the 10% target does not account for the actual distribution of biodiversity within forests, including area requirements of particular species and small scale habitat variations (Rodrigues and Gaston 2001; Svancara *et al.* 2005). For instance, although 10% of an ecoregion might be protected, the forest protected areas might not adequately represent the ecological character, because they are too small, have the wrong shape or lack key species (Dudley and Parish 2006; Langhammer *et al.* 2007). Studies on species based gap analysis (Rodrigues *et al.* 2004a; Rodrigues *et al.* 2004b) and regional work on designing representative protected area networks (Cowling *et al.* 1999; Cowling *et al.* 2003) suggest that 10% of the remaining forest protected will not be adequate to conserve biodiversity, or continue to provide ecosystem services for people. This holds true especially for the ecoregions with high species richness and high numbers of endemic species, such as CI conservation priority areas.

The 10% target and Conservation International's conservation priority areas. Our analysis shows that many hotspots have less than 10% of their forest area protected. As they have already lost most of their original habitat, this protection is a tiny proportion of the former habitat extent, and probably not sufficient to prevent further loss of endemic or threatened species. These areas require detailed regional scale plans that design a protected area network to incorporate the species distribution patterns and to capture as many of the

species in viable populations as possible. This can probably only be achieved if more than 10% of the remaining forest area is protected. Similarly, the high biodiversity wilderness areas have intrinsic value not only for the maintenance of biodiversity pattern, which often operates across large scales, but also for the mitigation of global climate change (Saatchi *et al*. 2007). Thus, conservation efforts should also aim to protect more than 10% of these areas.

The 10% target and systematic conservation planning. Our analysis has shown that assessments of progress towards the 10% target differ depending upon the scale of analysis, and it is important that these targets are not assessed at too coarse a scale, as this masks gaps in forest conservation. Systematic conservation planning considers biodiversity attributes of the area, the existing network of protected lands, conservation effectiveness and the costs of conservation (including social costs). It provides options for designing a fully representative network of protected areas that cover as much biological value as possible at the least possible cost. An appropriate scale for these analyses is within a single WWF ecoregion or CI hotspot – and several such initiatives are either completed, or are underway, for example in the Congo Basin (WWF unpublished), Madagascar (WWF unpublished) and South Africa (Cowling *et al.* 2003). As the Congo Basin has been highlighted for its lack of adequate protection, this is a positive step for forest conservation.

Conclusions regarding the CBD 10% target for forest protection:

- The 10% protected area target has managed to draw political attention to the protection of forests and meeting this target for all ecoregions and forest types can help consolidating forest conservation worldwide.
- Whilst the 10% target for protection should be considered a baseline for protection, some areas and forest types will require greater levels of protection, whereas some will have adequate protection at less than 10%, depending on what 'value' is being measured (e.g., carbon storage or species richness). Such analysis was beyond the scope of the present study, but will be important for prioritising areas for protection in the future.
- The generic 10% target needs reconsideration, especially for areas rich in endemic species, such as biodiversity hotspots, and for vast intact forest landscapes. In these areas the approach of 'systematic conservation planning' might provide a better way forward for nations under the CBD.

4.4 Limitations and caveats

During the course of this project a number of limitations and caveats to the results have become evident that should be noted by the readers of the report.

Global Forest Map. Although the map is a step forward in terms of global mapping of forest cover and forest types, a number of forest areas could not be assigned to a forest type within the time available. As such there are a number of unresolved forest areas that are presented as separate forest classes – when in reality they should probably be subsumed within one of the existing forest types. This makes the calculation of amounts of forest types protected problematic and the results presented here cannot be regarded as definitive. The further improvement of the updated GFM should therefore be considered as high priority action.

World Database of Protected Areas. The WDPA is the only global protected area database and has been sourced from multiple places, such as national authorities, regional authorities (e.g., the Common Database on Designated Areas from the European Union), conservation NGOs, projects and individuals. For some countries the information is up-to-date, including accurate maps with IUCN protected area management categories assigned and other

important attribute data for every protected area. However, many other countries do not provide accurate boundary maps and attribute data can be missing (such as IUCN category). The data presented here are considered as the best available estimate of the reality on the ground, although they cannot be 100% accurate. As a new process of protected area verification and expert review is rolled out globally, we expect the WDPA to improve greatly in coming years.

Areas of biodiversity importance. We have selected CI's biodiversity hotspots and high biodiversity wilderness areas as proxies for biologically important regions of the world. However, there are a number of other global prioritisation schemes in existence and a comprehensive assessment of the issue of protection of important areas for conservation would require a more thorough assessment than has been undertaken here.

Countries versus forest types and biogeographic regions. It is important to consider that none of the biogeographic units assessed in this report conform to national boundaries. The CBD is a nationally driven process that relies upon its Parties to achieve its objectives. For this analysis we have by necessity taken a global view of the world's forests and their biogeographic division. This makes sense from an analytical perspective and in terms of measuring overall progress towards achieving CBD targets. However, it is the nations of the world that have signed up to the CBD who will need to act upon the analyses and recommendations contained within this report. As such this document can only provide broad guidance to the CBD process and the achievement of national targets.

5 Recommendations

5.1 How should we measure the 10% target for forest protection?

An interim solution to measuring progress towards the CBD forest targets. Until a comprehensive GFM has been developed, we recommend that progress towards the 10% forest protection target is measured through analysis of the level of protection for forest cover within WWF ecoregions.

A proposed long term solution to measuring progress. Once a comprehensively updated GFM is available we believe this would ultimately provide a better template to measure the CBD protected area target for forests. Completing this GFM is therefore of the highest priority in order to accurately measure global progress with this CBD target. Once the GFM has been completed we recommend that:

- At global level, the analysis of forest types protected per ecoregion is complemented by an analysis of forest types split by realms to account for the forest types missed out by the ecoregions system. This exercise could be taken on by a consortium of international organisations.
- At regional level, i.e., within each ecoregion, the analysis of protected area coverage should be broken down by global forest types or finer-scale national classification systems. This work could form part of a process of 'systematic conservation planning', which is being employed to great effect in some countries. Such a process is essential if the designation of new protected areas is to contribute to a representative coverage of forest types. This exercise could be carried out by NGO and individual countries in a collaborative way.

5.2 What are the priorities for forest conservation?

Close the global gaps in forest conservation. From a global perspective, the current level of forest protection is inadequate. Further protection of forest area, with a focus on certain forest types and ecoregions as presented in this study, is therefore required.

Evaluate existing forest reserves without IUCN categories. In view of the large number of existing forest reserves without IUCN protected area management categories, governments are encouraged to assess whether these areas can be assigned an IUCN category. Doing so essentially requires evaluating if an existing area conforms to the definition of a protected area first and if yes, then assigning an IUCN category based upon the management objective. Secondly, governments may wish to consider whether stricter forms of protected area management are appropriate in order to meet the CBD targets for forest biodiversity conservation. This second suggestion should be undertaken by governments in full recognition of the rights and livelihoods needs of local and indigenous peoples.

Reconsider the 10% target. The CBD 10% target can be regarded as a minimum political target for forest protection. Especially for forest areas with globally significant biodiversity concentrations and for large wilderness areas, expansion of the protected area coverage above the 10% threshold is recommended (see below).

Increase conservation in the most important areas for forest biodiversity. In forest areas with globally significant concentrations of endemic species protecting 10% of the remaining

habitat, is not likely to be sufficient to conserve the existing species and habitat values, especially if this habitat is already highly deforested as in biodiversity hotspots. Governments should therefore consider increasing their forest protection beyond 10% coverage. Large protected areas are also required in high biodiversity wilderness areas in order to encompass the nature of the biodiversity in such areas, e.g., megafauna and large scale ecosystem processes.

Further update the Global Forest Map. Resolving the currently unresolved GFM forest types could greatly assist the tracking of progress in forest protection globally and regionally.

Conduct systematic conservation planning. At regional level, e.g., in individual ecoregions or hotspots, detailed spatial planning might resolve the best design of a representative protected area networks for forests. Systematic planning can ensure that protected areas are located in a way that they adequately capture variations in forest species and habitats. In these plans full use should be made of all IUCN categories (IUCN I-VI) in order to design conservation landscapes that are beneficial for people and for conservation. Regional planning processes can be facilitated by GFM forest types, the ecoregion framework and national forest classification systems.

Consider protected area management effectiveness. Evaluating and monitoring protected area management effectiveness is needed to ensure that existing protected areas of all IUCN categories (IUCN I-VI) are managed well enough to conserve the forest habitat and biodiversity values which they were established to protect.

Enhance sustainable forest management outside protected areas. Protected areas are a major tool for global biodiversity conservation; however, considering the pressure on the world's forests due to increasing demands for food, biofuels and timber there is also a strong need for sustainable forest management outside protected areas. Various forms of sustainable forest utilisation can have an important role to play in achieving conservation objectives, and forest protected areas should be integrated into the wider landscape in accordance with the ecosystem approach.

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Annex:
Protection of forest types within each biogeographic realm

Total forest area and percentage protected area coverage at IUCN categories I-IV and I-VI for forest types as identified by the updated Global Forest Map (GFM). Unresolved forest types indicate areas of forest that could not be identified to be consistent with the existing GFM forest types in the timeframe available. They are grouped according to Global Land Cover (GLC) classes. Forest types highlighted in grey are below the 10% target for protection at IUCN I-IV.

Realm	Forest Type	Forest Area (km^2)	% Protected (IUCN I-IV)	% Protected (IUCN I-VI)
Ice, Rock, Lakes	Tropical Lower montane forest	7	0	0
	Tropical Upper montane forest	5	0	47.4
	Unresolved Mosaic: Tree Cover / Other natural vegetation	47	0	5.9
	Tropical Semi-evergreen moist broadleaf forest	22	0	0
	Tropical Deciduous/semi-deciduous broadleaf forest	2	0	0
	Tropical Deciduous/semi-deciduous broadleaf forest	31	0	0
	Unresolved Tree Cover, broadleaved, evergreen	258.4	0.6	2.6
	Unresolved Tree Cover, broadleaved, deciduous, open	268	0.6	9
	Unresolved Tree Cover, broadleaved, deciduous, closed	307	1	8.1
	Unresolved Tree Cover, burnt	165	1.8	1.8
	Temperate Sparse trees/parkland	1,009	7.1	8.7
	Temperate Mixed broadleaf/needleleaf forest	837	11.2	19.2
	Unresolved Tree Cover, broadleaved, deciduous, closed	335	11.4	12.2
	Unresolved Tree Cover, mixed leaf type	291	12.4	22.4
	Unresolved Tree Cover, needle-leaved, evergreen	1,625	12.4	26.4
	Temperate Deciduous broadleaf forest	355	14.2	17
	Unresolved Mosaic: Tree Cover / Other natural vegetation	132	16	22.7
	Tropical Sparse trees/parkland	10	18	28.3
	Tropical Lowland evergreen broadleaf rain forest	14	22.8	77.3
	Unresolved Tree Cover, broadleaved, evergreen	120	26.5	27.2
	Temperate Evergreen needleleaf forest	2,292	28	30.8
	Temperate Deciduous needleleaf forest	506	40.8	40.8
	Unresolved Tree Cover, broadleaved, evergreen	168	50	63.1
	Unresolved Tree Cover, needle-leaved, deciduous	195	56.7	56.7
	Tropical Freshwater swamp forest	8	60.6	60.6
	Unresolved Tree Cover, broadleaved, deciduous, open	94	87.3	87.3
	Unresolved Tree Cover, broadleaved, deciduous, closed	52	93.4	93.4
	Unresolved Tree Cover, mixed leaf type	7	96.1	96.1
	Temperate Broadleaf evergreen forest	63	98.2	98.2
	Unresolved Tree Cover, broadleaved, deciduous, open	0.4	100	100
Australasia	Unresolved Tree Cover, needle-leaved, evergreen	9,192	2.2	3.2
	Tropical Deciduous/semi-deciduous broadleaf forest	16,832	3.7	3.7
	Unresolved Mosaic: Tree Cover / Other natural vegetation	20,352	4.2	4.5
	Temperate Deciduous broadleaf forest	1,820	4.3	4.3
	Temperate Evergreen needleleaf forest	9,071	5.4	5.6
	Tropical Lowland evergreen broadleaf rain forest	416,777	6.4	6.9
	Tropical Semi-evergreen moist broadleaf forest	62,281	7.3	7.5
	Unresolved Tree Cover, regularly flooded, saline water	1,470	9.3	9.7
	Tropical Sparse trees/parkland	118,648	10.2	11
	Tropical Sclerophyllous dry forest	57,680	10.3	11.6
	Tropical Lower montane forest	51,685	11.2	11.7
	Unresolved Tree Cover, broadleaved, evergreen	242,001	12.3	14.2
	Tropical Freshwater swamp forest	76,988	12.6	12.6
	Temperate Sparse trees/parkland	154,651	13.4	14.1
	Tropical Upper montane forest	117,270	13.9	14.3
	Tropical Mangrove	34,918	16.8	17.2
	Unresolved Tree Cover, broadleaved, deciduous, open	134,968	17.3	18.2
	Unresolved Tree Cover, regularly flooded, fresh water	1,799	23.2	23.5
	Temperate Sclerophyllous dry forest	182,176	23.6	24.4
	Unresolved Tree Cover, mixed leaf type	34,808	30.9	50.3
	Temperate Broadleaf evergreen forest	37,892	59.3	71.8

Afrotropics	Tropical Thorn forest	844.9	0	0
	Tropical Lower montane forest	28,727	0.7	1.2
	Unresolved Tree Cover, regularly flooded, fresh water	8,677	2.6	2.6
	Tropical Freshwater swamp forest	181,890	3	3.1
	Tropical Mangrove	28,353	3.7	4.2
	Unresolved Tree Cover, regularly flooded, saline water	8,170	3.9	4.1
	Unresolved Tree Cover, broadleaved, deciduous, closed	621,987	3.9	7.8
	Unresolved Tree Cover, broadleaved, evergreen	515,870	4.1	8.1
	Unresolved Mosaic: Tree Cover / Other natural vegetation	416,559	4.6	10.2
	Temperate Sparse trees/parkland	34,756	6	6
	Temperate Deciduous broadleaf forest	34,393	6	6.1
	Unresolved Tree Cover, broadleaved, deciduous, open	1,492,127	6.2	8.7
	Tropical Semi-evergreen moist broadleaf forest	18,228	6.6	7.7
	Tropical Deciduous/semi-deciduous broadleaf forest	1,298,644	6.8	10
	Tropical Lowland evergreen broadleaf rain forest	1,525,550	8	9.6
	Tropical Sparse trees/parkland	476,330	9.6	12.7
	Temperate Mixed broadleaf/needleleaf forest	3,464	11.2	47.2
	Tropical Upper montane forest	99,885	11.3	15.6
Indo-Malay	Tropical Sclerophyllous dry forest	491	0	34.5
	Temperate Freshwater swamp forest	5	0	0
	Unresolved Tree Cover, needle-leaved, evergreen	260,689	0.8	5.3
	Temperate Sparse trees/parkland	14,651	2.3	6.7
	Temperate Deciduous broadleaf forest	131,869	2.7	12.7
	Unresolved Tree Cover, regularly flooded, fresh water	1,904	3	11.5
	Unresolved Mosaic: Tree Cover / Other natural vegetation	161,251	3.3	7.6
	Temperate Sclerophyllous dry forest	5,426	3.8	11.6
	Unresolved Tree Cover, regularly flooded, saline water	3,084	3.9	4
	Unresolved Tree Cover, broadleaved, evergreen	534,397	5.8	10.1
	Unresolved Tree Cover, broadleaved, deciduous, closed	276,814	6.1	6.5
	Tropical Freshwater swamp forest	60,348.	6.7	8.2
	Unresolved Tree Cover, broadleaved, deciduous, open	685	7	7
	Tropical Mangrove	27,281	11.3	12.1
	Temperate Evergreen needleleaf forest	90,112	11.7	12.1
	Tropical Thorn forest	4,774	12	18.3
	Tropical Lowland evergreen broadleaf rain forest	382,688	12.2	15.7
	Temperate Mixed broadleaf/needleleaf forest	37,747	13.4	16.2
	Tropical Lower montane forest	116,945	15.4	24.6
	Tropical Deciduous/semi-deciduous broadleaf forest	283,044	18.5	19.1
	Tropical Needleleaf forest	5,735	22.4	37.1
	Tropical Sparse trees/parkland	2,591	26.5	26.8
	Tropical Semi-evergreen moist broadleaf forest	127,638	30	34.6
	Tropical Upper montane forest	40,748	34.8	43.2
Nearctic	Tropical Sparse trees/parkland	292	0	0
	Tropical Lowland evergreen broadleaf rain forest	91	0	0
	Tropical Mixed needleleaf/broadleaf forest	306	0.2	2.2
	Tropical Deciduous/semi-deciduous broadleaf forest	988	0.2	2.3
	Unresolved Tree Cover, broadleaved, evergreen	144	0.5	4.4
	Unresolved Tree Cover, broadleaved, deciduous, closed	230,216	0.9	5.3
	Tropical Upper montane forest	15,869	1	4
	Tropical Lower montane forest	15,591	1.3	10
	Unresolved Tree Cover, burnt	8,582	1.8	3.7
	Unresolved Tree Cover, mixed leaf type	110,480	3.1	8
	Temperate Freshwater swamp forest	88,197	3.2	8.2
	Temperate Deciduous needleleaf forest	10,254	4.4	67.7
	Temperate Deciduous broadleaf forest	957,363	4.4	18.2
	Temperate Mixed broadleaf/needleleaf forest	1,113,195	4.9	8.1
	Temperate Sparse trees/parkland	1,035,764	5.5	7.5
	Unresolved Tree Cover, needle-leaved, evergreen	370,626	5.7	14.1
	Temperate Sclerophyllous dry forest	91,249	6.8	45.4
	Temperate Evergreen needleleaf forest	3,077,688	8	19.2
	Tropical Mangrove	146	8.6	8.7
	Unresolved Mosaic: Tree Cover / Other natural vegetation	166,168	25.5	26.7

Neotropics	Temperate Sclerophyllous dry forest	35,036	0	2.7
	Temperate Mixed broadleaf/needleleaf forest	6,404	0.1	2.8
	Temperate Deciduous broadleaf forest	41,083	1.1	2.5
	Temperate Sparse trees/parkland	46,851	1.1	4.6
	Temperate Freshwater swamp forest	301	1.5	2
	Unresolved Tree Cover, broadleaved, deciduous, closed	468,308	3.1	5.7
	Unresolved Tree Cover, needle-leaved, evergreen	50,587	3.7	8.9
	Unresolved Tree Cover, broadleaved, deciduous, open	142,186	4.3	9.7
	Tropical Mixed needleleaf/broadleaf forest	8,553	4.5	6.9
	Tropical Sparse trees/parkland	409,445	5.3	8.8
	Temperate Evergreen needleleaf forest	3,584	5.8	31.2
	Tropical Needleleaf forest	26,304	5.8	8.1
	Unresolved Tree Cover, mixed leaf type	32,527	6.4	9.6
	Unresolved Tree Cover, regularly flooded, saline water	7,046	7.9	43
	Unresolved Tree Cover, broadleaved, evergreen	1,545,563	8	13.6
	Tropical Thorn forest	4,443	8.6	30.7
	Tropical Freshwater swamp forest	120,323	9.1	14.7
	Unresolved Tree Cover, regularly flooded, fresh water	83,870	9.4	25.8
	Tropical Deciduous/semi-deciduous broadleaf forest	129,239	9.7	26
	Tropical Lowland evergreen broadleaf rain forest	4,160,657	11.4	26.7
	Tropical Lower montane forest	235,521	13.9	17.7
	Tropical Semi-evergreen moist broadleaf forest	634,806	16.6	27.2
	Tropical Sclerophyllous dry forest	183,095	17.9	18
	Temperate Broadleaf evergreen forest	141,752	19.7	24.2
	Tropical Upper montane forest	201,884	22.1	36.4
	Unresolved Mosaic: Tree Cover / Other natural vegetation	207	23.1	30.5
	Tropical Mangrove	28,263	24.4	50
Oceania	Tropical Lowland evergreen broadleaf rain forest	3,239	5.7	6.5
	Unresolved Tree Cover, broadleaved, evergreen	2,017	9.7	10.2
	Unresolved Mosaic: Tree Cover / Other natural vegetation	581	10	10.3
Palearctic	Tropical Mangrove	8	0	94.3
	Tropical Thorn forest	9	0	0
	Unresolved Tree Cover, broadleaved, evergreen	106,220	0.6	13.6
	Temperate Mixed broadleaf/needleleaf forest	273,174	0.7	8.4
	Temperate Sclerophyllous dry forest	78,170	2.7	9.2
	Unresolved Tree Cover, broadleaved, deciduous, closed	1,008,282	3.6	9.8
	Unresolved Tree Cover, needle-leaved, evergreen	1,039,684	4	10.9
	Temperate Deciduous needleleaf forest	2,613,864	4.3	5.6
	Unresolved Tree Cover, needle-leaved, deciduous	609,041	5.6	9.4
	Temperate Sparse trees/parkland	651,633	5.8	9.8
	Unresolved Mosaic: Tree Cover / Other natural vegetation	80,612	6.1	7.5
	Unresolved Tree Cover, mixed leaf type	448,224	6.1	8.9
	Unresolved Tree Cover, regularly flooded, saline water	9	6.8	6.8
	Temperate Deciduous broadleaf forest	1,522,106	6.9	9.9
	Temperate Evergreen needleleaf forest	3,318,574	7.1	9.4
	Unresolved Tree Cover, burnt	22,090	9.1	9.9
	Unresolved Tree Cover, broadleaved, deciduous, open	21,061	11.5	15.7
	Unresolved Tree Cover, regularly flooded, fresh water	160	12.5	12.5