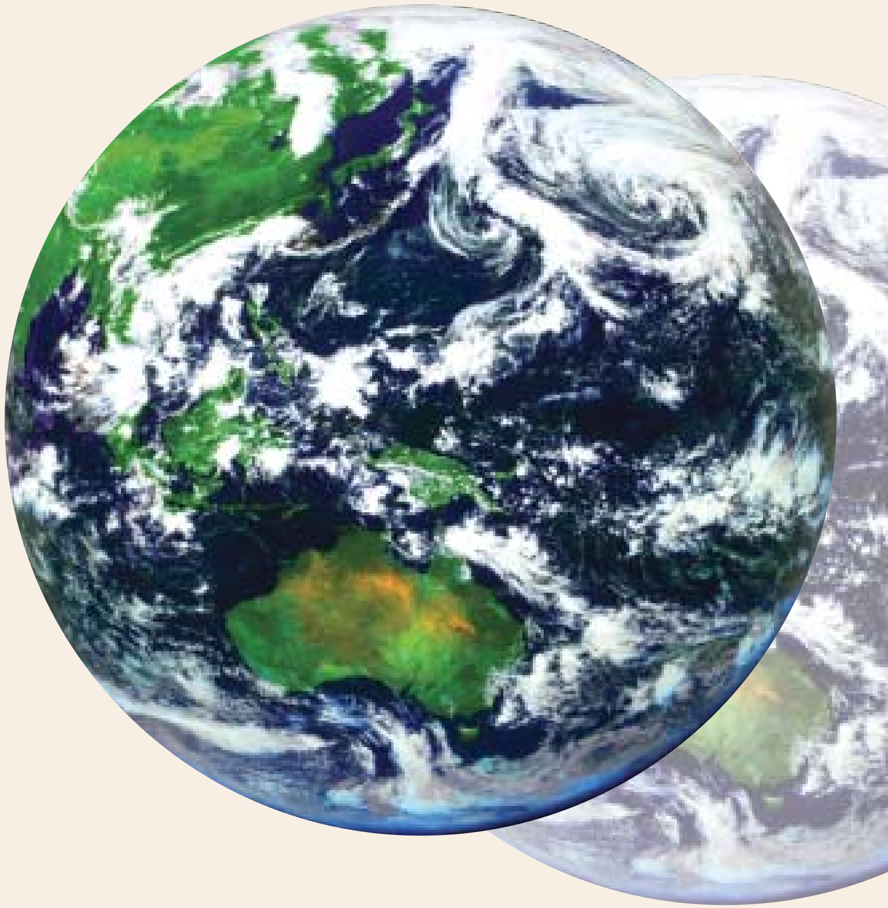
WWF

LIVING PLANET REPORT 2004



UNEP WCMC

Global Footprint Network
Advancing the Science of Sustainability

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WWF
(also known as World Wildlife Fund in the US and Canada) is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in 90 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

THE UNEP WORLD CONSERVATION MONITORING CENTRE
is the biodiversity assessment and policy implementation arm of the United Nations Environment Programme (UNEP). UNEP-WCMC provides objective, scientifically rigorous products and services including ecosystem assessments, support for implementation of environmental agreements, regional and global biodiversity information, research on environmental threats and impacts, and development of future scenarios.

GLOBAL FOOTPRINT NETWORK
promotes a sustainable economy by advancing the Ecological Footprint, a tool that makes sustainability measurable. Together with its partners, the Network coordinates research, develops methodological standards, and provides decision makers with robust resource accounts to help the human economy operate within the Earth's ecological limits.

EDITORS
Jonathan Loh[1]
Mathis Wackernagel[2]

LIVING PLANET INDEX:
Jonathan Loh[1]
Martin Jenkins[3]
Val Kapos[3]
Jorgen Randers[4]
Julio Bernal[3]
Kevin Smith[3]
Carmen Lacambra[3]
Eloise Phipps[3]

ECOLOGICAL FOOTPRINT:
Mathis Wackernagel[2]
Daniel Moran[2]
Steven Goldfinger[2]
Chad Monfreda[5]
Sarah Drexler[2]
Susan Burns[2]

ELIMINATING ECOLOGICAL DEBT AND ONE PLANET LIVING:
Mathis Wackernagel[2]
Steven Goldfinger[2]
Daniel Moran[2]
Jules Peck[6]
Paul King[6]
Jonathan Loh[1]

1. WWF INTERNATIONAL
Avenue du Mont-Blanc
CH-1196 Gland
Switzerland
www.panda.org

2. GLOBAL FOOTPRINT NETWORK
1050 Warfield Avenue
Oakland CA 94610, USA
www.footprintnetwork.org

3. UNEP-WCMC
219 Huntingdon Road
Cambridge CB3 0DL, UK
www.unep-wcmc.org

4. NORWEGIAN SCHOOL OF MANAGEMENT
Elias Smiths vei 15, Box 580
N-1302 Sandvika, Norway
www.bi.no

5. SAGE
University of Wisconsin
1710 University Avenue
Madison WI 53726, USA
www.sage.wisc.edu

6. WWF-UK
Panda House
Godalming
Surrey GU7 1XR, UK
www.wwf-uk.org

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Diagrams and maps: Chad Monfreda, Simon Blyth, David Burles, Helen de Mattos

Layout: Helen de Mattos
Production editor: Jane Lyons

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FOREWORD

In recent years, the global community has set clear targets for sustainability and biodiversity conservation. At the 2002 World Summit on Sustainable Development, governments adopted a plan to significantly reduce the loss of biodiversity by 2010. At the 2004 meeting of the United Nations Convention on Biological Diversity in Kuala Lumpur, governments agreed to set national and regional targets for creating networks of protected areas, including new parks, which will help safeguard biodiversity. Furthermore, all 191 Member States of the United Nations have signed up to support the Millennium Development Goals, which not only address the root causes of environmental degradation – such as escalating poverty – but also include a specific goal on environmental sustainability. Indicators have also been developed, which will help monitor governments' progress on achieving these goals by 2015.

Some might argue that governments are wasting their time talking about goals and targets, and should just get on with the job. But such public commitments to address these critical issues provide a golden opportunity. For the first time, the public can hold its leaders accountable for their success or failure in meeting measurable and quantifiable objectives on these critically important issues. WWF and other non-governmental organizations will be monitoring their progress carefully and, where we can, contributing to the achievement of global goals and targets. Equally, we will not fail to point out where nations are falling short on these aims and will continue to call for much-needed action.

The *Living Planet Report 2004* is the fifth in a series of Living Planet publications, which explore the impact of man on this finite planet. The analysis highlighted in this report is part of our contribution towards measuring the world's progress on sustainable development and biodiversity conservation. It is based on two key indicators. The first, the Living Planet Index (LPI), measures overall trends in populations of wild species around the world. It examines the planet's natural wealth of vertebrate species over time and, as such, provides an indicator of the state of the world's natural environment. The second, the Ecological Footprint, is a measure of environmental sustainability, and weighs humanity's past and present demand on the Earth's renewable natural resources. We believe these two indicators give us vital information about the state of the world's ecosystems and the human pressures affecting them.

Unfortunately, the news is not good. The LPI declined by about 40 per cent from 1970 to 2000, which represents a critical blow to the vitality and resilience of the world's natural systems. During the same period, humanity's Ecological Footprint grew to exceed the Earth's biological carrying capacity by 20 per cent. Although the Ecological Footprint is not one of the agreed indicators of the Millennium Development Goals, it is nonetheless a crucial yardstick, as it measures the total burden placed on the global environment by humanity. When we compare the current Ecological Footprint with the capacity of the Earth's life-supporting ecosystems, we must conclude that we no longer live within the sustainable limits of the planet. Ecosystems are suffering, the global climate is changing, and the further we continue down this path of unsustainable consumption and exploitation, the more difficult it will become to protect and restore the biodiversity that remains.

We support the governments of the United Nations in their bold efforts to set and measure goals and targets but, having agreed them, we must redouble our efforts to work together to attain them. The figures contained in this latest report are a startling reminder that the time to act is now.

Dr Claude Martin
Director General, WWF International

Fig. 1: **LIVING PLANET INDEX,** 1970–2000

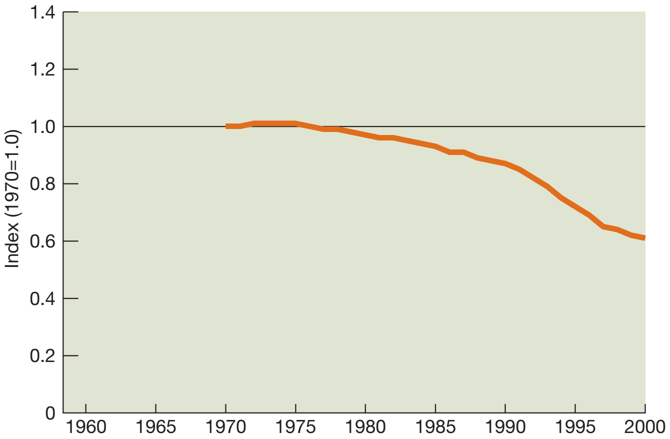


Fig. 2: **HUMANITY'S ECOLOGICAL FOOTPRINT,** 1961–2001

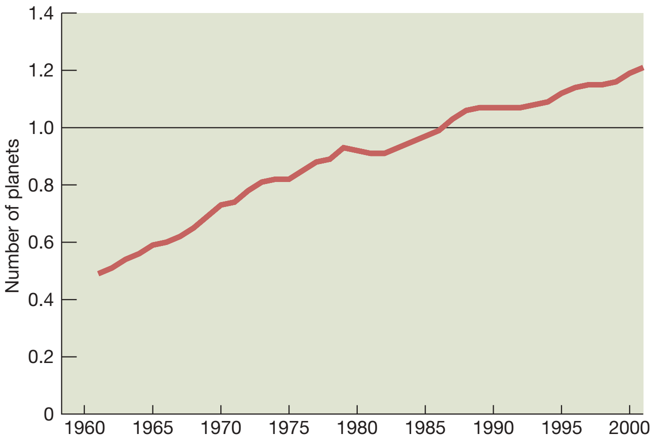


Figure 1: Species populations decreasing. The Living Planet Index shows average trends in populations of terrestrial, freshwater, and marine species worldwide. It declined by about 40 per cent from 1970 to 2000.

Figure 2: Human demand on biosphere increasing. The Ecological Footprint measures people's use of renewable natural resources. Humanity's Ecological Footprint is shown here in number of planets, where one planet equals the total biologically productive capacity of the Earth in any one year. In 2001, humanity's Ecological Footprint was 2.5 times larger than in 1961, and exceeded the Earth's biological capacity by about 20 per cent. This overshoot depletes the Earth's natural capital, and is therefore possible only for a limited period of time.

THE LIVING PLANET INDEX

The Living Planet Index (LPI) is an indicator of the state of the world's biodiversity: it measures trends in populations of vertebrate species living in terrestrial, freshwater, and marine ecosystems around the world. Figure 1 (see previous page) shows that the index fell by about 40 per cent between 1970 and 2000.

Since the last edition of the *Living Planet Report* in 2002, the number of population time series included in the index has increased, and now includes terrestrial species from ecosystems other than forest: grassland, savannah, desert, and tundra. The LPI currently incorporates data on approximately 3 000 population trends for more than 1 100 species. The methodology for calculating the index has also changed so that it now proceeds on an annual rather than a five-yearly basis. However, as there are relatively few data points from recent years, the index does not extend beyond the year 2000. The index is now more robust than its earlier versions but the results presented remain consistent.

The LPI is the average of three separate indices measuring changes in abundance of 555 terrestrial species, 323 freshwater species, and 267 marine species around the world. While the LPI fell by some 40 per cent between 1970 and 2000, the terrestrial index fell by about 30 per cent, the freshwater index by about 50 per cent, and the marine index by around 30 per cent over the same period.

These declines can be compared with the global Ecological Footprint, which grew by 70 per cent, and with the growth in the world's human population of 65 per cent, from 1970 to 2000.

The map shows remaining wilderness areas using distance from human settlements, roads, or other infrastructure as a proxy. It assumes that the degree of disturbance or transformation of natural landscapes by humans increases with the ease of access from places where people live. The greater the density of population centres or road networks, the lower the wilderness value.

Figure 3: The terrestrial species index shows a decline of about 30 per cent between 1970 and 2000 in 555 species of mammals, birds, and reptiles living in terrestrial ecosystems.

Figure 4: The freshwater species index shows a decline of approximately 50 per cent from 1970 to 2000 in 323 vertebrate species found in rivers, lakes, and wetland ecosystems.

Figure 5: The marine species index shows a decline of about 30 per cent from 1970 to 2000 in 267 species of mammals, birds, reptiles, and fish occurring in the world's ocean and coastal ecosystems.

Fig. 3: **TERRESTRIAL SPECIES POPULATION INDEX,** 1970–2000

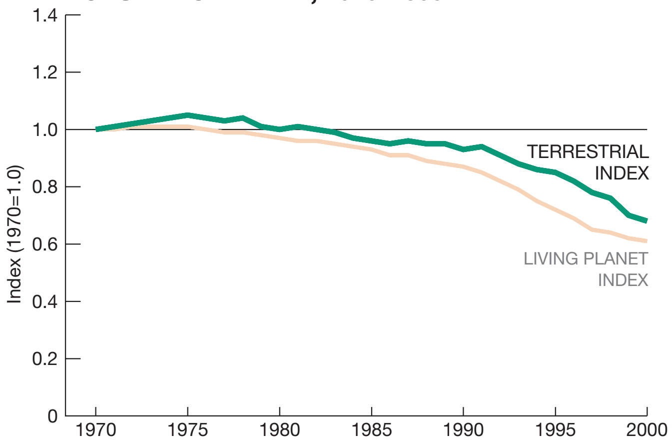


Fig. 4: **FRESHWATER SPECIES POPULATION INDEX,** 1970–2000

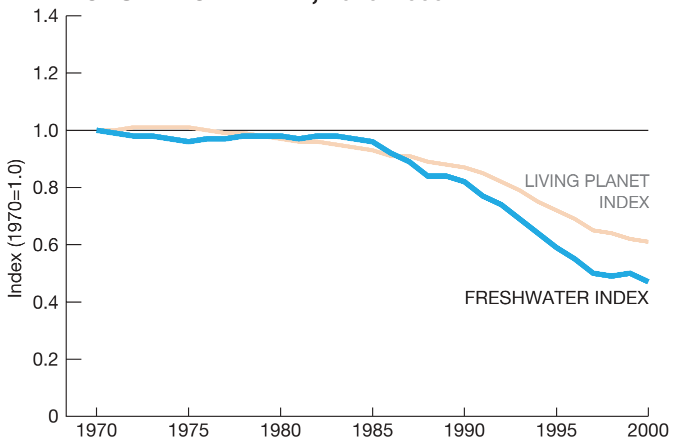
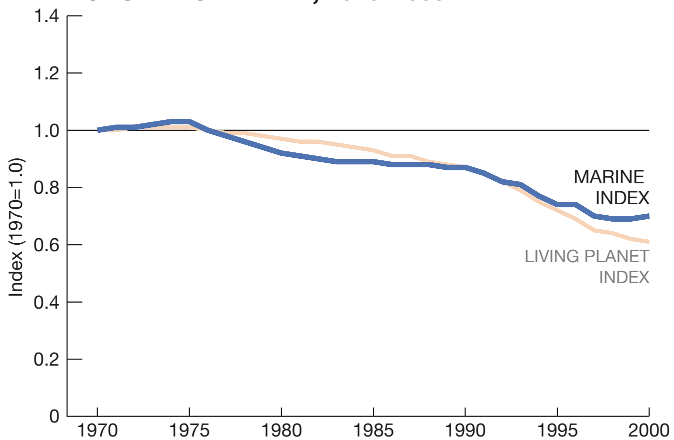
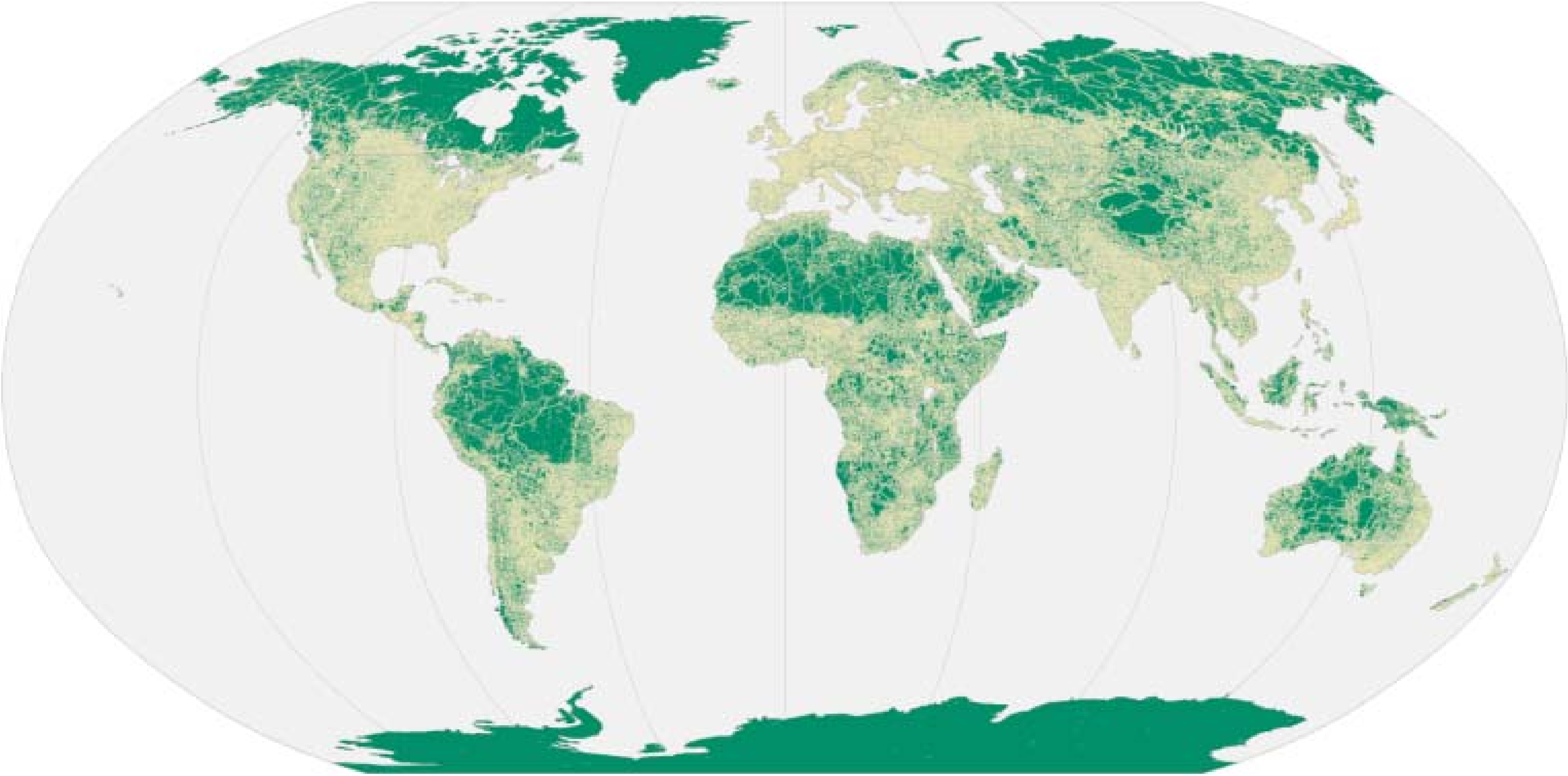


Fig. 5: **MARINE SPECIES POPULATION INDEX,** 1970–2000





Map 1: **REMAINING WILDERNESS**

High wilderness level Low wilderness level

The wilderness value of any point is a measure of its distance from the nearest human settlements, roads, or other infrastructure.

TERRESTRIAL SPECIES

The terrestrial species index indicates that populations of terrestrial species declined by approximately 30 per cent between 1970 and 2000. This average decline masks differences between the changes in temperate and tropical ecosystems. Figure 6 shows average trends in the populations of 431 temperate terrestrial species and 124 tropical terrestrial species. The temperate species declined by more than 10 per cent while the tropical species fell by about 65 per cent.

Different rates of decline between temperate regions and the tropics reflect differences in the rates of habitat loss. According to FAO data (Figure 7), tropical forest cover decreased by about 7 per cent from 1990 to 2000, while temperate forest cover increased by about 1 per cent. Figure 8 shows that the grassland, savannah, desert, and tundra species index declined by more than 60 per cent from 1970 to 2000. Populations of species living in tropical grassland ecosystems fell by about 80 per cent, while species populations in temperate grassland ecosystems declined by more than 10 per cent over the same period. The greater rate of decline in tropical ecosystems does not mean that tropical species are less abundant than temperate species; it simply reflects the relative change in their populations from 1970 to 2000. The majority of natural forests and grasslands in temperate regions were lost prior to 1970, whereas in the tropics the loss of natural habitat is a relatively recent and on-going phenomenon.

The steep fall in abundance of grassland species is mirrored by a corresponding rise in the grazing land component of the Ecological Footprint. The grazing land footprint more than doubled between 1970 and 2000 while the forest footprint increased by about 30 per cent (see page 12).

The map shows examples of trends in selected terrestrial species populations and their approximate locations around the world. The graphs do not necessarily indicate trends for the global population of each species, but in some cases represent trends in a local or regional population.

Figure 6: Temperate terrestrial species populations declined by more than 10 per cent from 1970 to 2000 while tropical terrestrial species declined by about 65 per cent.

Figure 7: Temperate forest cover increased by about 1 per cent from 1990 to 2000, while tropical forest cover declined by about 7 per cent (FAO 2001).

Figure 8: The grassland, savannah, desert, and tundra species index declined by more than 60 per cent from 1970 to 2000. Temperate grassland species populations declined by more than 10 per cent while tropical grassland species populations declined by about 80 per cent over the same period.

Fig. 6: **TERRESTRIAL SPECIES POPULATION INDEX,** 1970–2000

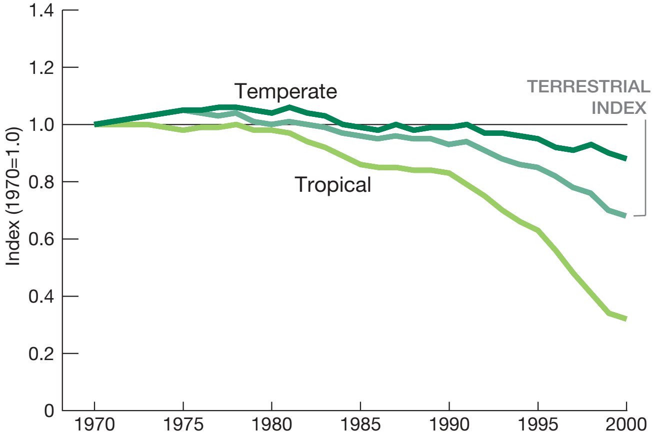


Fig. 7: **NATURAL FOREST COVER AND NET CHANGE,** 1990–2000

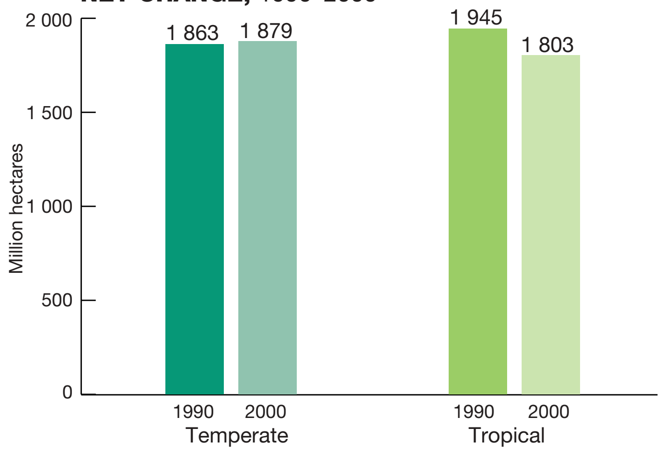
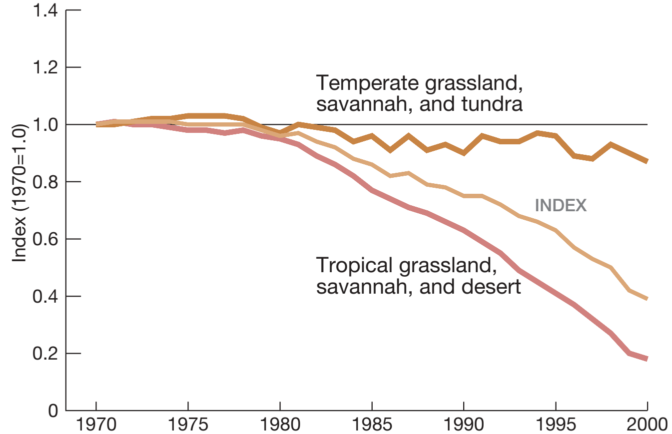
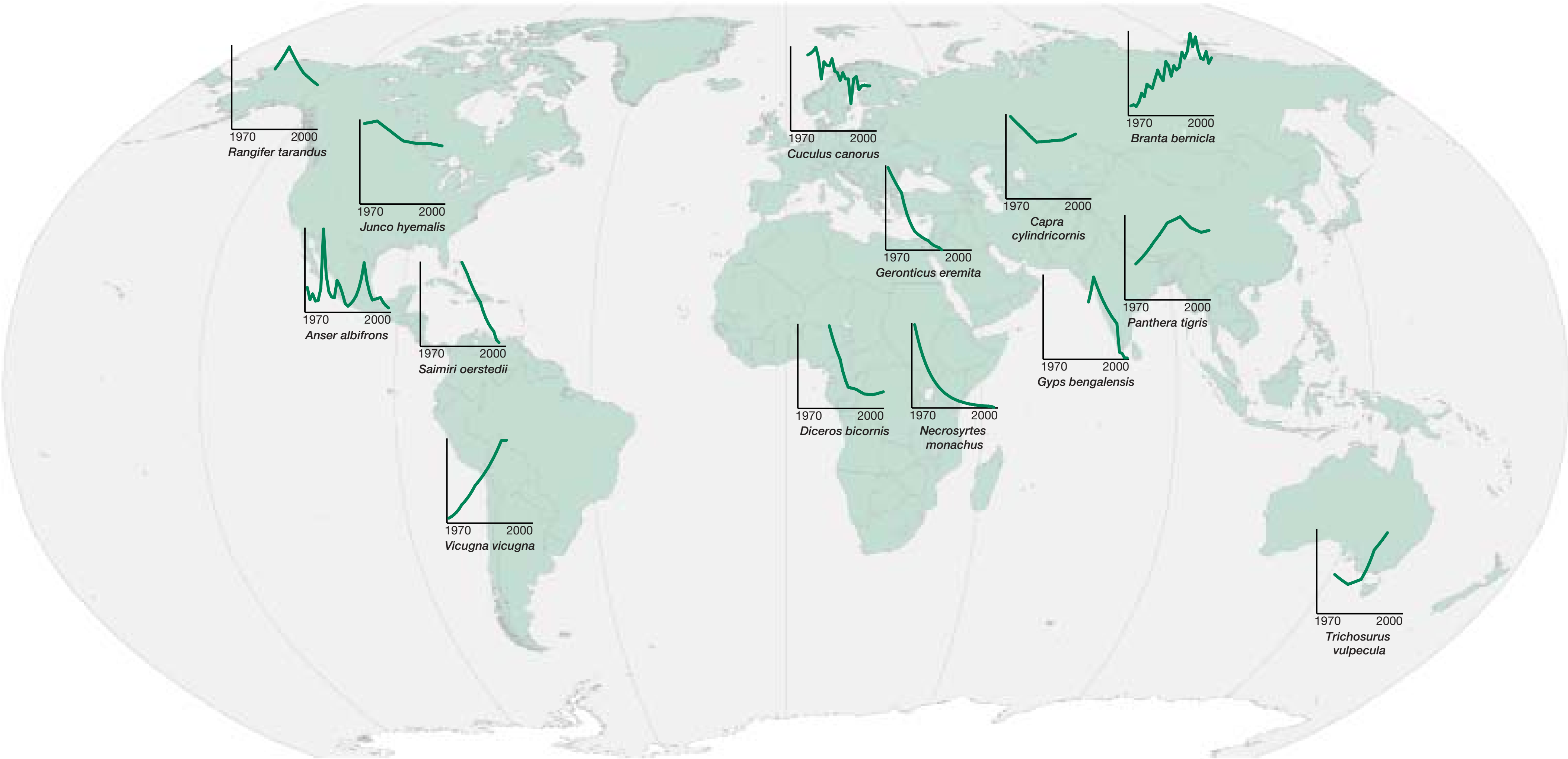


Fig. 8: **GRASSLAND, SAVANNAH, DESERT, AND TUNDRA SPECIES POPULATION INDEX,** 1970–2000





Map 2: **TRENDS IN SELECTED TERRESTRIAL SPECIES POPULATIONS**

1970-2000

Species	Common name	Location of population surveyed
Rangifer tarandus	Caribou	Denali National Park, Alaska
Junco hyemalis	Dark-eyed junco	North America
Anser albifrons	White-fronted goose	Mexico
Saimiri oerstedii	Central American squirrel monkey	Costa Rica, Panama
Vicugna vicugna	Vicuna	South America
Cuculus canorus	Cuckoo	Sweden
Geronticus eremita	Waldrapp/northern bald ibis	Turkey
Diceros bicornis	Black rhinoceros	Africa
Necrosyrtes monachus	Hooded vulture	Queen Elizabeth and Murchison Falls National Parks, Uganda
Capra cylindricornis	East Caucasian or Daghestan tur	East Caucasus
Branta bernicla	Brent goose	Siberia
Gyps bengalensis	Oriental white-backed vulture	Keoladeo National Park, India
Panthera tigris	Tiger	India, all states
Trichosurus vulpecula	Common brush-tailed possum	Tasmania

FRESHWATER SPECIES

The freshwater species index fell by about 50 per cent from 1970 to 2000, the most rapid decline of the three species indices. Figure 9 shows average trends in the populations of 269 temperate freshwater species and 54 tropical freshwater species.

Ten thousand of the 25,000 known species of fish, 40 per cent of the world total, live in freshwater. Yet freshwater makes up only about 2.5 per cent of the world's water, and 99 per cent of it is locked up in ice caps or underground. In terms of their size relative to the Earth's surface, freshwater ecosystems – wetlands, rivers, and lakes – account for a disproportionately large fraction of global biodiversity.

Ecological degradation of freshwater ecosystems is a direct consequence of the increasing human demand for food, fibre, energy, and water. The growth in demand for water for irrigation in Central Asia since the 1960s, mostly to grow cotton and rice, reduced and eventually stopped the flow of water from the Amu Darya and Syr Darya rivers into the Aral Sea. The area of the sea more than halved between 1960 and 2000 while its salinity increased nearly five-fold (Figure 10). The Aral Sea fisheries collapsed. Only 160 of 319 species of bird and 32 of more than 70 species of mammal inhabiting the river deltas prior to 1960 remained in 2000.

The rate of extinction of freshwater fish species worldwide far exceeds background extinction rates. Figure 11 shows that 91 species went extinct in the last century, including 50 cichlid fishes from Lake Victoria. Many of the endemic freshwater fish species of the Rift Valley have become very rare or extinct in recent decades following the introduction of the Nile perch *Lates niloticus* into Lake Victoria around 1970 as a food source. Lake Victoria supported around 300 species of cichlids before introduction of the perch, which turned out to be a voracious predator of the endemic cichlids.

The map shows examples of trends in selected freshwater species populations and their approximate locations around the world. The graphs do not necessarily indicate trends for the global population of each species, but in some cases represent trends in a local or regional population.

Figure 9: Temperate freshwater species declined by about 50 per cent from 1970 to 2000 while tropical freshwater species declined by about 50 per cent from 1970 to 1995 (insufficient data to determine the rate from 1995 to 2000).

Figure 10: The area of the Aral Sea declined by 60 per cent between 1960 and 2000 while its salinity increased 380 per cent (UNEP-GRID Arendal 2004).

Figure 11: Ninety-one species of freshwater fish are listed as extinct in the wild in the 2000 IUCN Red List. Of these, ten species could not be assigned to a particular year, so this chart includes them at the rate of one per decade over the 20th century (WCMC 1998, IUCN 2000).

Fig. 9: **FRESHWATER SPECIES POPULATION INDEX,** 1970–2000

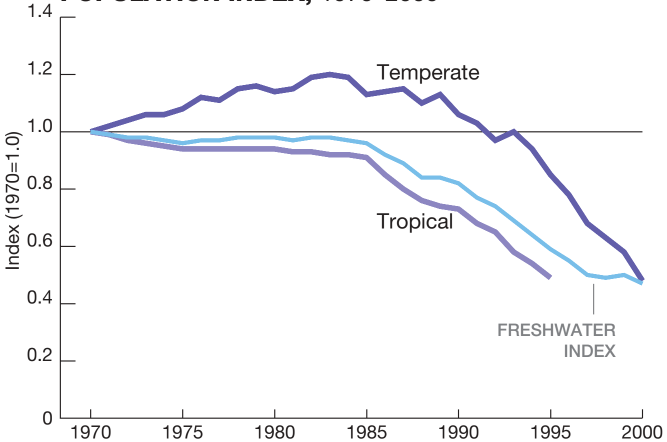


Fig. 10: **AREA AND SALINITY OF THE ARAL SEA,** 1960–2000

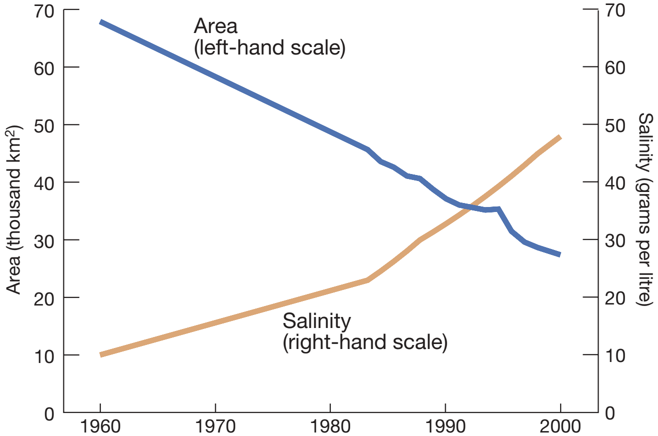
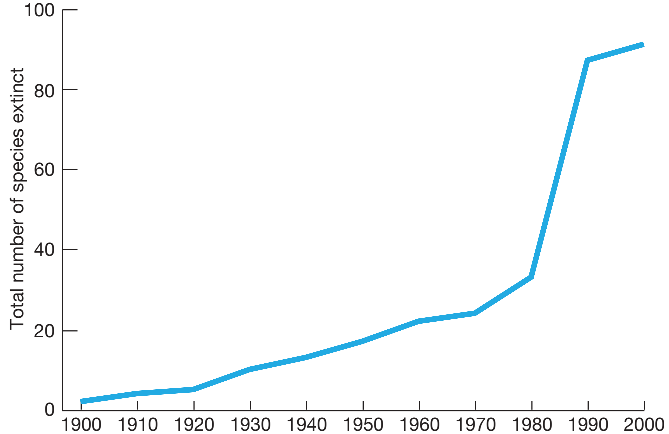
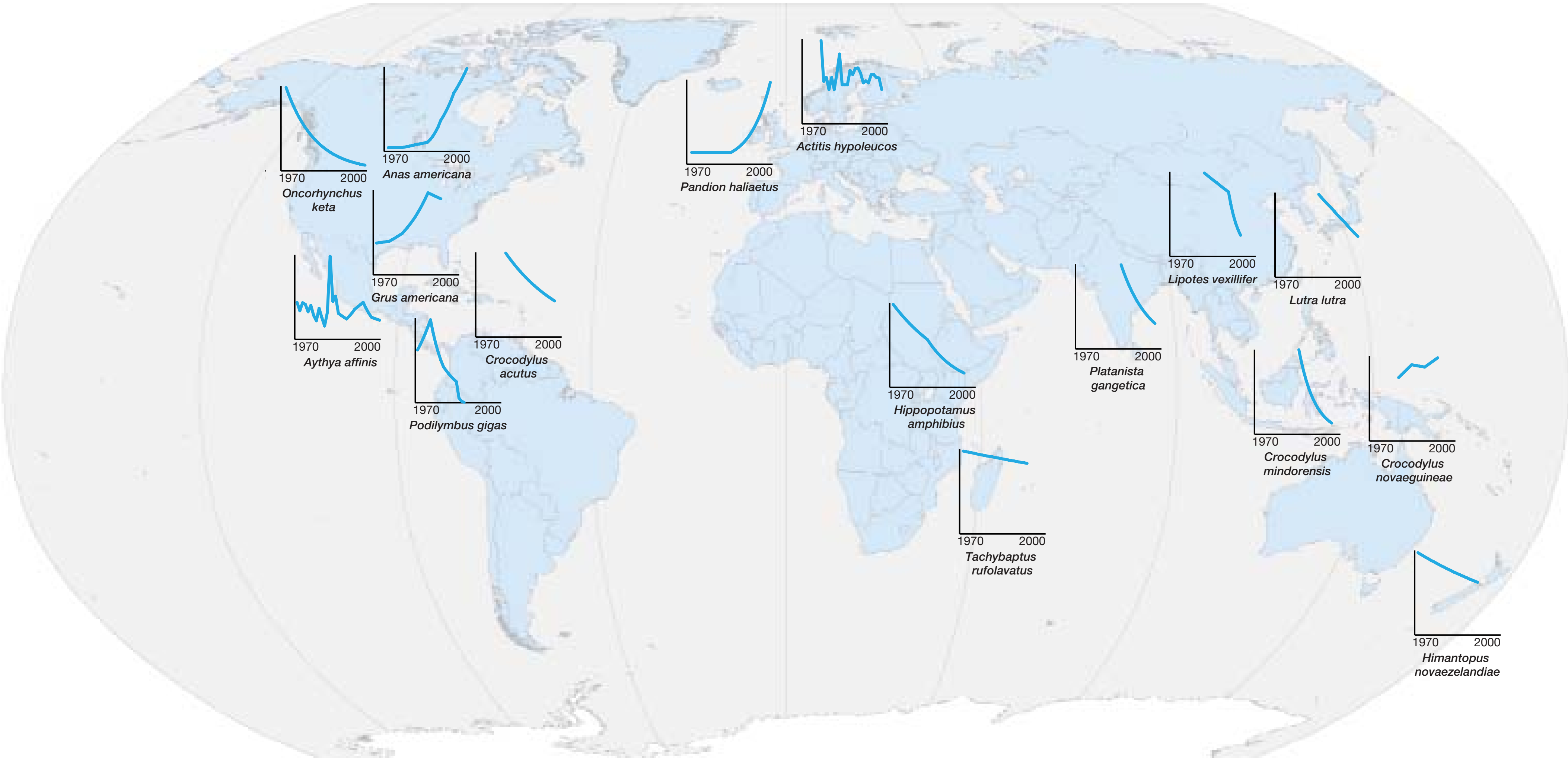


Fig. 11: **KNOWN 20TH CENTURY FRESHWATER FISH EXTINCTIONS** (cumulative)





Map 3: **TRENDS IN SELECTED FRESHWATER SPECIES POPULATIONS**

1970-2000

Species	Common name	Location of population surveyed
Oncorhynchus keta	Chum salmon	Columbia River, USA
Anas americana	American wigeon	USA and Canada
Grus americana	Whooping crane	Texas, USA
Aythya affinis	Lesser scaup	Mexico
Podilymbus gigas	Atitlan grebe	Guatemala
Crocodylus acutus	American crocodile	Lago Enriquillo, Dominican Republic
Pandion haliaetus	Osprey	United Kingdom
Actitis hypoleucos	Common sandpiper	Sweden

Species	Common name	Location of population surveyed
Hippopotamus amphibius	Hippopotamus	Uganda
Tachybaptus rufolavatus	Rusty grebe	Madagascar
Platanista gangetica	Ganges river dolphin	Ganga River, India
Lipotes vexillifer	Baiji	Yangtze River, China
Lutra lutra	Otter	Korea
Crocodylus mindorensis	Philippine crocodile	Southeast Asia
Crocodylus novaeguineae	New Guinea crocodile	Papua New Guinea
Himantopus novaezelandiae	Black stilt	New Zealand

MARINE SPECIES

The marine species index indicates that populations of 267 species of marine mammal, bird, reptile, and fish declined by about 30 per cent between 1970 and 2000. Figure 12 shows average trends in the populations of 117 Atlantic and Arctic Ocean species, 105 Pacific Ocean species, 15 Indian Ocean species, and 30 Southern Ocean species.

The relatively stable trends in abundance of species in the Pacific and in the Atlantic and Arctic Oceans hide an effect known as "fishing down the food web". Commercial fish species preferred for human consumption, such as cod and tuna, are generally high up in the food chain. If plants such as phytoplankton and other primary producers are assigned to trophic level 1, and zooplankton and other animals that feed on them are assigned to trophic level 2, then species such as cod and tuna are at around trophic level 4. The biomass of these high trophic-level fishes is estimated to have declined by two-thirds in the North Atlantic between 1950 and 2000. As the top predators have been systematically reduced in number, so the species around trophic level 3 have increased in abundance. To compensate for declining catches of high trophic-level fishes such as cod (Figure 13), species occupying lower trophic levels have been targeted. Not only has the cod catch declined, but the average size of cod caught has also shrunk. As smaller, younger cod tend to feed lower down the food chain than fully mature fish, this adds to the fishing down the food web effect.

Figure 14 shows that the mean trophic level of fish catches in the Northwest and Western Central Atlantic fell from 3.3 in 1970 to 2.9 in 1994, a decline of about 12 per cent. In the Northeast Atlantic the mean trophic level of catches declined from about 3.5 to 3.4 over the same period. The decline of stocks of high trophic-level species is a direct consequence of overfishing, supported by subsidies which, in the North Atlantic, amount to about US$2.5 billion per year.

The map shows the location of both warm and cold water corals, and examples of trends in selected marine species populations and their approximate locations around the world. The graphs do not necessarily indicate trends for the global population of each species, but may reflect trends in a local or regional population.

Figure 12: The marine species index declined by about 30 per cent from 1970 to 2000. Indian and Southern Ocean species declined overall, while average trends in Atlantic and Arctic species and in Pacific species remained stable.

Figure 13: Landings of Atlantic cod (*Gadus morhua*) declined 70 per cent between 1970 and 2000 (FAO 2004b).

Figure 14: The average trophic level of fish catches in the Northwest and Western Central Atlantic declined by about 12 per cent and in the Northeast Atlantic by about 3 per cent between 1970 and 1994 (Pauly et al. 1998).

Fig. 12: **MARINE SPECIES POPULATION INDEX,** 1970–2000

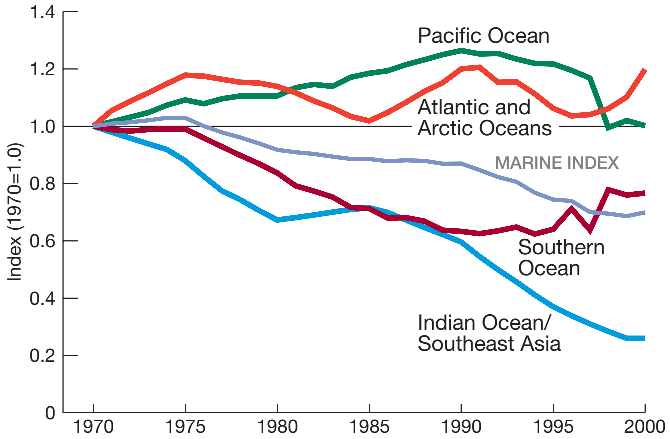


Fig. 13: **ATLANTIC COD LANDINGS** 1970–2000

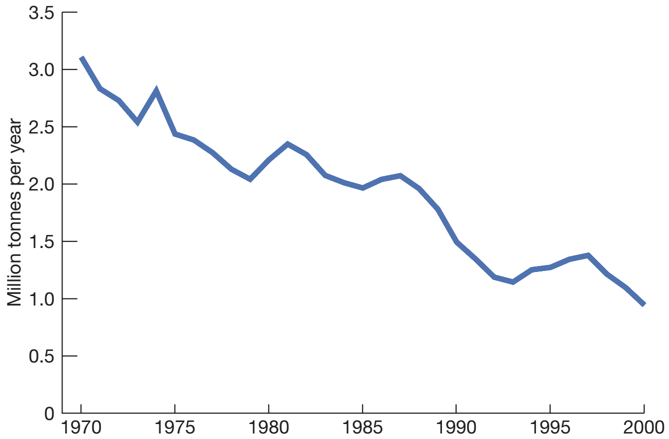
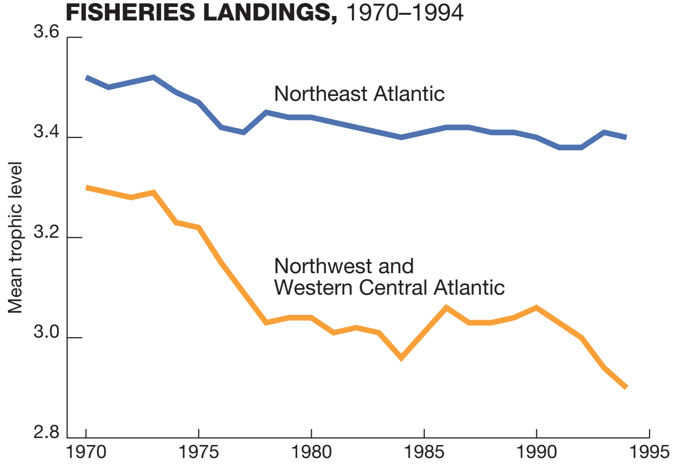
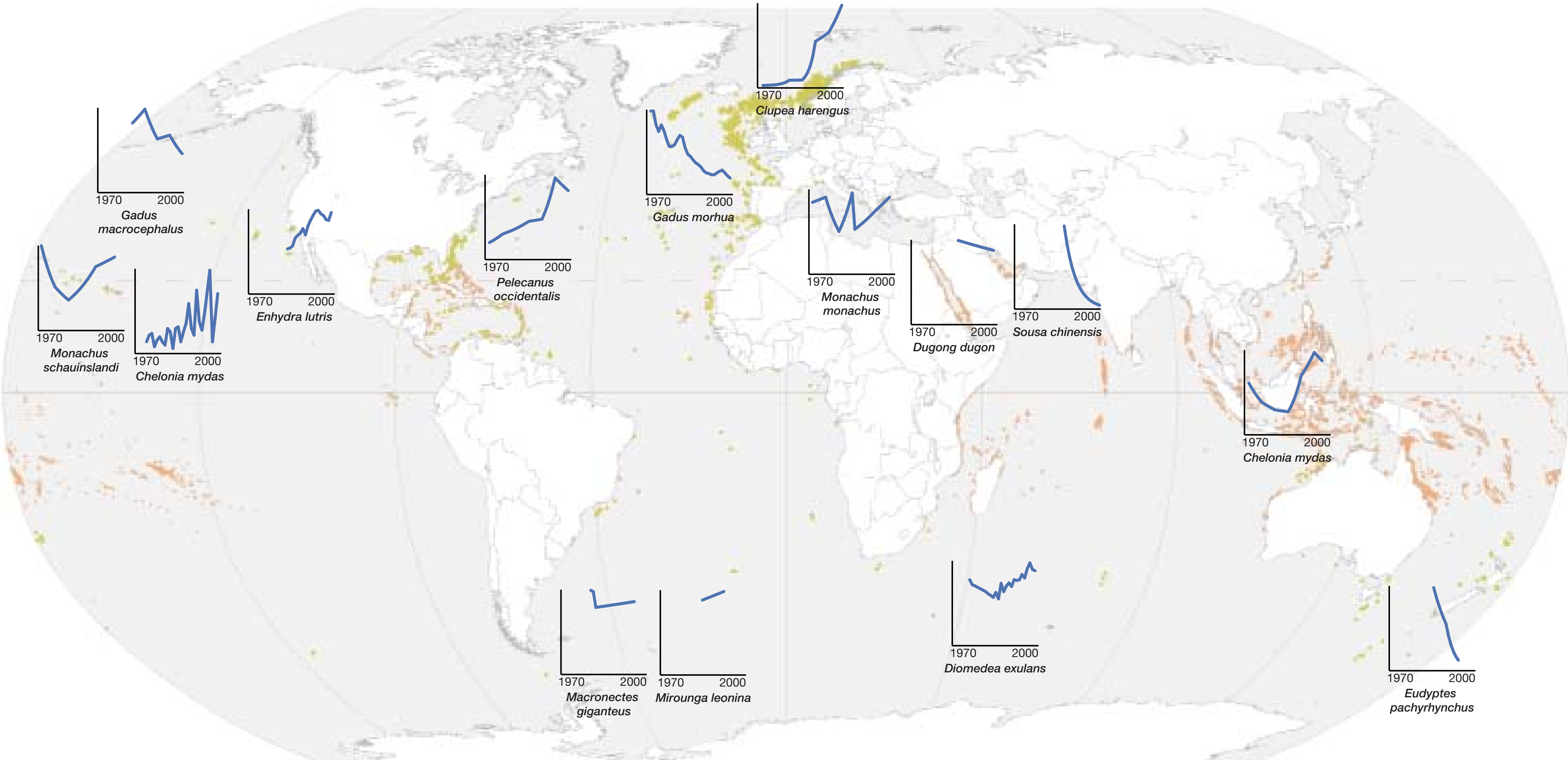


Fig. 14: **MEAN TROPHIC LEVEL OF ATLANTIC FISHERIES LANDINGS,** 1970–1994





Map 4: **CORAL DISTRIBUTION AND TRENDS IN SELECTED MARINE SPECIES POPULATIONS**
1970-2000

Warm water coral   Cold water coral
Graphic presentation at this scale exaggerates actual reef area.

Species	Common name	Location of population surveyed
Gadus macrocephalus	Pacific cod	Aleutian Islands, Bering Sea
Monachus schauinslandi	Hawaiian monk seal	Hawaii
Chelonia mydas	Green turtle	East Island, Hawaii
Enhydra lutris	Sea otter	California Coast, USA
Pelecanus occidentalis	Brown pelican	North America
Macronectes giganteus	Southern giant petrel	Bird Island, South Georgia
Mirounga leonina	Southern elephant seal	South Georgia
Gadus morhua	Atlantic cod	North Sea

Species	Common name	Location of population surveyed
Clupea harengus	Herring	Norwegian Sea
Monachus monachus	Mediterranean monk seal	Mediterranean Sea
Dugong dugon	Dugong	United Arab Emirates
Sousa chinensis	Indo-pacific humpbacked dolphin	United Arab Emirates
Diomedea exulans	Wandering albatross	Possession Island, Crozet Islands
Chelonia mydas	Green turtle	Turtle Islands, Sabah
Eudyptes pachyrhynchus	Fiordland penguin	Southern New Zealand

ECOLOGICAL FOOTPRINT

The Ecological Footprint measures people's natural resource consumption. The footprint can be compared with nature's ability to renew these resources. A country's footprint is the total area required to produce the food and fibre that it consumes, absorb the waste from its energy consumption, and provide space for its infrastructure. People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they are on the planet.

The global Ecological Footprint was 13.5 billion global hectares in 2001, or 2.2 global hectares per person (a global hectare is a hectare whose biological productivity equals the global average). This demand on nature can be compared with the Earth's biocapacity, based on its biologically productive area – approximately 11.3 billion global hectares, which is a quarter of the Earth's surface. The productive area of the biosphere translates into an average of 1.8 global hectares per person in 2001.

The global Ecological Footprint changes with population size, average consumption per person, and resource efficiency. The Earth's biocapacity changes with the amount of biologically productive area and its average productivity.

In 2001, humanity's Ecological Footprint exceeded global biocapacity by 0.4 global hectares per person, or 21 per cent. This global overshoot began in the 1980s and has been growing ever since (see Figure 2). In effect, overshoot means spending nature's capital faster than it is being regenerated. Overshoot may permanently reduce ecological capacity.

Figure 15: The Ecological Footprint per person for countries with populations over 1 million.

Figure 16: Humanity's Ecological Footprint grew by about 160 per cent from 1961 to 2001, somewhat faster than population which doubled over the same period.

Figure 17: Ecological Footprint by region in 2001. The height of each bar is proportional to each region's average footprint per person, the width of the bar is proportional to its population, and the area of the bar is proportional to the region's total Ecological Footprint.

Fig. 15: **ECOLOGICAL FOOTPRINT PER PERSON,** by country, 2001

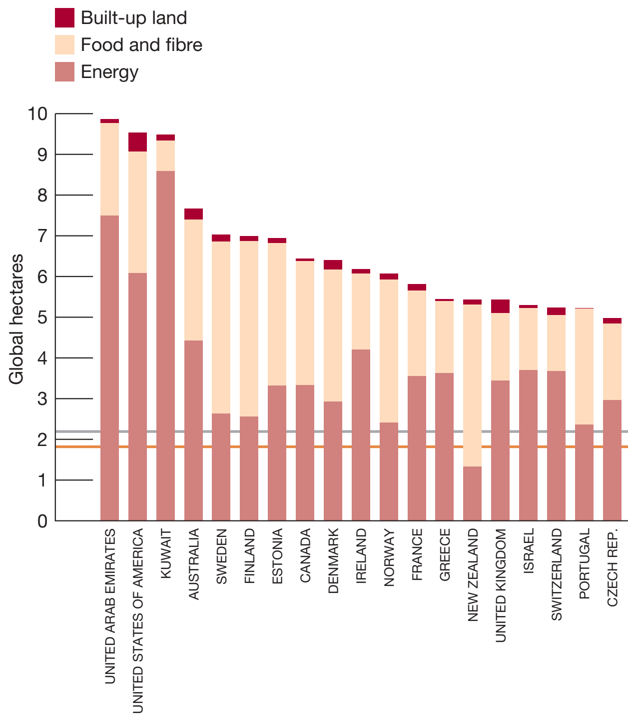
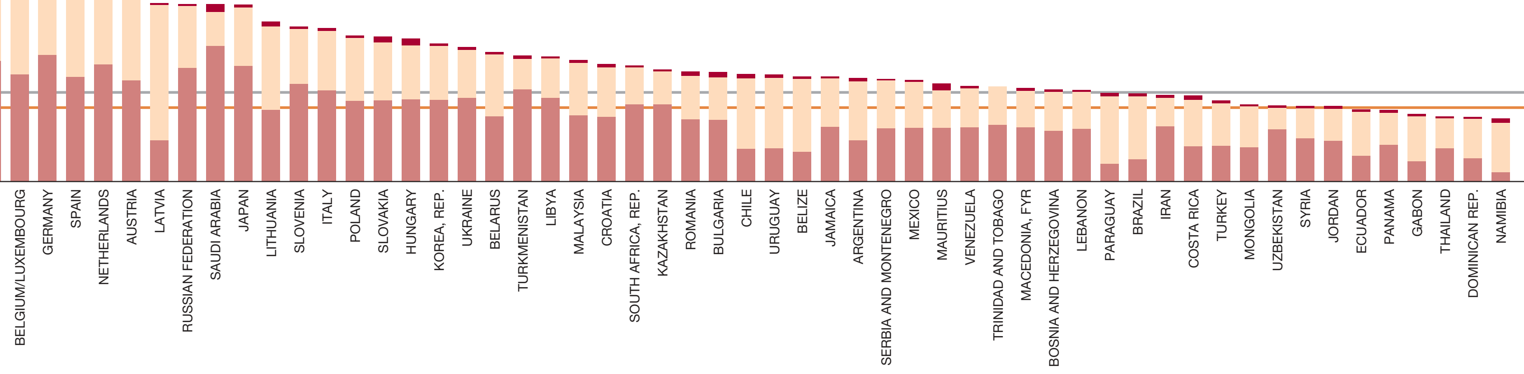



Fig. 16: **HUMANITY'S ECOLOGICAL FOOTPRINT,** 1961–2001

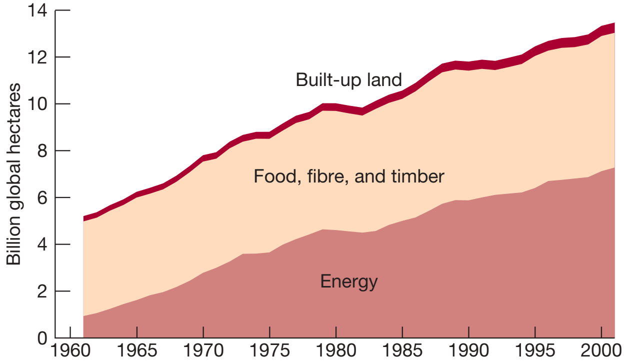
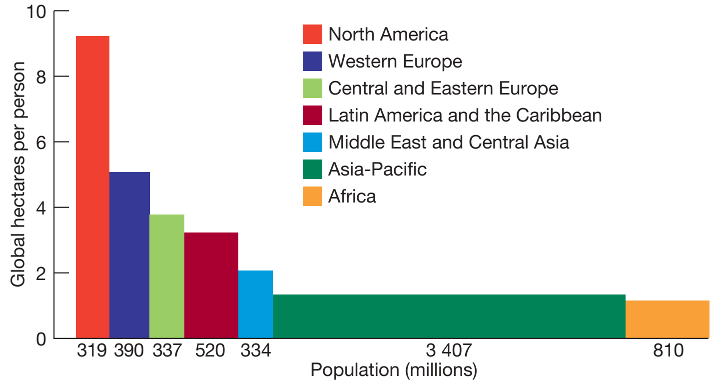
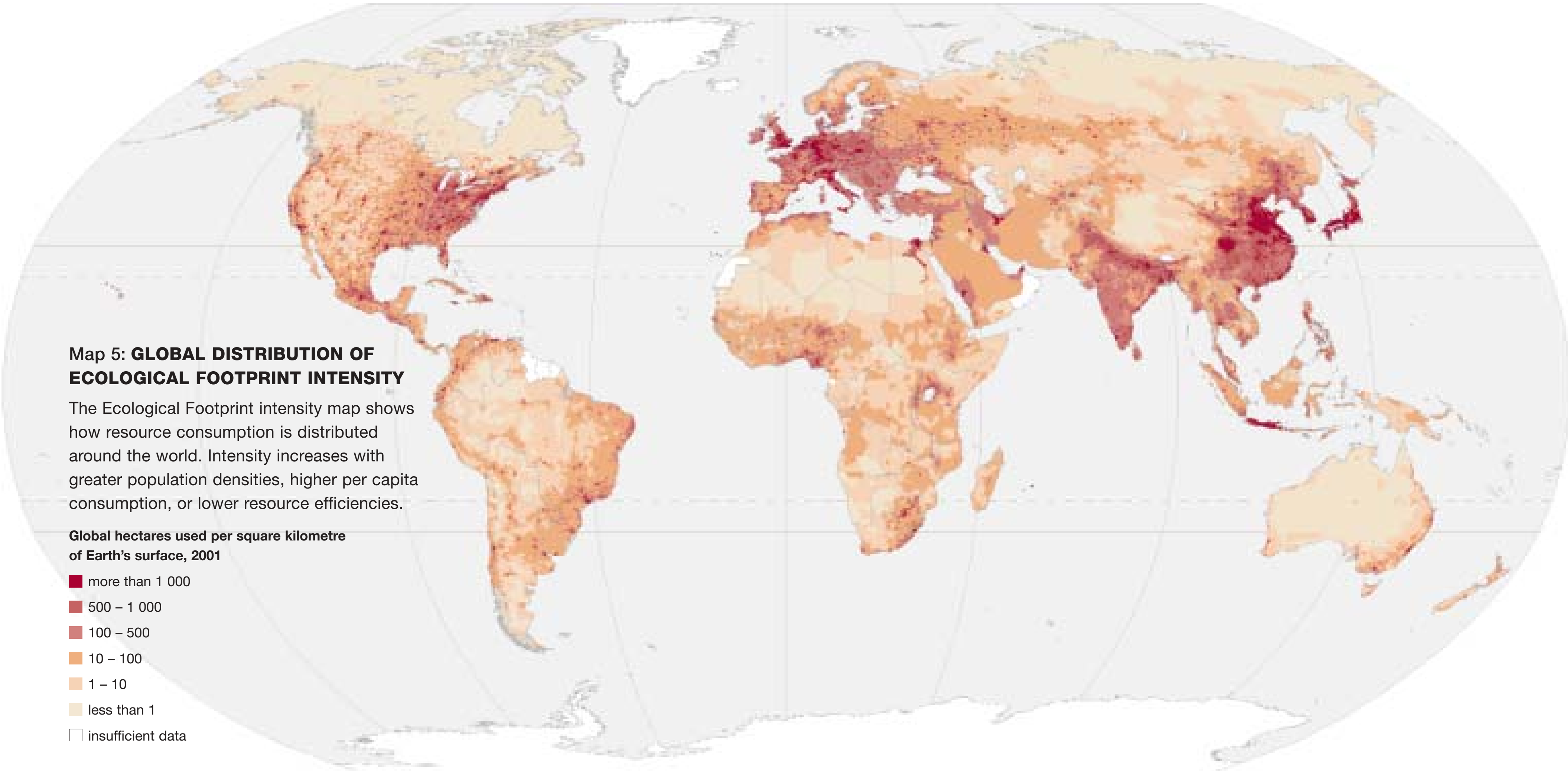


Fig. 17: **ECOLOGICAL FOOTPRINT BY REGION,** 2001



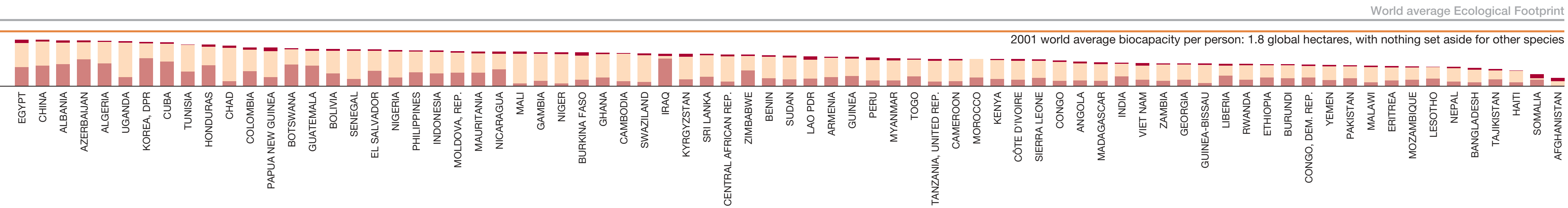


Map 5: **GLOBAL DISTRIBUTION OF ECOLOGICAL FOOTPRINT INTENSITY**

The Ecological Footprint intensity map shows how resource consumption is distributed around the world. Intensity increases with greater population densities, higher per capita consumption, or lower resource efficiencies.

Global hectares used per square kilometre of Earth's surface, 2001

- more than 1 000
- 500 – 1 000
- 100 – 500
- 10 – 100
- 1 – 10
- less than 1
- insufficient data



FOOD, FIBRE, AND TIMBER FOOTPRINT

A country's food, fibre, and timber footprint includes the area required to maintain people's consumption from: a) cropland, which provides crops for food, animal feed, fibre, and oil; b) grassland and pasture, which support grazing of animals for meat, hides, wool, and milk; c) fishing ground, for production of fish and seafood products; and d) forest areas, which provide wood, wood fibre, and pulp. (Forest for fuelwood and absorption of carbon dioxide (CO_2) is included in the energy footprint.)

Changing ecosystem products and services can alter the size of each of these areas. For example, tropical forests are being converted to cropland and grazing land. In Southeast Asia, Latin America, and Africa plantations are replacing natural forests to supply the growing demand for palm oil for margarine, sweets, soaps, and body lotions. Elsewhere, irrigated cropland is becoming unproductive as a result of water shortages or salination.

The food, fibre, and timber footprint of an average North American in 2001 was 3.0 global hectares, more than three times the world average, whereas the food, fibre, and timber footprint of an average African or Asian was less than 0.7 global hectares.

Demand for animal products is rising particularly rapidly, as is visible in the growth of grazing land. A significant proportion of crops is also used for feed, leading to a loss of available food calories – a kilogram of pork from grain-fed pigs has at least four times the footprint of a kilogram of the grain itself.

Figure 18. The food, fibre, and timber footprint (indicating cropland, forest area, grazing land, and fishing ground) per person, by country, 2001. Note that the world average line reflects average amount consumed, not a sustainable level.

Figure 19. Humanity's food, fibre, and timber footprint grew by 42 per cent between 1961 and 2001, with the largest increases in the use of fishing grounds (98 per cent) and grazing land (186 per cent).

Figure 20. Each regional bar shows both population and per person footprint, with its area representing the total food, fibre, and timber footprint for that region.

Fig. 18: **FOOD, FIBRE, AND TIMBER FOOTPRINT PER PERSON,** by country, 2001

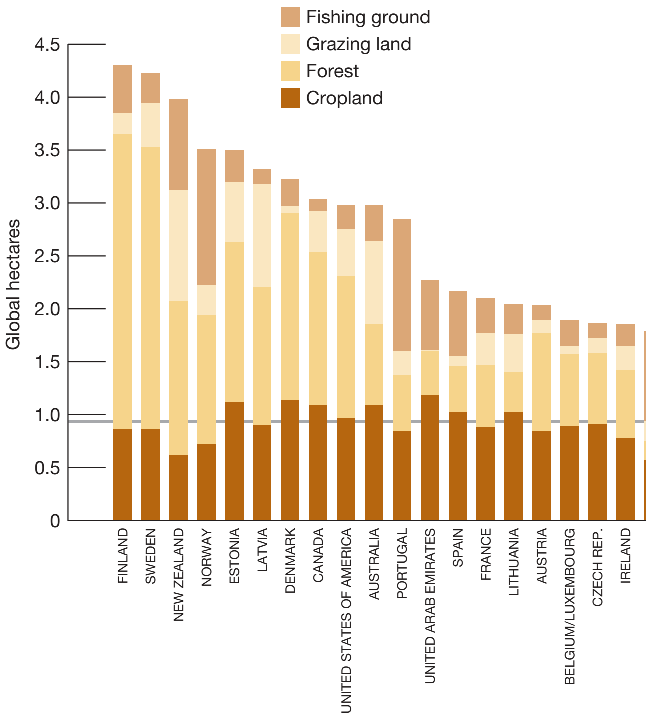
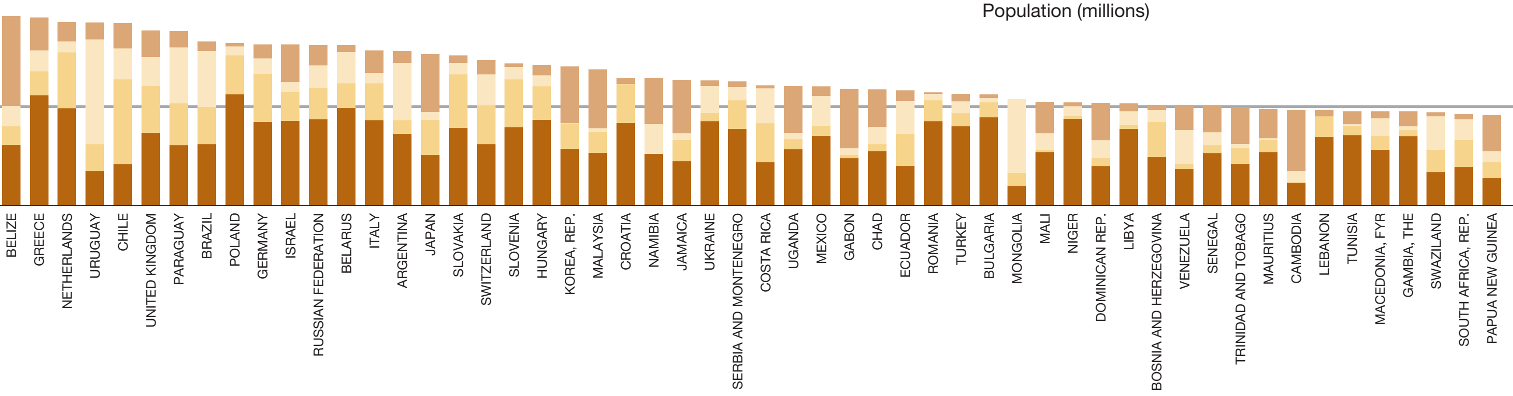



Fig. 19: **HUMANITY'S FOOD, FIBRE, AND TIMBER FOOTPRINT,** 1961–2001

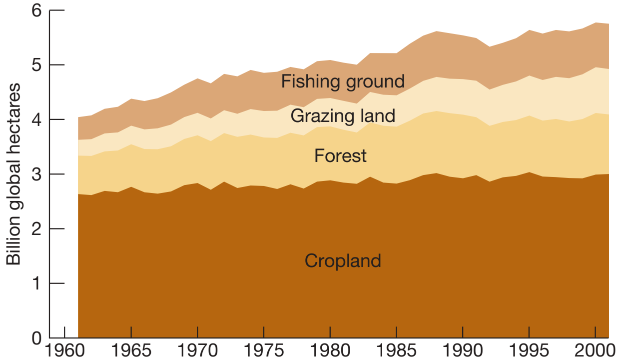
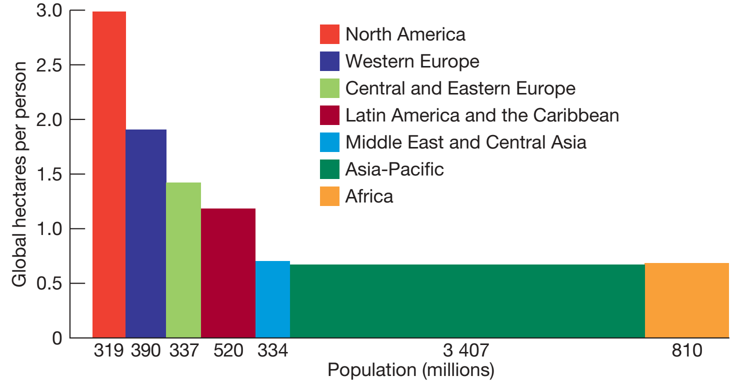
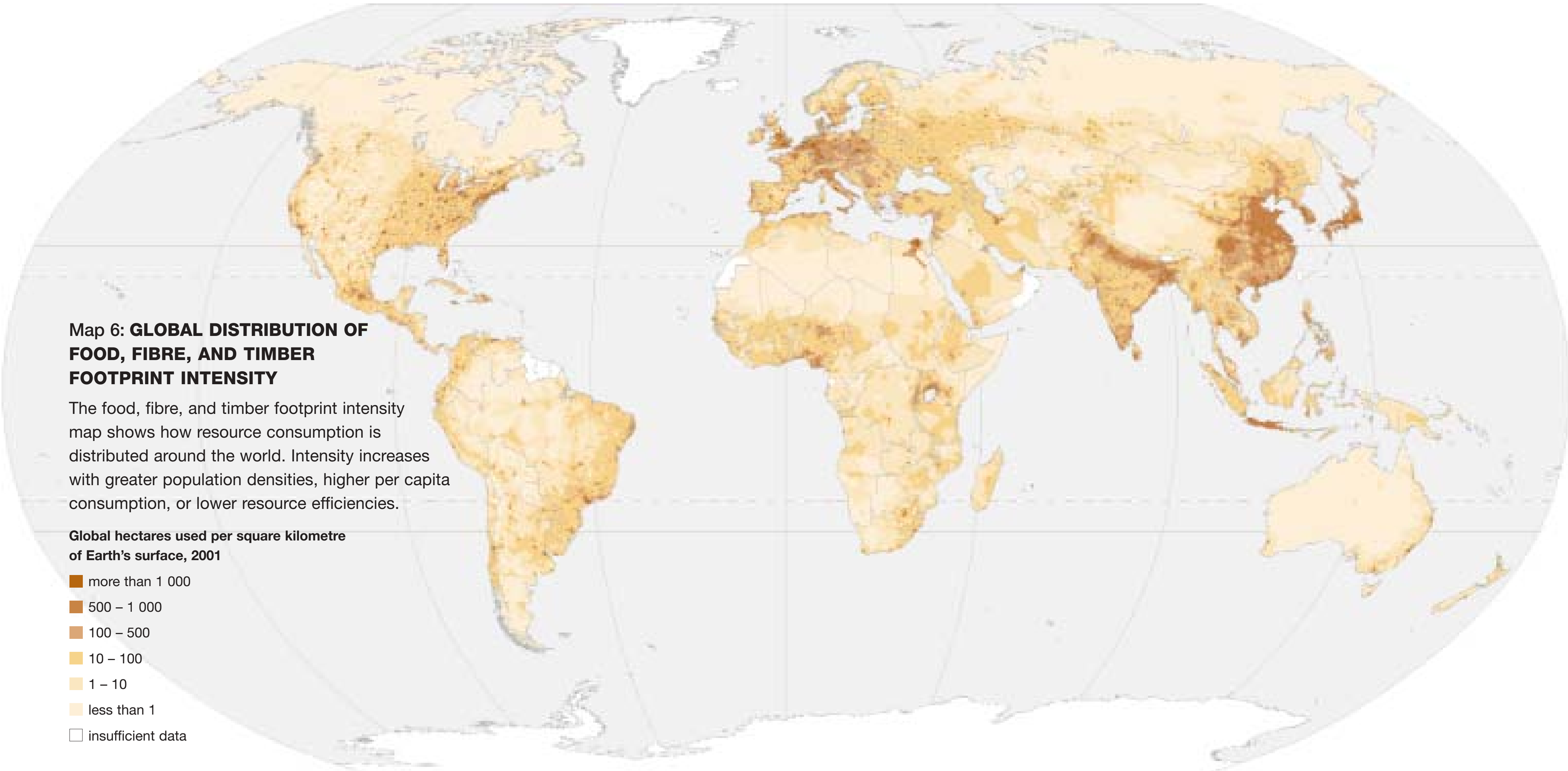


Fig. 20: **FOOD, FIBRE, AND TIMBER FOOTPRINT BY REGION,** 2001



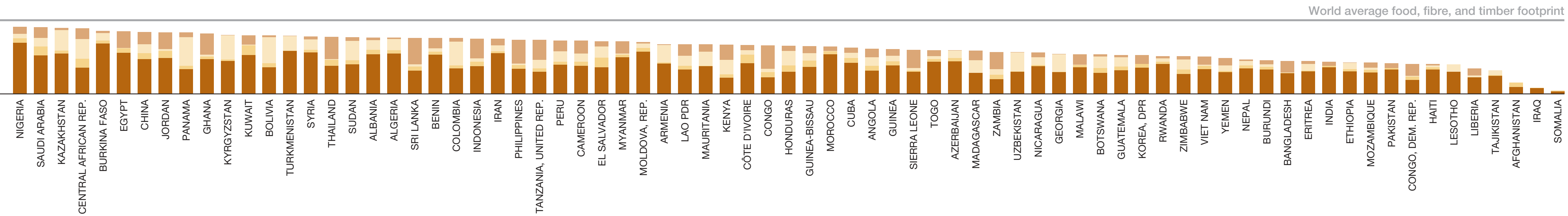


Map 6: **GLOBAL DISTRIBUTION OF FOOD, FIBRE, AND TIMBER FOOTPRINT INTENSITY**

The food, fibre, and timber footprint intensity map shows how resource consumption is distributed around the world. Intensity increases with greater population densities, higher per capita consumption, or lower resource efficiencies.

Global hectares used per square kilometre of Earth's surface, 2001

- more than 1 000
- 500 – 1 000
- 100 – 500
- 10 – 100
- 1 – 10
- less than 1
- insufficient data



ENERGY FOOTPRINT

A country's energy footprint is calculated here as the area required to provide, or absorb the waste from, fossil fuels (coal, oil, and natural gas), fuelwood, nuclear energy, and hydropower.

The fossil fuel footprint is calculated here as the area required to sequester the CO_2 released when fuels such as coal, oil, or natural gas are burnt, less the amount absorbed by the ocean. Other accounting methods are discussed on page 22. The fuelwood footprint is the area of forest needed to grow it. Nuclear power, about 4 per cent of global energy use, does not generate CO_2. Its footprint is calculated as the area required to absorb the CO_2 emitted by using the equivalent amount of energy from fossil fuels. The hydropower footprint is the area occupied by dams and their reservoirs. Neither solar nor wind power is included; their current footprint is negligible, and most solar collectors are located on built-up land, which is already counted.

National energy footprints are adjusted for the energy contained in traded goods. Energy used to manufacture a product in one country that is consumed in another is subtracted from the footprint of the producer and added to that of the consumer.

The energy footprint shows the largest per person disparity between high and low income countries. This is, in part, because people can eat only a finite amount of food while energy consumption is limited only by consumers' ability to pay.

Figure 21: National energy footprint per person, indicating fossil fuel, fuelwood, nuclear, and hydro components in 2001. Note that the world average line reflects average amount consumed, not a sustainable level.

Figure 22: The energy footprint, dominated by fossil fuels, was the fastest growing component of the global Ecological Footprint between 1961 and 2001, increasing by nearly 700 per cent over this period. Although the amount of hydroelectric power is now equivalent to nuclear power production, its footprint is too small to be clearly read on this graph.

Figure 23: Per person energy footprints in 2001 show a 14-fold difference between high and low income countries.

Fig. 21: **ENERGY FOOTPRINT PER PERSON,** by country, 2001

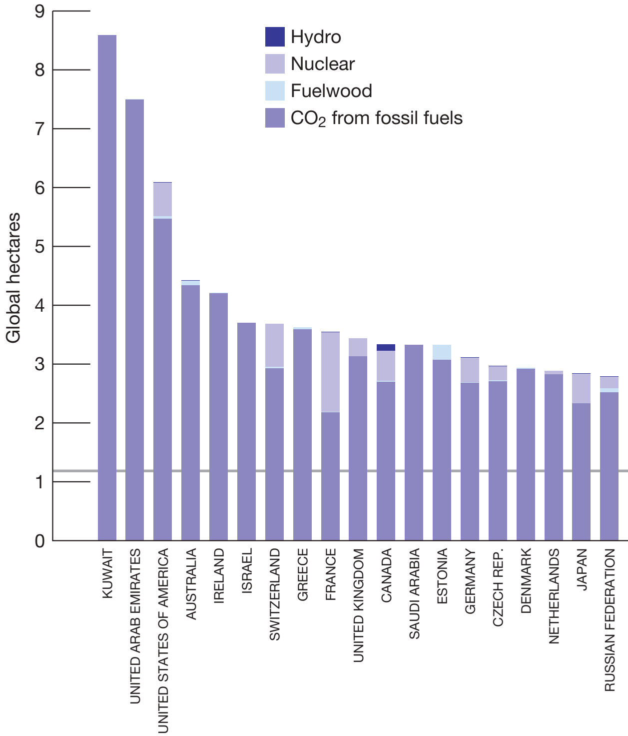
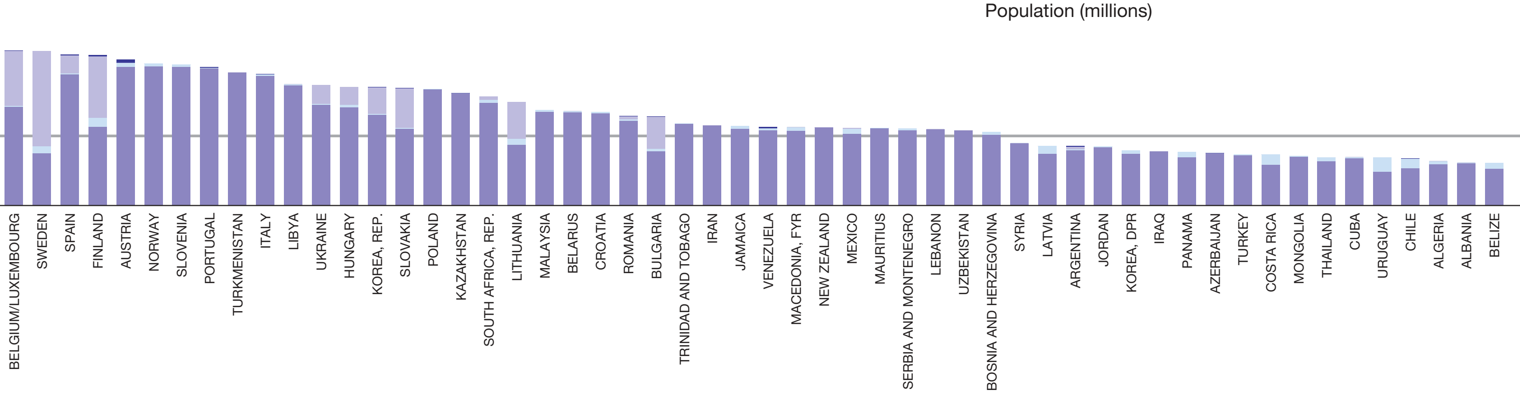



Fig. 22: **HUMANITY'S ENERGY FOOTPRINT,** 1961–2001

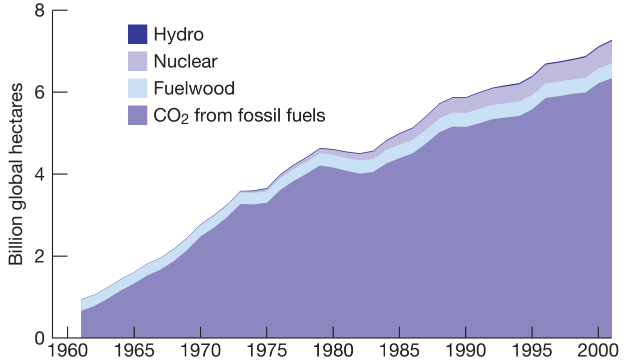
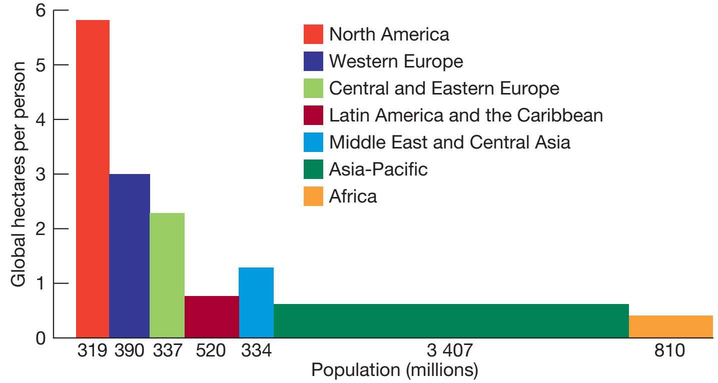
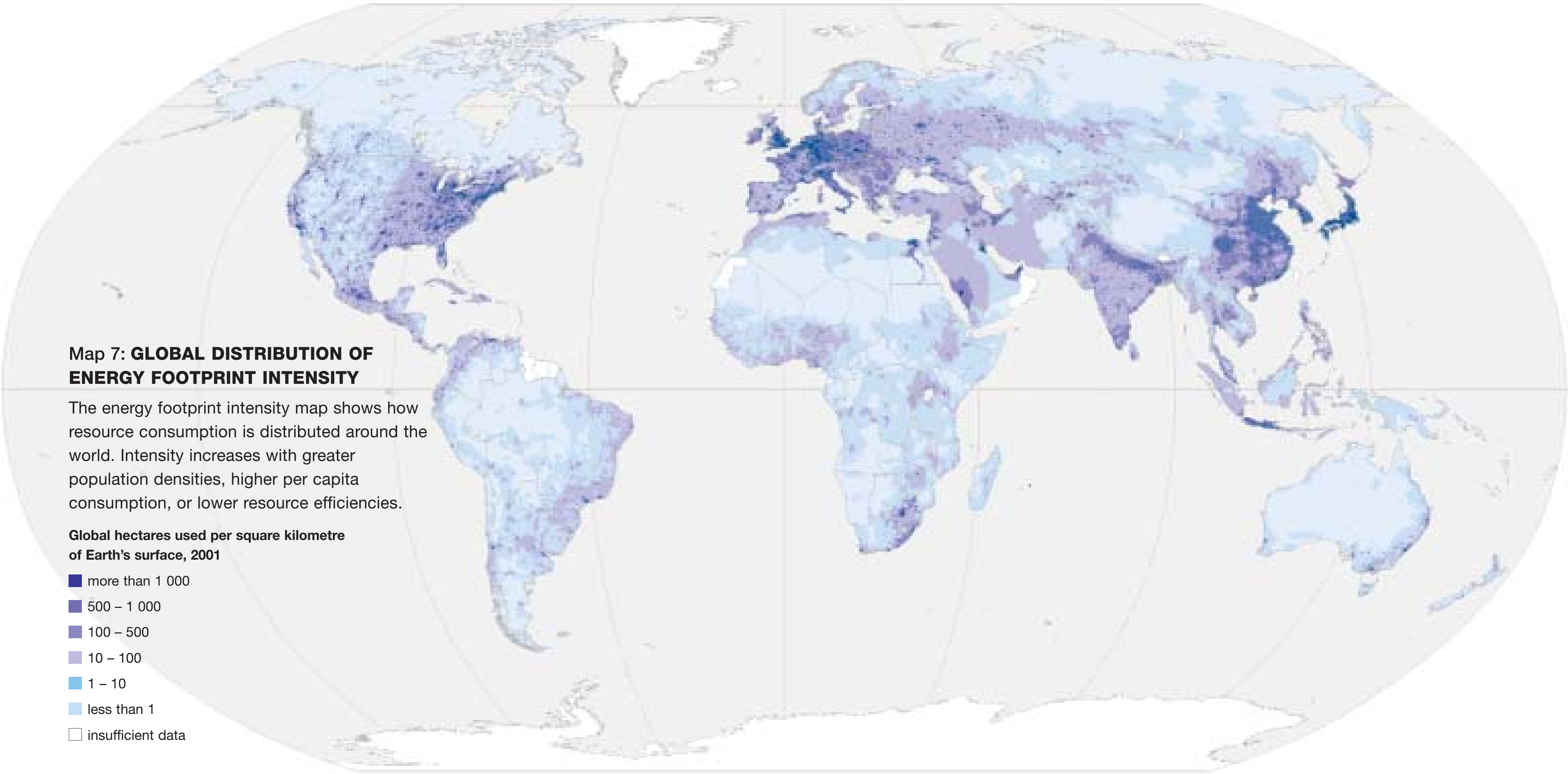


Fig. 23: **ENERGY FOOTPRINT BY REGION,** 2001



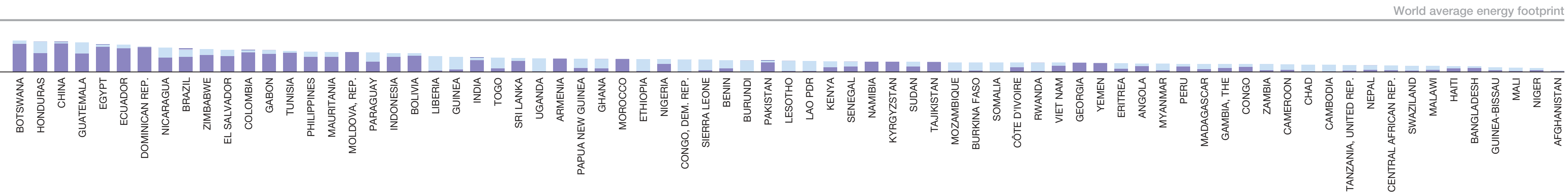


Map 7: **GLOBAL DISTRIBUTION OF ENERGY FOOTPRINT INTENSITY**

The energy footprint intensity map shows how resource consumption is distributed around the world. Intensity increases with greater population densities, higher per capita consumption, or lower resource efficiencies.

Global hectares used per square kilometre of Earth's surface, 2001

- more than 1 000
- 500 – 1 000
- 100 – 500
- 10 – 100
- 1 – 10
- less than 1
- insufficient data



WATER WITHDRAWALS

Less than 1 per cent of the world's freshwater is available as a renewable resource. The rest is locked up in ice caps, deep underground as fossil groundwater, or is geographically inaccessible or not accessible throughout the year. It is estimated that more than half of what is readily available is used by humanity.

Figure 24 shows water withdrawals per person, the quantity of water taken annually from sources such as rivers, lakes, reservoirs, or underground. Water is not normally consumed in the same way as food or fuel, as it may be returned after it has been used, although with a reduction in its quality. Therefore withdrawals are measured rather than consumption.

The map shows freshwater withdrawals as a percentage of a country's annual renewable water resources in 2001. If withdrawals exceed a threshold, which varies depending on the ecological situation but which experts put in the range of 20-40 per cent, natural ecosystems will be put under stress. Many countries already exceed this threshold, and some countries withdraw more than 100 per cent of their annual renewable resources. This is only possible by withdrawing fossil water from underground aquifers, a resource that can only be used once.

The consequences of overuse can be seen in large rivers such as the Nile, Yellow, and Colorado rivers, which are often so depleted by withdrawals for irrigation that in dry periods they fail to reach the sea. Wetlands and inland water bodies are drying up and aquifers are being drawn down faster than they replenish.

Figure 24: Freshwater withdrawals per person in 2001, showing agricultural, industrial, and domestic use (Gleick 2004).

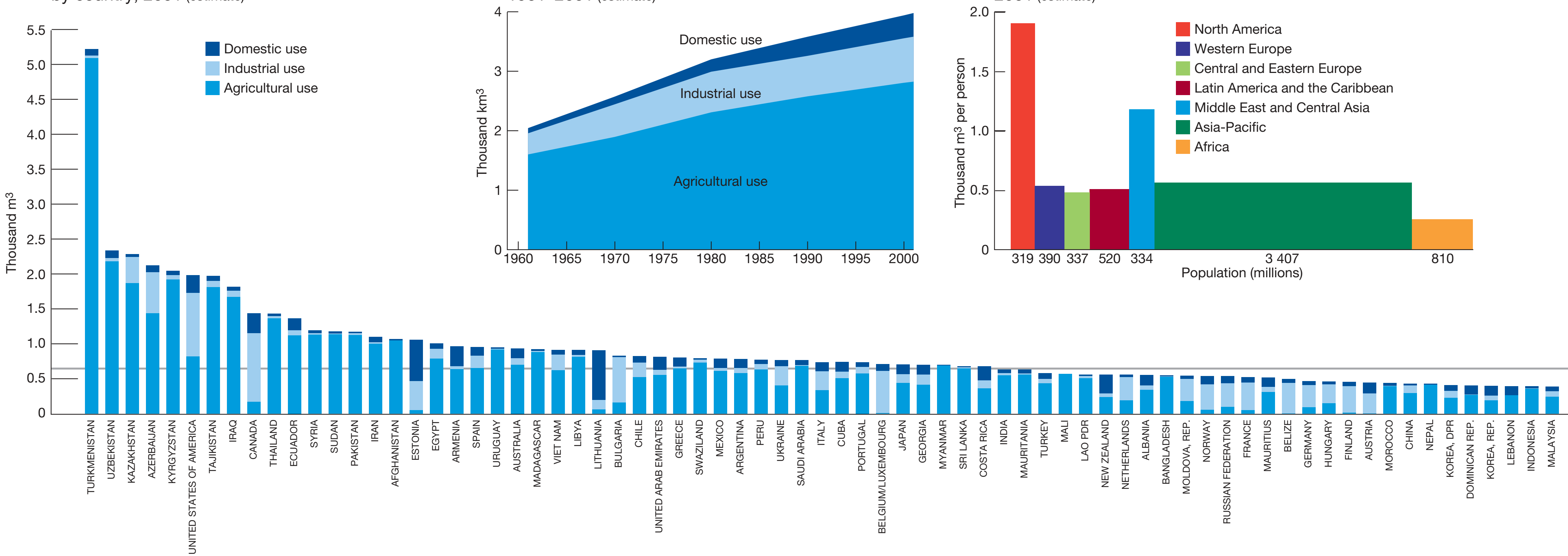
Figure 25: Global water use doubled from 1961 to 2001, an average annual increase of 1.7 per cent. Agricultural use grew by three-quarters, industrial use more than doubled, and domestic use grew more than four-fold.

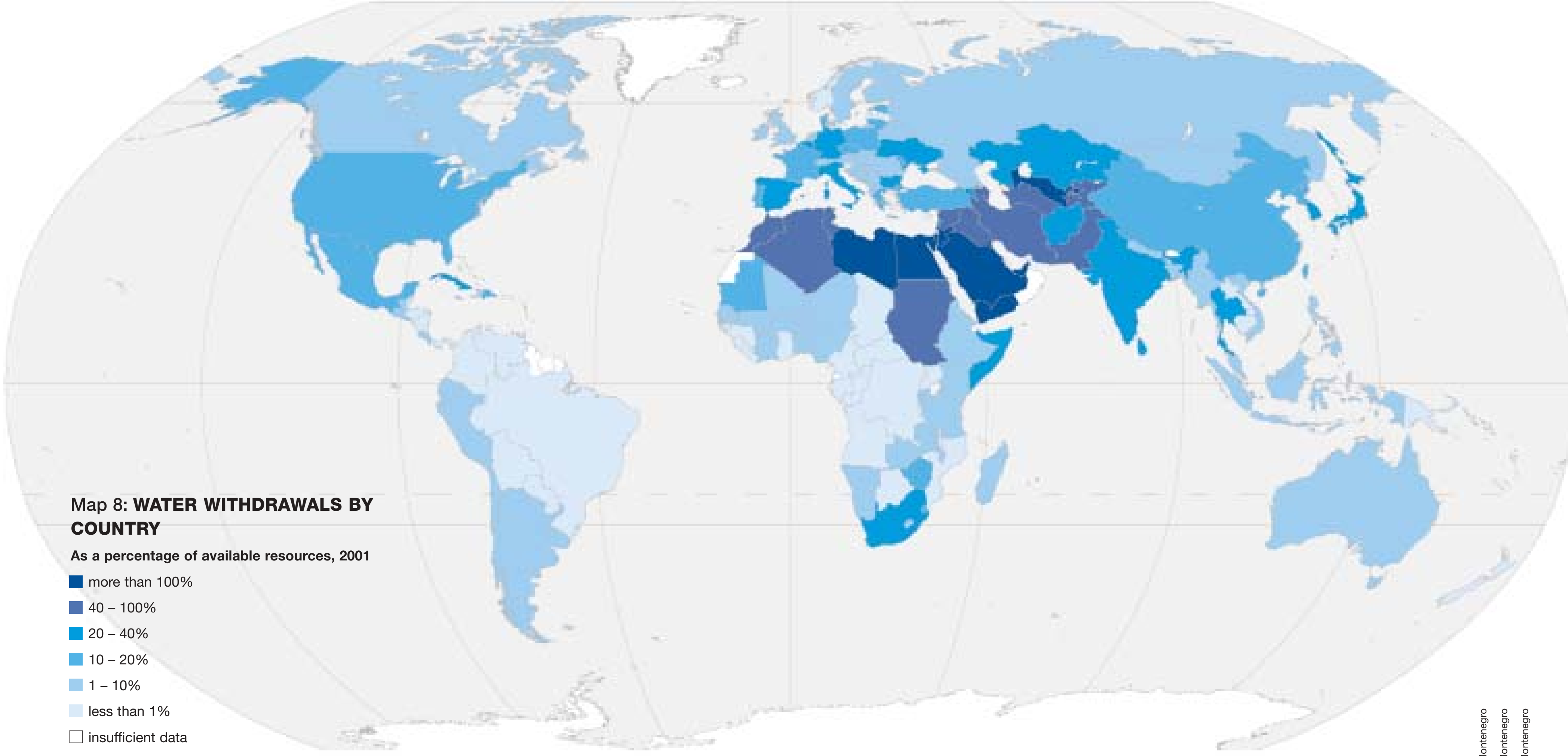
Figure 26: World average water use was about 650 cubic metres per person in 2001, ranging from around 1 900 cubic metres per person in North America to around 250 cubic metres in Africa. High income countries used about 1 000 cubic metres per person, twice as much as middle and low income countries, on average.

Fig. 24: **WATER WITHDRAWALS PER PERSON,** by country, 2001 (estimate)

Fig. 25: **WORLD WATER WITHDRAWALS,** 1961–2001 (estimate)

Fig. 26: **WATER WITHDRAWALS BY REGION,** 2001 (estimate)

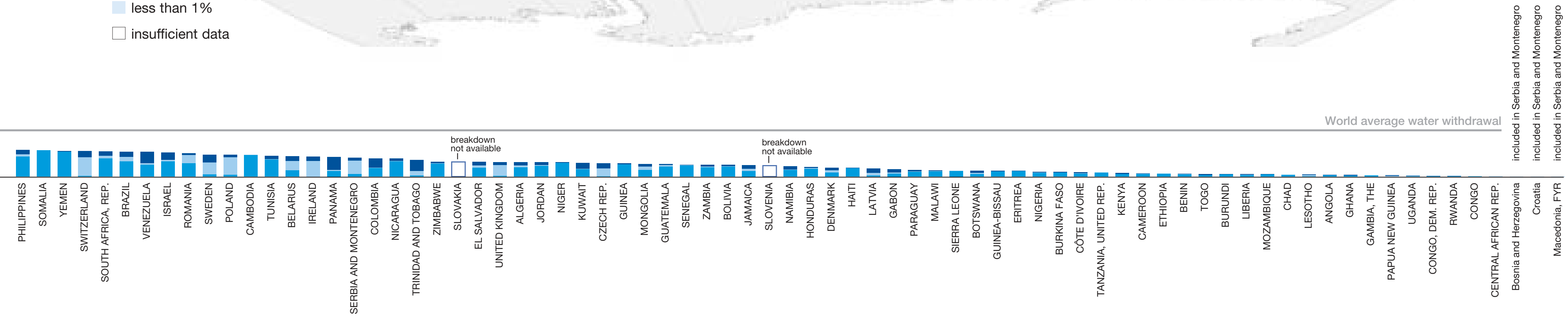




Map 8: **WATER WITHDRAWALS BY COUNTRY**

As a percentage of available resources, 2001

- more than 100%
- 40 – 100%
- 20 – 40%
- 10 – 20%
- 1 – 10%
- less than 1%
- insufficient data



ELIMINATING ECOLOGICAL DEBT

The Ecological Footprint documents humanity's past and present demand on nature. It can also help identify future consequences of current societal choices if assumptions about future technology, population, consumption levels, and biological productivity are spelled out. This section explores four possible paths into the future.

The reference scenario assumes a path of slow growth in global resource demand, based on conservative estimates from several international agencies. This path builds on moderate demographic growth leading to a population of 9 billion people by 2050 (Figure 27) (UNDESA 2003), relatively slow increases in CO_2 emissions (Figure 28) (IPCC 2000b), and the continuation of current trends in food and fibre consumption (Figure 29) (Bruinsma/FAO 2003). It assumes that improvements in technology and resource management will slowly increase total global bioproductivity at a rate similar to that of the last decade. In this scenario, humanity will be using the biological capacity of 2.3 Earths in 2050.

This "slow growth" scenario is contrasted with three possible paths that would return humanity to living within the biocapacity of the Earth (Figure 30). All these paths allocate a portion of the Earth's biocapacity for wild species, in order to preserve biodiversity. This is not to say that any of these paths will prove politically feasible; pathways are merely possibilities.

The first path shows a reduction of humanity's Ecological Footprint by 2030 to 50 per cent of the planet's biocapacity, the level proposed by biologist E O Wilson (2002). A second path shows a reduction to 67 per cent of biocapacity by mid-century. The third path shows humanity reducing its demand on ecological services to 88 per cent of the planet's biocapacity by the end of the century. This reflects the suggestion put forward by the Brundtland Commission (WCED 1987) that the remaining 12 per cent be available for wild species.

Ecological debt

The paths differ in the extent to which human demand exceeds the Earth's biocapacity, and the number of years this overshoot continues. For each of them, adding up the annual global deficits provides a measure of accumulated ecological debt. In Figure 30, this debt corresponds to the area above the "one planet" line and below the Ecological Footprint curve for each pathway.

Ecological debt is expressed in planet-years, with one planet-year equal to the bioproductivity of the Earth for one year. Between 1983 and 2001, humanity accumulated 1.5 planet-years of ecological debt. In the "slow growth" scenario, this ecological debt rises to more than 40 planet-years by 2050 and then continues to accumulate. The 50 per cent path results in a total debt of 3.5 planet-years, the 67 per cent path 6 planet-years, and the 88 per cent path 20 planet-years (Figure 31).

Ecological assets

Financial capital of one type can easily be exchanged for another type by matching monetary value. Ecological assets are less interchangeable. Overuse of one type of ecological asset, such as fisheries, cannot always be compensated for by less intense use of another, such as forests. Nevertheless, these asset types do not exist independently: if cropland is expanded at the expense of forests, fewer trees will be available to provide wood, paper, and fuel, or to absorb CO_2. If fisheries collapse, more pressure may be put on cropland for feeding domestic animals and humans. Thus ecological assets, while not homogeneous, can be considered as a whole when estimating the extent and duration of the biosphere's tolerance for overshoot.

Fig. 27: **WORLD POPULATION, UN MEDIAN PROJECTION,** 1950–2050

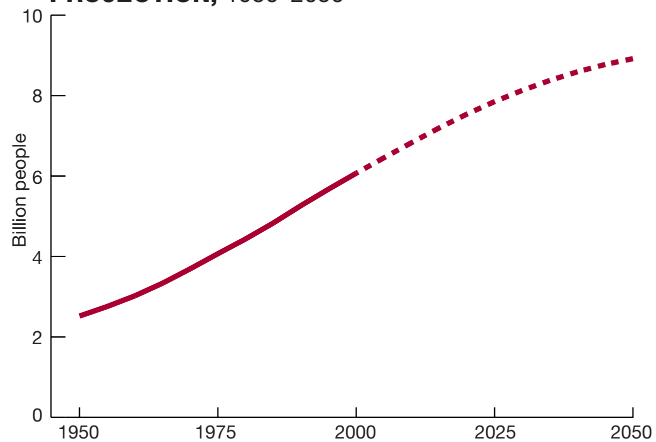


Fig. 28: **IPCC CO_2 EMISSIONS SCENARIO, B1,** 1950–2050

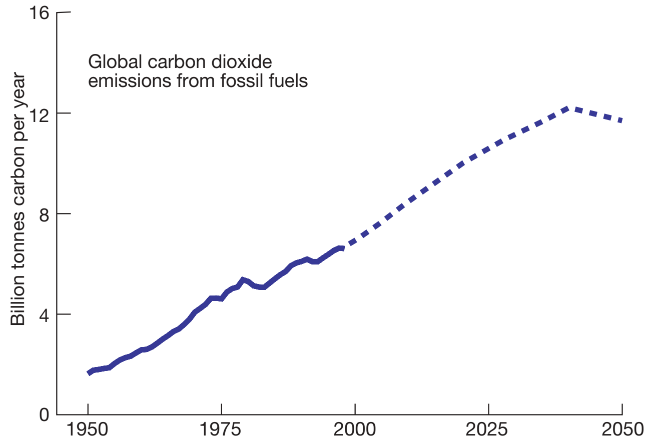
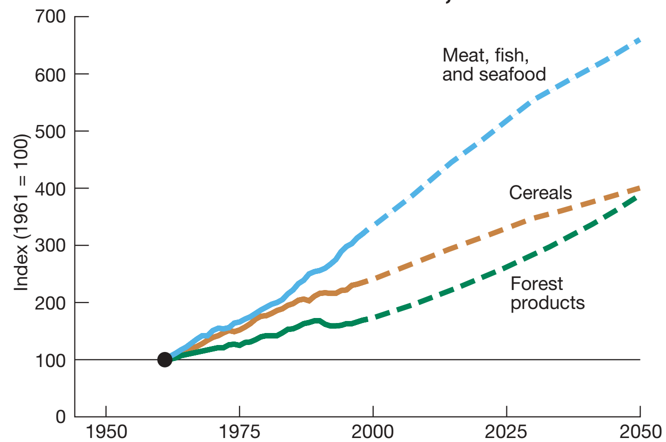


Fig. 29: **FAO FOOD AND FIBRE CONSUMPTION PROJECTIONS,** 1961–2050



Assessing risk

Forests are productive ecosystems with a large biomass stock. Each year immature, productive forests accumulate about 2 per cent of the biomass of a mature forest, making the ecological assets in a mature forest equal to 50 years of production. If the entire biocapacity of the planet were forest, the maximum possible one-time depletion would be 50 planet-years.

However, most ecosystem types have less stock available than forests and are depleted more rapidly if overused. In addition, assuming full substitutability among types of ecological assets underestimates the severity of overshoot, since overuse of one type may lead to depletion and degradation of that particular asset, even if overall demand does not indicate global overshoot. Furthermore, irreversible damage to ecosystems and ecosystem services may occur as a result of ecosystem loss. A debt of 50 planet-years may therefore be a high estimate of what the biosphere can tolerate.

This comparison helps to interpret the risk associated with each of the four pathways. The 50 per cent path, for example, is economically risky in that it requires large investments now, but ecologically the least risky, as it minimizes ecological debt. On the other hand, the 88 per cent path requires smaller financial investment up front, but runs the risk of seriously compromising the ability of the biosphere to meet humanity's demands.

Shrink and share

If overshoot is to be eliminated and biodiversity maintained, human demand for resources will need to shrink until it no longer exceeds available supply. Figure 32 shows each region's Ecological Footprint in 1961, 2001, and, according to the 67 per cent path, 2050. Two alternatives are shown for 2050, one in which each region uses two-thirds of the biocapacity available within its territory, and another in which access to global biocapacity is distributed between regions in proportion to each region's population. Neither is necessarily the correct strategy, but they represent two possible choices for sharing global biocapacity sustainably.

Figure 27: Under the UN median projection world population will grow to 9 billion by 2050, an increase of 47 per cent between 2000 and 2050.

Figure 28: Under an IPCC low emissions scenario global emissions of carbon will rise to 11.7 billion tonnes by 2050, an increase of 70 per cent from 2000.

Figure 29: FAO projections show an increase of 104 per cent in consumption of meat, fish, and seafood from 2000 to 2050, while cereal consumption is expected to increase by 71 per cent and overall forest product consumption by 87 per cent.

Figure 30: Four possible paths into the future: a "slow growth" scenario based on conservative projections from international agencies, and three approaches towards living within the planet's biocapacity.

Figure 31: Ecological debt is the result of accumulated global deficits. It will continue to grow unless the Ecological Footprint is less than the world's biocapacity.

Figure 32: Footprints for each region in 1961, 2001, and 2050 under the 67% path, assuming a future in which each region's footprint is proportional to a) its biocapacity or b) its population.

Fig. 30: **FOUR PATHS INTO THE FUTURE,** 1961–2120

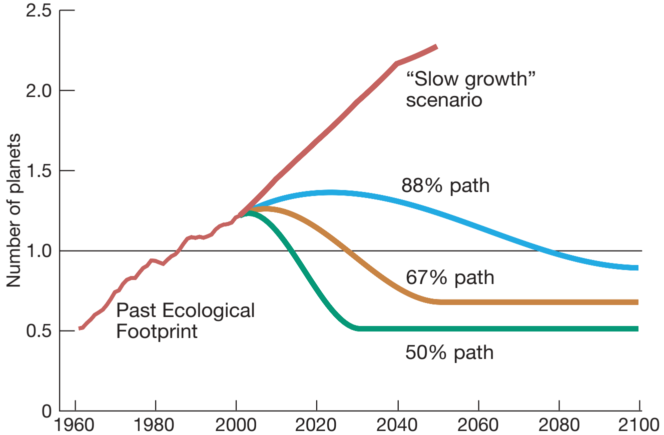


Fig. 31: **LEVELS OF ECOLOGICAL DEBT, ACTUAL AND PROJECTED**

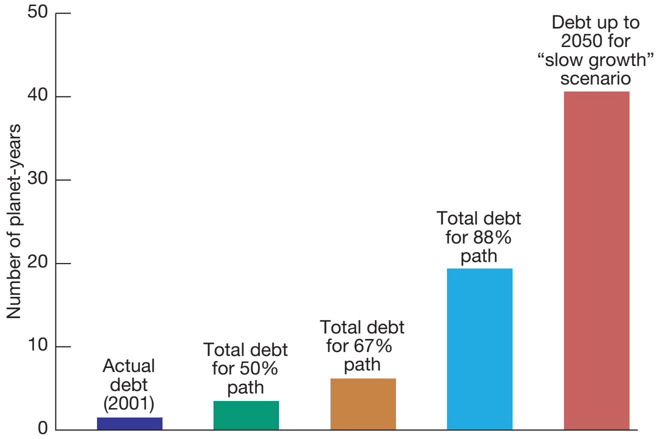
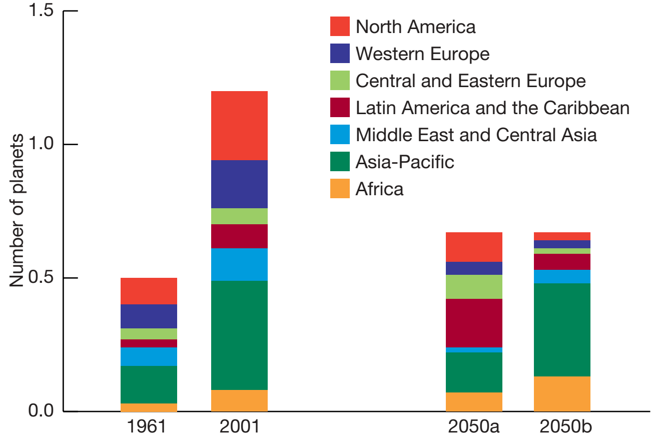


Fig. 32: **REGIONAL FOOTPRINTS: PAST, PRESENT, AND FUTURE UNDER THE 67% PATH**



ONE PLANET LIVING

Global ecological debt will continue to grow as long as the Ecological Footprint exceeds biocapacity. The resulting risk for humanity, and the Earth's biodiversity, can only be ended by shrinking and ultimately eliminating the debt – by living within the biocapacity of one planet. To succeed, such One Planet Living must be affordable, and attractive to people of divergent cultural backgrounds, living in different parts of the world.

Four factors make up the ecological debt; therefore, debt reduction requires policies and actions that lead to:

1. Increasing biocapacity by protecting, conserving, and restoring ecosystems and biodiversity, to maintain biological productivity and ecological services.

2. Lowering world population.

3. Reducing per person consumption of goods and services.

4. Improving the resource efficiency with which goods and services are produced.

Increasing biocapacity boosts the robustness of Earth's life support system. Practically, it involves establishing and maintaining networks of protected areas covering all terrestrial, freshwater, and marine ecosystem types, restoring degraded ecosystems and managing ecosystems in order to adapt to climate change. It means protecting soil from erosion and degradation, and preserving existing croplands for agriculture rather than urban and industrial development. It includes protecting river basins, wetlands, and watershed ecosystems to sustain freshwater supply. And it implies eliminating the use of toxic chemicals that degrade ecosystems.

Population growth can be reduced and eventually reversed by providing respectful and equitable support for people who choose to have fewer children. Offering women better education, economic opportunities, and health care are three proven approaches.

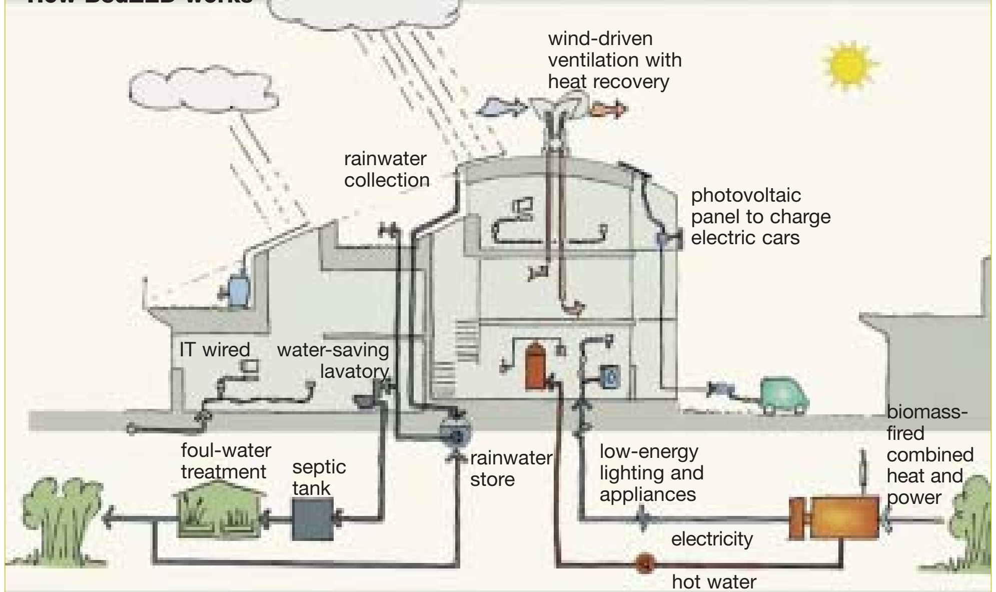
The potential for reducing per capita consumption depends in part on income level. People consuming at a level barely adequate for survival have little margin for reducing their resource use, while those in wealthy cities and countries can often shrink their footprint without compromising quality of life. In the past, the most politically acceptable way of minimizing the Ecological Footprint has been to improve the efficiency of production systems that convert energy and resources into goods and services. Over the past 40 years, technological progress has helped to compensate for much of the increase in per capita consumption, keeping the average

WHAT IS ONE PLANET LIVING?

A partnership between the BioRegional Development Group and WWF, One Planet Living is an initiative based on the experience of the Beddington Zero fossil Energy Development (BedZED). BedZED is a sustainable housing and work space project in London. Its homes and offices are highly energy efficient: it consumes 90 per cent less heating energy than average UK housing and less than half the water, and is designed so that all energy is renewably generated. Construction materials are from local, recycled, or certified well-managed sources. And although it is a compact design, residents have private gardens and conservatories. Residents find BedZED a desirable place to live, contradicting the common but erroneous assumption that a smaller Ecological Footprint means a lower quality of life.

One Planet Living aims to demonstrate how it is possible to make the challenge of living on one planet achievable, affordable, and attractive. This is relevant to all human activities, from natural resource management to sustainable agriculture, sustainable forestry or fishing, carbon-free industrial production, protected areas, and urban development. A goal is to establish One Planet Living communities on every continent by 2009, with projects under way or planned in Portugal, the United Kingdom, South Africa, North America, and China (see www.bioregional.com).

How BedZED works



Source: ARUP

Ecological Footprint per person relatively constant. But although efficiency gains are important and offer great opportunities (Pacala and Socolow 2004), they will not be enough on their own to reverse the current growth of the global Ecological Footprint.

The following actions will help create a society where all people live well, within the capacity of one planet.

1. **Improving information for decision making by**
- Providing better quality and quantity of information in the media. Governments and companies will not receive appropriate signals from citizens and consumers unless the public is well informed.
- Presenting responsible and accurate product information so that consumers are not misled by advertising.
- Encouraging wide use of corporate environmental reporting to show which companies are making efforts to become sustainable, and how.
- Supporting public information and education campaigns on sustainability challenges and opportunities covering issues such as climate change, forests, and fisheries.
- Asking governments to measure and report on more comprehensive indicators of social, economic, and ecological performance to complement existing economic measures like GDP, trade balance, and rate of inflation.
- Encouraging full cost pricing for all goods and services from energy to water.

2. **Advancing product design and urban infrastructure by**
- Making transport pricing reflect the full social and environmental costs of road and air travel, and encouraging public transport.
- Implementing comprehensive waste reduction systems which include municipal resource reuse and recycling, and give priority to preventing the release of hazardous substances.
- Introducing building design requirements that lead to reductions in waste generation and energy use.

3. **Using markets and regulation by**
- Providing incentives for financial markets to favour long-term sustainability over short-term gains. Pension funds and insurance companies in particular have opportunities to invest in ecologically responsible ways and divest their interests in unsustainable activities.
- Allowing governments to adjust market frameworks and provide regulatory and fiscal incentives to become less resource intensive and minimize waste.
- Creating incentives for promoting renewable energy and energy efficiency technologies.

4. **Enhancing international cooperation by**
- Pressuring governments to move from short-term national self-interests to long-term global common interests. In a global economy, governments rarely engage in unilateral action on international issues such as climate change, biodiversity conservation, or management of the oceans. International conventions and treaties encourage equitable solutions to sustainability challenges.

Globally, One Planet Living is possible, and compatible with meaningful and rewarding lives for all. High rates of material and energy consumption are not necessary to support a decent standard of living. As Meadows et al. (2004) suggest in *Limits to Growth: The 30-Year Update*: “We don’t think a sustainable society need be stagnant, boring, uniform, or rigid. It need not be, and probably could not be, centrally controlled or authoritarian. It could be a world that has the time, the resources, and the will to correct its mistakes, to innovate, to preserve the fertility of its planetary ecosystems. It could focus on mindfully increasing the quality of life rather than on mindlessly expanding material consumption…”.

INNOVATIVE ACTION

There are many ways in which new coalitions of business leaders, members of governments, and civil society can develop innovative models for tackling the challenges of living within the capacity of one planet. These actors have the power to bring sustainable development to the centre-stage. An example is the power sector. Significant CO_2 savings could be made by switching to green electricity or reducing energy demand through basic energy efficiency measures. These alternatives could become attractive more rapidly if the price for electricity generated from fossil fuel reflected its full costs.

Individual …if consumers bought green electricity where it was available, it would encourage utilities to produce more clean energy.

Corporate …if utilities paid the true cost of coal it would encourage them to switch to less carbon-intensive energy sources.

Governmental …governments could encourage the building of cleaner power plants by setting robust carbon caps in emissions trading systems.

International …to make sure that perverse cap and trade systems do not emerge in different countries, international agreements, such as the Kyoto Protocol, should enter into force and post-2012 agreements should include an equitable global cap and trade system.

ECOLOGICAL FOOTPRINT: FREQUENTLY ASKED QUESTIONS

What is included in the Ecological Footprint? What is excluded?

To avoid exaggerating human demand on nature, the Ecological Footprint includes only those aspects of resource consumption and waste production that are potentially sustainable, and for which there are data that allow this demand to be expressed in terms of the area required.

Since nature has no significant absorptive capacity for heavy metals, radioactive materials such as plutonium, or persistent synthetic compounds (e.g. chlordane, PCBs, CFCs, PVCs, dioxins), sustainability requires eliminating the release of such substances into the biosphere. Also, the impacts of many other waste flows are poorly captured by the present Ecological Footprint accounts. For example, accurate data on the reduction of biocapacity due to acid rain are not yet available, and so are not included in the accounts.

Water is addressed only indirectly in Ecological Footprint accounts. Overuse of freshwater affects present and future plant growth, reflected as changes in biocapacity. Further, the Ecological Footprint includes the energy needed to supply and treat water, and the area occupied by reservoirs.

Ecological Footprint accounts provide snapshots of past resource demand and availability. They do not predict the future. Thus, the Ecological Footprint does not estimate future losses caused by present degradation of ecosystems, be it soil salination or loss, deforestation, or destruction of fisheries through bottom trawling. These impacts will, however, be reflected in future Ecological Footprint accounts as a loss of biocapacity. Footprint accounts also do not indicate the intensity with which a biologically productive area is being used. Intensity can lead to degradation, but not always. For example, in China yields of cultivated rice have remained stable for more than a thousand years. While the Ecological Footprint captures overall demand on the biosphere, it does not pinpoint specific biodiversity pressures. It only summarizes the overall risk biodiversity is facing. Lastly, the Ecological Footprint does not evaluate the social and economic dimension of sustainability.

How is fossil fuel accounted for?

The Ecological Footprint measures humanity's past and present demand on nature. Although fossil fuels such as coal, oil, and natural gas are extracted from the Earth's crust and not regenerated in human time scales, their use still requires ecological services. Burning these fuels puts pressure on the biosphere as the resulting CO_2 accumulates in the atmosphere, contributing to global warming. The Ecological Footprint includes the biocapacity needed to sequester this CO_2, less the amount absorbed by the ocean. One global hectare can absorb the CO_2 released from consuming 1 450 litres of gasoline per year.

The fossil fuel footprint does not suggest that carbon sequestration is the key to resolving global warming. Rather, it points out the lack of ecological capacity for coping with excess CO_2, and underlines the importance of reducing CO_2 emissions. The sequestration rate used in Ecological Footprint calculations is based on an estimate of how much human-induced carbon emissions the world's forests can currently remove from the atmosphere and retain. This rate approaches zero as the forests mature, so sequestration is time limited. Further, global warming may turn forests from carbon sources to carbon sinks, reducing sequestration even more. Hence, carbon "credits" from forests may be deceptive since they do not permanently remove carbon from the atmosphere but only delay fossil fuels' carbon emission to the atmosphere.

Energy efficiency may be the most cost-effective way to reduce the energy footprint. On the supply side, renewable energy technologies such as biomass, solar thermal and photovoltaic, wind, hydropower, ocean thermal, geothermal, and tidal power have the potential to reduce the size of the energy footprint significantly too. With the exception of firewood and hydroelectricity (which is close to saturation in industrialized countries), renewables provide collectively less than 1 per cent of global power (Aitken 2004, Hoffert et al. 2002). Biomass can produce carbon-neutral fuels for power plants or transportation, and has a huge potential in industrialized as well as developing countries. But since photosynthesis has a low power density, it requires a large surface area. In contrast, photovoltaic cells, thermal solar collectors, and wind turbines take up less land, and it need not be biologically productive land. However, the present costs and the intermittent nature of these energy resources make them less attractive in most of today's markets.

Are current biological yields likely to be sustainable?

In calculating the national footprints, yields for forests and fisheries as reported by the Food and Agriculture Organization of the United Nations (FAO) are used. These are estimates of the maximum amount of a single species stock that can be harvested without reducing the stock's productivity over time. With many fisheries in decline, there are strong indications that the reported fishery yields are too optimistic. In fact, research suggests that fisheries exploited above 75 per cent capacity risk becoming unstable (Roughgarden and Smith 1996).

If current overuse leads to lower yields in the future, this will be reflected in future biocapacity assessments. Harvesting at or below the maximum level that can be regenerated is a necessary condition for sustainability. Yet it is not sufficient. Taking less than the "maximum sustainable yield" can still cause ecological damage if harvests cause unintended damage to ecosystems, if there is local overuse, or if insufficient area is protected for wild species.

How is international trade taken into account?

The Ecological Footprint accounts calculate each country's net consumption by adding its imports to its production, and subtracting its exports. This means that the resources used for producing a car that is manufactured in Germany, but sold and used in France, will contribute to the French, not the German, footprint.

The resulting "apparent consumption" can be distorted since the waste generated in making products for export is insufficiently documented. This can exaggerate the footprint of countries whose economies produce largely for export, and understate that of importing countries. Similarly, because relevant data are unavailable, resource demands associated with tourism are included in the destination country's footprint. These demands should instead be assigned to the tourist's country of residence. While these misallocations distort the national averages, they do not bias the overall global Ecological Footprint.

What about built-up land?
The area required to accommodate infrastructure for housing, transport, industrial production, and hydropower occupies a significant portion of the world's bioproductive land. In 2001, the footprint for built-up area was 0.44 billion global hectares, but the accuracy of this calculation is limited by uncertainties in the underlying data. For instance, in urban areas are gardens differentiated from paved-over surfaces? How much of a road's shoulder and corridor is included? Even high-resolution satellite images cannot adequately distinguish between these different types of surface.

Since historically cities have been located in fertile agricultural areas with moderate climates and access to freshwater, Ecological Footprint accounts assume that built-up area occupies average cropland. This may underestimate the footprint of built-up area, since many cities are in fact located on the best farmland, with higher than average productivity. However, this may be balanced out again by built-up area on marginal land. While the physical compactness of infrastructure directly affects the footprint for built-up area, it also influences other footprint components. For example, larger homes on larger plots require more resources and energy for heating, cooling, and furnishing, and this low density housing typically increases private car use and makes public transport systems less efficient.

Figure 33: In Latin America unique forests and savannahs are being converted to soy fields. Some of the protein-rich soy becomes feed for European livestock, while some is exported to China for direct human consumption. The graph shows Brazil's rapidly growing crop area for soy which has increased almost 60-fold since 1961, rising from 0.24 million hectares to almost 14 million hectares in 2001 (Casson 2003, FAO 2004b).

Figure 34: Range of footprints of renewable energy technologies in comparison with fossil fuels. The size of the energy footprint of biofuels varies widely depending on the amount of energy needed to convert the crop into a fuel.

Figure 35: In low and middle income countries the average person's footprint has changed little over the past 40 years, and declined by 8 per cent in the ten years before 2001. The average person's footprint in high income countries was almost three times larger in 1961 than in low and middle income countries, and has grown considerably since, including an 8 per cent increase in the ten years before 2001.

Table 1: **POPULATION AND FOOTPRINT, BY INCOME GROUP,** 1961-2001

	Population (millions)	Total footprint (billion global ha)	Footprint per person (global ha/person)
High income countries			
1961	670	2.576	3.8
1971	744	3.828	5.1
1981	805	4.369	5.4
1991	860	5.097	5.9
2001	920	5.893	6.4
Middle and low income countries			
1961	2 319	3.303	1.4
1971	3 006	4.323	1.4
1981	3 685	5.762	1.6
1991	4 463	7.099	1.6
2001	5 197	7.602	1.5

Fig. 33: **EXPANSION OF BRAZIL'S SOY CROP AREA,** 1961–2001

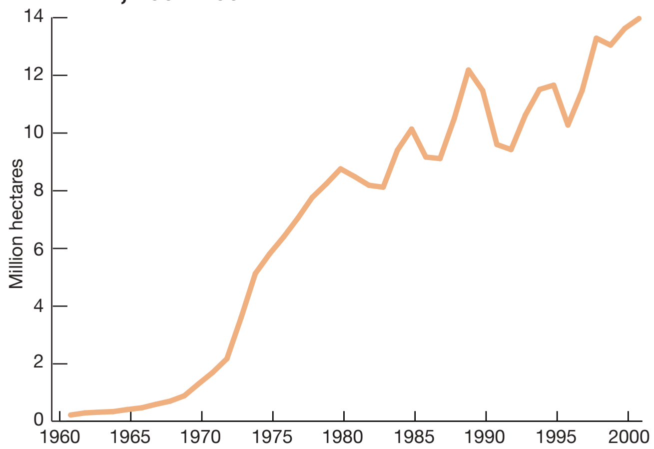


Fig. 34: **COMPARING THE FOOTPRINTS OF ENERGY TECHNOLOGIES**

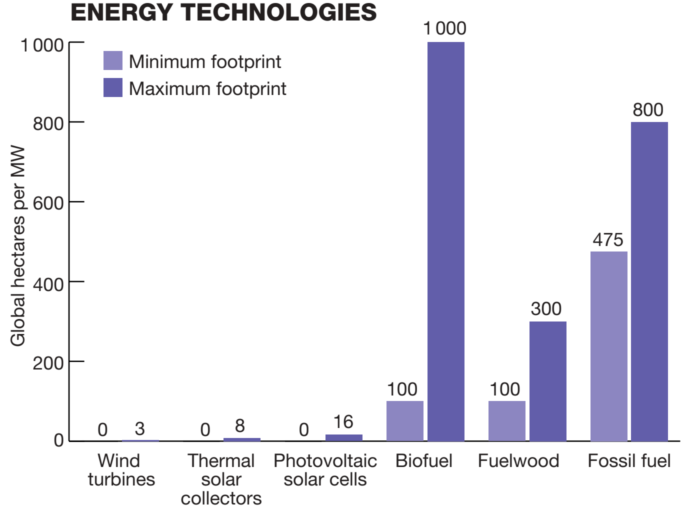


Fig. 35: **ECOLOGICAL FOOTPRINT PER PERSON,** by income group, 1961–2001

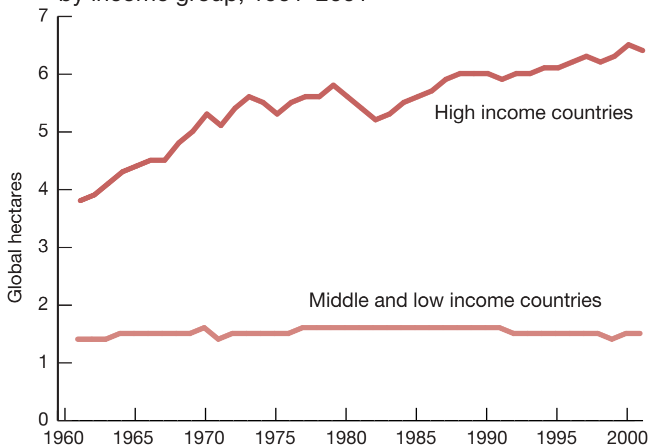


Table 2: ECOLOGICAL FOOTPRINT AND BIOCAPACITY

2001 data *See notes on pages 33-37*	Population (millions)	Total Ecological Footprint (global ha/person)	Total food, fibre, and timber footprint (global ha/person)	Included in total food, fibre, and timber: Cropland (global ha/person)	Forest (global ha/person)	Grazing land (global ha/person)	Fishing ground (global ha/person)	Total energy footprint (global ha/person)	Included in total energy: CO_2 from fossil fuels (global ha/person)	Fuelwood (global ha/person)	Nuclear (global ha/person)	Hydro (global ha/person)
WORLD	**6 148.1**	**2.2**	**0.9**	**0.49**	**0.18**	**0.14**	**0.13**	**1.2**	**1.03**	**0.06**	**0.09**	**0.00**
High income countries	**920.1**	**6.4**	**2.2**	**0.82**	**0.80**	**0.26**	**0.33**	**4.0**	**3.44**	**0.02**	**0.49**	**0.01**
Middle income countries	**2 970.8**	**1.9**	**0.9**	**0.50**	**0.12**	**0.15**	**0.15**	**0.9**	**0.85**	**0.05**	**0.02**	**0.00**
Low income countries	**2 226.3**	**0.8**	**0.5**	**0.35**	**0.03**	**0.03**	**0.09**	**0.3**	**0.20**	**0.09**	**0.00**	**0.00**
AFRICA	**810.2**	**1.2**	**0.7**	**0.42**	**0.06**	**0.08**	**0.13**	**0.4**	**0.27**	**0.13**	**0.00**	**0.00**
Algeria	30.7	1.5	0.7	0.51	0.04	0.14	0.02	0.8	0.70	0.05	0.00	0.00
Angola	12.8	0.8	0.6	0.30	0.06	0.11	0.11	0.2	0.13	0.05	0.00	0.00
Benin	6.4	1.0	0.7	0.50	0.04	0.04	0.13	0.3	0.08	0.19	0.00	0.00
Botswana	1.8	1.3	0.5	0.27	0.06	0.15	0.03	0.7	0.64	0.07	0.00	0.00
Burkina Faso	12.3	1.1	0.8	0.64	0.03	0.10	0.03	0.2	0.03	0.19	0.00	0.00
Burundi	6.4	0.7	0.4	0.31	0.04	0.03	0.05	0.3	0.01	0.25	0.00	0.00
Cameroon	15.4	0.9	0.7	0.36	0.05	0.11	0.16	0.2	0.05	0.12	0.00	0.00
Central African Rep.	3.8	1.1	0.8	0.33	0.11	0.26	0.14	0.1	0.04	0.11	0.00	0.00
Chad	8.1	1.3	1.1	0.51	0.07	0.16	0.35	0.2	0.01	0.15	0.00	0.00
Congo	3.5	0.9	0.6	0.21	0.07	0.04	0.30	0.2	0.11	0.07	0.00	0.00
Congo, Dem. Rep.	49.8	0.7	0.4	0.18	0.04	0.01	0.15	0.3	0.01	0.27	0.00	0.00
Côte d'Ivoire	16.1	0.9	0.6	0.39	0.11	0.06	0.07	0.2	0.10	0.11	0.00	0.00
Egypt	69.1	1.5	0.8	0.52	0.05	0.00	0.22	0.6	0.58	0.05	0.00	0.00
Eritrea	3.8	0.7	0.4	0.29	0.01	0.09	0.04	0.2	0.07	0.12	0.00	0.00
Ethiopia	67.3	0.7	0.4	0.29	0.03	0.08	0.01	0.3	0.02	0.27	0.00	0.00
Gabon	1.3	1.7	1.1	0.45	0.03	0.07	0.56	0.5	0.42	0.08	0.00	0.00
Gambia, The	1.4	1.1	0.9	0.65	0.06	0.04	0.14	0.2	0.09	0.09	0.00	0.00
Ghana	20.0	1.1	0.8	0.44	0.03	0.02	0.27	0.3	0.08	0.21	0.00	0.00
Guinea	8.2	1.0	0.6	0.36	0.05	0.07	0.08	0.3	0.05	0.29	0.00	0.00
Guinea-Bissau	1.4	0.7	0.6	0.34	0.08	0.09	0.09	0.1	0.04	0.06	0.00	0.00
Kenya	31.1	0.9	0.6	0.20	0.04	0.18	0.20	0.2	0.11	0.13	0.00	0.00
Lesotho	1.8	0.6	0.4	0.28	0.00	0.09	0.00	0.3	0.02	0.23	0.00	0.00
Liberia	3.1	0.7	0.3	0.21	0.00	0.02	0.09	0.4	0.03	0.32	0.00	0.00
Libya	5.3	3.1	1.0	0.72	0.04	0.13	0.08	2.1	2.04	0.02	0.00	0.00
Madagascar	16.4	0.8	0.6	0.27	0.00	0.16	0.12	0.2	0.06	0.12	0.00	0.00
Malawi	11.6	0.7	0.5	0.34	0.03	0.00	0.13	0.1	0.05	0.09	0.00	0.00
Mali	12.3	1.1	1.0	0.50	0.02	0.16	0.30	0.1	0.02	0.08	0.00	0.00
Mauritania	2.7	1.1	0.6	0.35	0.00	0.18	0.09	0.5	0.34	0.11	0.00	0.00
Mauritius	1.2	2.4	0.9	0.50	0.12	0.01	0.28	1.3	1.32	0.00	0.00	0.00
Morocco	29.6	0.9	0.6	0.50	0.04	0.00	0.06	0.3	0.29	0.00	0.00	0.00
Mozambique	18.2	0.7	0.4	0.27	0.03	0.03	0.06	0.2	0.03	0.19	0.00	0.00
Namibia	1.9	1.6	1.2	0.49	0.00	0.28	0.44	0.2	0.23	0.00	0.00	0.00
Niger	11.1	1.1	1.0	0.82	0.03	0.09	0.04	0.1	0.04	0.05	0.00	0.00

Built-up land[†] (global ha/person)	Total biocapacity (global ha/person)	Included in total biocapacity: Cropland (global ha/person)	Grazing land (global ha/person)	Forest (global ha/person)	Fishing ground (global ha/person)	Ecological deficit* (global ha/person)	Ecological Footprint change per capita** (% change 1991-2001)	Biocapacity change per capita** (% change 1991-2001)	Water withdrawals est.*** (thousand m3/ person/year)	Water resources est.*** (thousand m3/ person/year)	2001 data *See notes on pages 33-37*
0.07	**1.8**	**0.53**	**0.27**	**0.81**	**0.13**	**0.4**	**-2**	**-12**	**0.65**	**8.87**	**WORLD**
0.23	**3.3**	**1.12**	**0.33**	**1.57**	**0.31**	**3.1**	**8**	**-7**	**1.03**	**10.24**	**High income countries**
0.07	**2.0**	**0.51**	**0.30**	**1.07**	**0.13**	**-0.1**	**-5**	**-10**	**0.54**	**11.10**	**Middle income countries**
0.05	**0.7**	**0.32**	**0.19**	**0.13**	**0.07**	**0.1**	**-11**	**-16**	**0.55**	**5.45**	**Low income countries**
0.06	**1.3**	**0.38**	**0.51**	**0.28**	**0.12**	**-0.13**	**-5**	**-18**	**0.26**	**6.85**	**AFRICA**
0.04	0.7	0.25	0.35	0.01	0.01	0.8	1	-17	0.20	0.47	Algeria
0.05	3.5	0.25	2.45	0.32	0.46	-2.7	9	-22	0.03	14.41	Angola
0.04	0.7	0.47	0.06	0.09	0.08	0.3	-10	-12	0.04	3.88	Benin
0.04	4.3	0.11	3.02	1.15	0.00	-3.1	-4	-22	0.08	8.23	Botswana
0.10	1.0	0.58	0.24	0.06	0.01	0.1	4	-3	0.06	1.02	Burkina Faso
0.04	0.6	0.30	0.21	0.06	0.03	0.1	-22	-21	0.04	0.56	Burundi
0.06	1.4	0.63	0.14	0.46	0.11	-0.5	-3	-19	0.05	18.50	Cameroon
0.07	3.7	0.59	0.71	2.37	0.00	-2.7	-9	-19	0.01	38.30	Central African Rep.
0.08	2.8	0.49	1.87	0.14	0.18	-1.4	-6	-24	0.03	5.31	Chad
0.06	8.1	0.10	3.97	3.77	0.25	-7.3	-40	-27	0.01	234.90	Congo
0.05	1.6	0.17	0.37	0.98	0.07	-0.9	-19	-24	0.01	25.77	Congo, Dem. Rep.
0.06	2.1	0.79	0.75	0.42	0.04	-1.2	-5	-9	0.06	5.03	Côte d'Ivoire
0.12	0.5	0.30	0.00	0.00	0.08	1.0	4	-1	0.99	0.84	Egypt
0.05	0.7	0.12	0.31	0.00	0.24	-0.1	-12	-25	0.08	1.64	Eritrea
0.04	0.5	0.23	0.16	0.10	0.00	0.2	-2	-36	0.04	1.64	Ethiopia
0.06	20.1	0.49	4.85	12.85	1.83	-18.4	-2	-23	0.10	127.83	Gabon
0.05	1.0	0.42	0.16	0.08	0.28	0.1	-2	-13	0.02	5.92	Gambia, The
0.05	1.3	0.45	0.34	0.37	0.11	-0.2	11	-15	0.03	2.66	Ghana
0.06	2.8	0.27	1.11	1.01	0.36	-1.8	-3	-21	0.18	27.42	Guinea
0.04	3.0	0.39	0.45	0.61	1.55	-2.3	-16	-26	0.08	22.03	Guinea-Bissau
0.04	0.7	0.19	0.35	0.04	0.12	0.2	-12	-24	0.05	0.97	Kenya
0.02	1.1	0.14	0.89	0.00	0.00	-0.4	-1	-5	0.03	1.68	Lesotho
0.06	3.4	0.23	0.88	1.94	0.30	-2.7	-20	-30	0.04	74.86	Liberia
0.04	1.0	0.36	0.28	0.02	0.32	2.0	9	-18	0.90	0.11	Libya
0.06	3.1	0.26	1.20	1.33	0.24	-2.3	-14	-25	0.91	20.50	Madagascar
0.05	0.5	0.30	0.11	0.03	0.07	0.1	-21	-14	0.09	1.49	Malawi
0.06	1.5	0.46	0.78	0.04	0.15	-0.4	-10	-21	0.57	8.16	Mali
0.06	6.0	0.16	4.29	0.00	1.45	-4.8	-14	-24	0.62	4.19	Mauritania
0.18	1.2	0.22	0.00	0.01	0.82	1.2	27	-12	0.51	1.84	Mauritius
0.00	0.7	0.29	0.00	0.12	0.27	0.2	-5	-28	0.43	0.98	Morocco
0.04	2.1	0.21	1.40	0.42	0.04	-1.5	2	-21	0.04	11.87	Mozambique
0.12	4.5	0.61	1.99	0.00	1.77	-2.9	24	-22	0.14	9.30	Namibia
0.06	1.2	0.73	0.35	0.04	0.02	-0.1	-12	-15	0.20	3.02	Niger

2001 data	Population	Total Ecological Footprint	Total food, fibre, and timber footprint	Included in total food, fibre, and timber				Total energy footprint	Included in total energy			
	(millions)	(global ha/person)	(global ha/person)	Cropland (global ha/person)	Forest (global ha/person)	Grazing land (global ha/person)	Fishing ground (global ha/person)	(global ha/person)	CO_2 from fossil fuels (global ha/person)	Fuelwood (global ha/person)	Nuclear (global ha/person)	Hydro (global ha/person)
Nigeria	117.8	1.2	0.9	0.65	0.06	0.05	0.09	0.3	0.19	0.10	0.00	0.00
Rwanda	8.1	0.7	0.5	0.38	0.03	0.04	0.03	0.2	0.02	0.19	0.00	0.00
Senegal	9.6	1.2	0.9	0.49	0.07	0.13	0.25	0.2	0.13	0.11	0.00	0.00
Sierra Leone	4.6	0.9	0.6	0.28	0.02	0.03	0.23	0.3	0.04	0.24	0.00	0.00
Somalia	9.1	0.4	0.0	0.03	0.01	0.00	0.00	0.2	0.00	0.21	0.00	0.00
South Africa, Rep.	44.4	2.8	0.9	0.37	0.25	0.19	0.05	1.9	1.74	0.06	0.05	0.00
Sudan	32.2	1.0	0.7	0.38	0.05	0.25	0.05	0.2	0.12	0.11	0.00	0.00
Swaziland	1.1	1.1	0.9	0.32	0.21	0.32	0.04	0.1	0.03	0.11	0.00	0.00
Tanzania, United Rep.	35.6	0.9	0.7	0.28	0.04	0.11	0.25	0.2	0.03	0.12	0.00	0.00
Togo	4.7	0.9	0.6	0.41	0.03	0.04	0.08	0.3	0.08	0.24	0.00	0.00
Tunisia	9.6	1.4	0.9	0.66	0.08	0.03	0.12	0.5	0.43	0.04	0.00	0.00
Uganda	24.2	1.5	1.1	0.53	0.09	0.06	0.45	0.3	0.01	0.29	0.00	0.00
Zambia	10.6	0.8	0.5	0.19	0.06	0.07	0.22	0.2	0.04	0.14	0.00	0.00
Zimbabwe	12.8	1.0	0.5	0.25	0.05	0.13	0.04	0.5	0.39	0.13	0.00	0.00
MIDDLE EAST AND CENTRAL ASIA	**334.3**	**2.1**	**0.7**	**0.47**	**0.06**	**0.11**	**0.07**	**1.3**	**1.28**	**0.01**	**0.00**	**0.00**
Afghanistan	22.1	0.3	0.1	0.09	0.05	0.00	0.00	0.0	0.01	0.01	0.00	0.00
Armenia	3.1	1.0	0.6	0.38	0.02	0.22	0.01	0.3	0.30	0.00	0.00	0.00
Azerbaijan	8.2	1.5	0.6	0.42	0.04	0.09	0.01	0.9	0.89	0.00	0.00	0.00
Georgia	5.2	0.8	0.5	0.28	0.00	0.22	0.00	0.2	0.21	0.00	0.00	0.00
Iran	67.2	2.1	0.7	0.52	0.02	0.08	0.08	1.4	1.36	0.00	0.00	0.00
Iraq	23.9	1.1	0.1	0.07	0.00	0.00	0.00	0.9	0.92	0.00	0.00	0.00
Israel	6.2	5.3	1.5	0.80	0.27	0.10	0.35	3.7	3.70	0.00	0.00	0.00
Jordan	5.2	1.9	0.8	0.46	0.09	0.02	0.21	1.0	0.99	0.01	0.00	0.00
Kazakhstan	15.5	2.8	0.8	0.51	0.03	0.26	0.03	1.9	1.91	0.00	0.00	0.01
Kuwait	2.4	9.5	0.7	0.49	0.12	0.01	0.12	8.6	8.59	0.00	0.00	0.00
Kyrgyzstan	5.0	1.1	0.7	0.42	0.02	0.31	0.00	0.2	0.23	0.00	0.00	0.00
Lebanon	3.5	2.3	0.9	0.65	0.19	0.00	0.06	1.3	1.29	0.00	0.00	0.00
Saudi Arabia	22.8	4.4	0.8	0.49	0.11	0.11	0.13	3.3	3.33	0.00	0.00	0.00
Syria	17.0	1.9	0.7	0.53	0.03	0.13	0.04	1.1	1.06	0.00	0.00	0.00
Tajikistan	6.1	0.6	0.3	0.23	0.01	0.06	0.00	0.2	0.23	0.00	0.00	0.00
Turkey	69.3	2.0	1.1	0.75	0.12	0.11	0.07	0.9	0.85	0.02	0.00	0.00
Turkmenistan	4.7	3.1	0.7	0.55	0.01	0.18	0.01	2.3	2.27	0.00	0.00	0.00
United Arab Emirates	2.9	9.9	2.3	1.19	0.42	0.01	0.66	7.5	7.50	0.00	0.00	0.00
Uzbekistan	25.3	1.9	0.5	0.28	0.01	0.24	0.01	1.3	1.28	0.00	0.00	0.00
Yemen	18.7	0.7	0.5	0.28	0.01	0.07	0.09	0.2	0.20	0.00	0.00	0.00
ASIA-PACIFIC	**3 406.8**	**1.3**	**0.7**	**0.39**	**0.07**	**0.06**	**0.16**	**0.6**	**0.54**	**0.05**	**0.03**	**0.00**
Australia	19.4	7.7	3.0	1.09	0.77	0.78	0.34	4.4	4.34	0.07	0.00	0.01
Bangladesh	140.9	0.6	0.4	0.26	0.01	0.00	0.15	0.1	0.09	0.04	0.00	0.00
Cambodia	13.5	1.1	0.9	0.22	0.01	0.11	0.58	0.2	0.01	0.15	0.00	0.00
China	1 292.6	1.5	0.8	0.44	0.08	0.11	0.16	0.7	0.65	0.03	0.00	0.00
India	1 033.4	0.8	0.4	0.34	0.01	0.00	0.05	0.3	0.27	0.05	0.00	0.00
Indonesia	214.4	1.2	0.7	0.35	0.05	0.05	0.25	0.4	0.34	0.08	0.00	0.00

Built-up land† (global ha/person)	Total biocapacity (global ha/person)	Included in total biocapacity: Cropland (global ha/person)	Grazing land (global ha/person)	Forest (global ha/person)	Fishing ground (global ha/person)	Ecological deficit* (global ha/person)	Ecological Footprint change per capita** (% change 1991-2001)	Biocapacity change per capita** (% change 1991-2001)	Water withdrawals est.*** (thousand m³/ person/year)	Water resources est.*** (thousand m³/ person/year)	2001 data
0.05	1.0	0.54	0.23	0.09	0.04	0.2	-6	-11	0.07	2.43	Nigeria
0.05	0.5	0.30	0.10	0.05	0.01	0.2	6	-23	0.01	0.64	Rwanda
0.05	0.9	0.35	0.27	0.10	0.17	0.3	-8	-23	0.17	4.10	Senegal
0.05	1.2	0.16	0.49	0.11	0.36	-0.3	-8	-17	0.08	34.99	Sierra Leone
0.14	1.1	0.21	0.67	0.02	0.07	-0.7	3	-19	0.36	1.49	Somalia
0.05	2.0	0.55	0.72	0.47	0.21	0.8	2	-4	0.34	1.13	South Africa, Rep.
0.06	1.8	0.49	1.09	0.11	0.03	-0.8	1	-15	1.16	2.01	Sudan
0.07	1.1	0.27	0.73	0.00	0.00	0.0	-9	-19	0.78	4.26	Swaziland
0.07	1.3	0.24	0.70	0.11	0.14	-0.3	-29	-26	0.06	2.56	Tanzania, United Rep.
0.04	0.8	0.54	0.18	0.06	0.02	0.1	-1	-17	0.04	3.14	Togo
0.01	0.7	0.52	0.00	0.02	0.18	0.6	13	-25	0.28	0.47	Tunisia
0.05	1.1	0.52	0.23	0.06	0.25	0.4	-11	-20	0.01	2.72	Uganda
0.05	3.6	0.43	1.98	1.00	0.11	-2.8	-25	-22	0.16	9.95	Zambia
0.05	0.9	0.28	0.51	0.03	0.02	0.2	-21	-18	0.20	1.57	Zimbabwe
0.08	**1.0**	**0.51**	**0.27**	**0.12**	**0.08**	**1.1**	**-27**	**-16**	**1.17**	**2.58**	**MIDDLE EAST AND CENTRAL ASIA**
0.10	1.1	0.65	0.28	0.05	0.00	-0.8	-35	-33	1.05	2.94	Afghanistan
0.05	0.6	0.27	0.18	0.09	0.02	0.4	-82	1	0.96	3.41	Armenia
0.06	1.2	0.42	0.24	0.13	0.34	0.3	-73	1	2.10	3.68	Azerbaijan
0.04	1.2	0.23	0.32	0.58	0.01	-0.4	-86	1	0.69	12.12	Georgia
0.07	0.7	0.39	0.13	0.02	0.09	1.4	23	-13	1.08	2.04	Iran
0.08	0.6	0.45	0.03	0.00	0.00	0.5	16	-21	1.79	3.16	Iraq
0.07	0.4	0.23	0.01	0.05	0.02	4.9	22	-22	0.33	0.27	Israel
0.08	0.2	0.12	0.03	0.00	0.00	1.6	13	-12	0.20	0.17	Jordan
0.05	4.1	1.23	2.12	0.30	0.35	-1.2	-49	1	2.25	7.06	Kazakhstan
0.15	0.3	0.03	0.01	0.00	0.10	9.2	181	15	0.19	0.01	Kuwait
0.09	1.4	0.55	0.74	0.01	0.00	-0.3	-81	1	2.02	4.12	Kyrgyzstan
0.06	0.3	0.23	0.00	0.00	0.01	2.0	29	-34	0.39	1.25	Lebanon
0.19	0.9	0.44	0.16	0.00	0.15	3.4	14	-30	0.76	0.11	Saudi Arabia
0.07	0.9	0.64	0.14	0.00	0.01	1.0	12	24	1.18	1.55	Syria
0.04	0.4	0.22	0.17	0.01	0.00	0.1	-90	1	1.95	2.60	Tajikistan
0.07	1.4	0.75	0.11	0.40	0.03	0.6	4	-22	0.57	3.31	Turkey
0.09	3.5	0.62	2.19	0.02	0.55	-0.4	-44	1	5.22	5.24	Turkmenistan
0.10	1.0	0.21	0.00	0.00	0.64	8.9	36	-16	0.80	0.05	United Arab Emirates
0.06	0.7	0.39	0.24	0.00	0.04	1.1	-66	1	2.30	1.99	Uzbekistan
0.05	0.4	0.12	0.12	0.00	0.13	0.3	-19	-26	0.36	0.22	Yemen
0.06	**0.7**	**0.34**	**0.11**	**0.16**	**0.09**	**0.6**	**6**	**-11**	**0.56**	**4.67**	**ASIA-PACIFIC**
0.26	19.2	4.46	8.26	3.47	2.73	-11.5	16	-6	0.92	25.42	Australia
0.05	0.3	0.19	0.00	0.01	0.08	0.3	0	-11	0.54	8.59	Bangladesh
0.03	1.0	0.31	0.12	0.19	0.37	0.1	9	-3	0.30	35.32	Cambodia
0.07	0.8	0.35	0.12	0.17	0.05	0.8	14	-7	0.43	2.24	China
0.04	0.4	0.29	0.00	0.02	0.03	0.4	1	-15	0.62	1.84	India
0.05	1.0	0.34	0.07	0.27	0.28	0.2	4	-14	0.39	13.24	Indonesia

2001 data	Population	Total Ecological Footprint	Total food, fibre, and timber footprint	Included in total food, fibre, and timber: Cropland	Forest	Grazing land	Fishing ground	Total energy footprint	Included in total energy: CO_2 from fossil fuels	Fuelwood	Nuclear	Hydro
	(millions)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)	(global ha/person)
Japan	127.3	4.3	1.4	0.48	0.33	0.08	0.55	2.8	2.33	0.00	0.50	0.01
Korea, DPR	22.4	1.5	0.5	0.33	0.05	0.00	0.11	0.9	0.88	0.05	0.00	0.00
Korea, Rep.	47.1	3.4	1.3	0.54	0.24	0.00	0.54	2.0	1.54	0.01	0.46	0.00
Lao PDR	5.4	1.0	0.6	0.31	0.05	0.13	0.15	0.2	0.02	0.22	0.00	0.00
Malaysia	23.5	3.0	1.3	0.50	0.19	0.04	0.55	1.6	1.60	0.03	0.00	0.00
Mongolia	2.5	1.9	1.0	0.18	0.13	0.70	0.00	0.8	0.83	0.02	0.00	0.00
Myanmar	48.2	0.9	0.7	0.47	0.03	0.02	0.15	0.2	0.04	0.15	0.00	0.00
Nepal	24.1	0.6	0.4	0.32	0.04	0.06	0.02	0.2	0.04	0.11	0.00	0.00
New Zealand	3.8	5.5	4.0	0.62	1.45	1.05	0.86	1.3	1.33	0.00	0.00	0.00
Pakistan	146.3	0.7	0.4	0.31	0.02	0.00	0.06	0.3	0.22	0.04	0.00	0.00
Papua New Guinea	5.5	1.3	0.9	0.26	0.14	0.11	0.35	0.3	0.09	0.21	0.00	0.00
Philippines	77.2	1.2	0.7	0.32	0.04	0.02	0.30	0.5	0.34	0.11	0.00	0.00
Sri Lanka	18.8	1.1	0.7	0.30	0.05	0.03	0.34	0.3	0.25	0.06	0.00	0.00
Thailand	61.6	1.6	0.7	0.36	0.07	0.01	0.29	0.8	0.75	0.07	0.00	0.00
Viet Nam	79.2	0.8	0.5	0.31	0.05	0.01	0.10	0.2	0.14	0.07	0.00	0.00
LATIN AMERICA AND THE CARIBBEAN	**520.3**	**3.1**	**1.2**	**0.51**	**0.20**	**0.37**	**0.10**	**0.8**	**0.64**	**0.11**	**0.01**	**0.01**
Argentina	37.5	2.6	1.5	0.68	0.13	0.55	0.11	1.0	0.94	0.02	0.04	0.01
Belize	0.2	2.6	1.8	0.58	0.17	0.19	0.85	0.7	0.62	0.11	0.00	0.00
Bolivia	8.5	1.2	0.7	0.34	0.05	0.33	0.02	0.4	0.37	0.05	0.00	0.00
Brazil	174.0	2.2	1.5	0.58	0.35	0.53	0.09	0.5	0.35	0.16	0.02	0.02
Chile	15.4	2.6	1.7	0.39	0.80	0.29	0.24	0.8	0.63	0.16	0.00	0.02
Colombia	42.8	1.3	0.7	0.33	0.04	0.30	0.04	0.5	0.44	0.05	0.00	0.01
Costa Rica	4.0	2.1	1.1	0.41	0.37	0.33	0.03	0.9	0.69	0.18	0.00	0.00
Cuba	11.2	1.4	0.6	0.39	0.06	0.07	0.07	0.8	0.80	0.02	0.00	0.00
Dominican Rep.	8.5	1.6	1.0	0.37	0.08	0.17	0.35	0.6	0.56	0.01	0.00	0.00
Ecuador	12.6	1.8	1.1	0.38	0.30	0.31	0.10	0.6	0.54	0.08	0.00	0.01
El Salvador	6.3	1.2	0.7	0.34	0.12	0.14	0.07	0.5	0.36	0.15	0.00	0.00
Guatemala	11.7	1.2	0.5	0.30	0.05	0.12	0.03	0.7	0.42	0.26	0.00	0.00
Haiti	8.1	0.5	0.4	0.31	0.02	0.02	0.02	0.1	0.08	0.05	0.00	0.00
Honduras	6.6	1.4	0.6	0.28	0.08	0.18	0.07	0.7	0.43	0.27	0.00	0.00
Jamaica	2.6	2.6	1.2	0.42	0.20	0.06	0.51	1.4	1.30	0.05	0.00	0.00
Mexico	100.5	2.5	1.1	0.66	0.09	0.28	0.09	1.3	1.22	0.08	0.02	0.00
Nicaragua	5.2	1.1	0.5	0.35	0.01	0.10	0.06	0.6	0.33	0.23	0.00	0.00
Panama	3.0	1.8	0.8	0.31	0.04	0.36	0.06	0.9	0.82	0.09	0.00	0.00
Paraguay	5.6	2.2	1.6	0.57	0.40	0.53	0.15	0.4	0.24	0.21	0.00	0.00
Peru	26.4	0.9	0.7	0.37	0.04	0.13	0.14	0.2	0.12	0.06	0.00	0.01
Trinidad and Tobago	1.3	2.3	0.9	0.40	0.15	0.04	0.35	1.4	1.39	0.01	0.00	0.00
Uruguay	3.4	2.6	1.7	0.33	0.25	0.99	0.16	0.8	0.57	0.24	0.00	0.00
Venezuela	24.8	2.4	0.9	0.35	0.04	0.33	0.24	1.3	1.28	0.03	0.00	0.03
NORTH AMERICA	**319.1**	**9.2**	**3.0**	**0.98**	**1.35**	**0.44**	**0.22**	**5.8**	**5.20**	**0.04**	**0.56**	**0.02**
Canada	31.0	6.4	3.0	1.09	1.45	0.39	0.11	3.3	2.70	0.02	0.51	0.12
United States of America	288.0	9.5	3.0	0.96	1.35	0.44	0.23	6.1	5.47	0.04	0.57	0.01

Built-up land† (global ha/person)	Total biocapacity (global ha/person)	Included in total biocapacity: Cropland (global ha/person)	Grazing land (global ha/person)	Forest (global ha/person)	Fishing ground (global ha/person)	Ecological deficit* (global ha/person)	Ecological Footprint change per capita** (% change 1991-2001)	Biocapacity change per capita** (% change 1991-2001)	Water withdrawals est.*** (thousand m³/person/year)	Water resources est.*** (thousand m³/person/year)	2001 data
0.07	0.8	0.14	0.00	0.42	0.13	3.6	6	-6	0.69	3.38	Japan
0.05	0.7	0.23	0.00	0.30	0.10	0.8	-37	-33	0.40	3.44	Korea, DPR
0.06	0.6	0.16	0.00	0.08	0.27	2.8	30	-12	0.39	1.48	Korea, Rep.
0.10	1.4	0.33	0.21	0.68	0.07	-0.4	-4	-12	0.55	61.73	Lao PDR
0.07	1.9	0.79	0.02	0.63	0.42	1.1	10	-48	0.38	24.69	Malaysia
0.04	11.8	0.25	11.04	0.47	0.00	-9.9	-33	-11	0.17	13.77	Mongolia
0.08	1.3	0.54	0.01	0.48	0.21	-0.4	10	1	0.69	21.69	Myanmar
0.05	0.5	0.27	0.06	0.08	0.01	0.2	-4	-12	0.42	8.74	Nepal
0.13	14.5	2.76	4.36	6.82	0.45	-9.0	16	-13	0.55	85.71	New Zealand
0.04	0.4	0.26	0.01	0.02	0.04	0.3	2	-18	1.16	1.52	Pakistan
0.12	2.6	0.33	0.05	1.15	0.90	-1.3	-8	-16	0.02	146.70	Papua New Guinea
0.04	0.6	0.28	0.02	0.12	0.12	0.6	-6	-22	0.37	6.21	Philippines
0.05	0.4	0.20	0.02	0.05	0.06	0.7	20	-12	0.67	2.67	Sri Lanka
0.06	1.0	0.59	0.01	0.19	0.14	0.6	20	-1	1.41	6.66	Thailand
0.08	0.8	0.36	0.01	0.14	0.17	0.0	14	6	0.90	11.25	Viet Nam
0.07	**5.5**	**0.68**	**1.03**	**3.62**	**0.22**	**-2.4**	**6**	**-12**	**0.51**	**34.99**	**LATIN AMERICA AND THE CARIBBEAN**
0.08	6.7	2.31	2.71	1.07	0.54	-4.2	-6	-7	0.77	21.69	Argentina
0.07	6.9	0.66	0.32	5.58	0.27	-4.3	70	-19	0.49	75.73	Belize
0.07	15.6	0.48	2.92	12.16	0.01	-14.4	7	-18	0.16	73.40	Bolivia
0.08	10.2	0.80	1.19	8.05	0.10	-8.0	9	-10	0.34	47.31	Brazil
0.11	5.5	0.50	0.49	2.62	1.74	-2.8	30	-14	0.81	59.80	Chile
0.07	3.7	0.24	1.42	1.93	0.01	-2.4	-3	-16	0.25	49.78	Colombia
0.11	1.6	0.46	0.70	0.25	0.03	0.6	14	-13	0.67	28.01	Costa Rica
0.04	0.8	0.44	0.07	0.16	0.04	0.7	-7	-24	0.73	3.39	Cuba
0.05	0.8	0.31	0.25	0.21	0.03	0.7	30	-19	0.40	2.47	Dominican Rep.
0.06	2.1	0.39	0.40	0.97	0.30	-0.3	23	-24	1.35	34.24	Ecuador
0.04	0.6	0.27	0.14	0.10	0.03	0.6	24	-5	0.20	4.00	El Salvador
0.06	1.3	0.35	0.31	0.57	0.02	-0.1	25	-20	0.17	9.49	Guatemala
0.02	0.3	0.15	0.04	0.03	0.03	0.3	-4	-26	0.12	1.73	Haiti
0.07	1.9	0.38	0.29	1.08	0.06	-0.5	17	-26	0.13	14.49	Honduras
0.05	0.5	0.20	0.04	0.11	0.08	2.1	38	8	0.16	3.61	Jamaica
0.06	1.7	0.52	0.30	0.61	0.25	0.8	5	-15	0.78	4.55	Mexico
0.07	3.7	0.62	1.05	1.87	0.10	-2.6	1	-20	0.25	37.80	Nicaragua
0.07	2.7	0.39	0.58	1.58	0.10	-1.0	1	-16	0.27	49.21	Panama
0.08	5.7	1.14	3.67	0.68	0.08	-3.5	-2	-17	0.09	59.96	Paraguay
0.09	4.3	0.31	0.89	2.58	0.41	-3.3	5	-14	0.76	72.57	Peru
0.00	0.4	0.15	0.01	0.04	0.24	1.9	18	-2	0.23	2.97	Trinidad and Tobago
0.08	7.5	0.73	5.59	0.55	0.52	-4.9	2	-3	0.94	41.30	Uruguay
0.07	2.5	0.27	0.73	1.35	0.06	-0.1	1	-18	0.34	49.82	Venezuela
0.42	**5.4**	**1.86**	**0.30**	**2.8**	**0.43**	**3.9**	**7**	**-11**	**1.90**	**18.72**	**NORTH AMERICA**
0.06	14.4	2.77	0.49	10.04	1.08	-8.0	-2	-12	1.41	93.54	Canada
0.45	4.9	1.76	0.28	2.01	0.36	4.7	7	-11	1.95	10.66	United States of America

2001 data	Population	Total Ecological Footprint	Total food, fibre, and timber footprint	Included in total food, fibre, and timber				Total energy footprint	Included in total energy			
	(millions)	(global ha/person)	(global ha/person)	Cropland (global ha/person)	Forest (global ha/person)	Grazing land (global ha/person)	Fishing ground (global ha/person)	(global ha/person)	CO_2 from fossil fuels (global ha/person)	Fuelwood (global ha/person)	Nuclear (global ha/person)	Hydro (global ha/person)
WESTERN EUROPE	**390.1**	**5.1**	**1.9**	**0.84**	**0.58**	**0.19**	**0.31**	**3.0**	**2.51**	**0.02**	**0.47**	**0.01**
Austria	8.1	4.6	2.0	0.84	0.92	0.13	0.14	2.5	2.36	0.07	0.00	0.06
Belgium/Luxembourg	10.7	4.9	1.9	0.90	0.67	0.08	0.24	2.6	1.68	0.01	0.94	0.00
Denmark	5.3	6.4	3.2	1.14	1.77	0.06	0.26	2.9	2.92	0.01	0.00	0.00
Finland	5.2	7.0	4.3	0.87	2.78	0.20	0.46	2.6	1.34	0.15	1.04	0.03
France	59.6	5.8	2.1	0.89	0.58	0.30	0.33	3.6	2.18	0.01	1.35	0.01
Germany	82.3	4.8	1.5	0.79	0.46	0.14	0.14	3.1	2.68	0.01	0.42	0.00
Greece	10.9	5.4	1.8	1.04	0.23	0.20	0.31	3.6	3.59	0.03	0.00	0.00
Ireland	3.9	6.2	1.9	0.78	0.63	0.23	0.21	4.2	4.21	0.00	0.00	0.00
Italy	57.5	3.8	1.5	0.80	0.35	0.10	0.21	2.2	2.21	0.02	0.00	0.01
Netherlands	16.0	4.7	1.7	0.92	0.53	0.10	0.19	2.9	2.83	0.00	0.06	0.00
Norway	4.5	6.2	3.5	0.72	1.21	0.29	1.28	2.4	2.37	0.05	0.00	0.10
Portugal	10.0	5.2	2.9	0.85	0.53	0.22	1.25	2.4	2.33	0.01	0.00	0.02
Spain	40.9	4.8	2.2	1.03	0.43	0.09	0.61	2.6	2.24	0.01	0.31	0.01
Sweden	8.9	7.0	4.2	0.86	2.66	0.42	0.29	2.6	0.89	0.12	1.62	0.00
Switzerland	7.2	5.3	1.4	0.58	0.37	0.29	0.13	3.7	2.92	0.03	0.73	0.00
United Kingdom	59.1	5.4	1.7	0.69	0.44	0.27	0.25	3.4	3.13	0.00	0.31	0.00
CENTRAL AND EASTERN EUROPE	**336.5**	**3.8**	**1.4**	**0.83**	**0.29**	**0.19**	**0.12**	**2.2**	**2.01**	**0.04**	**0.18**	**0.01**
Albania	3.1	1.5	0.7	0.50	0.06	0.12	0.03	0.7	0.72	0.01	0.00	0.00
Belarus	10.0	3.2	1.5	0.93	0.23	0.30	0.07	1.6	1.58	0.02	0.00	0.00
Bosnia and Herzegovina	4.1	2.3	1.0	0.46	0.33	0.12	0.05	1.2	1.21	0.04	0.00	0.00
Bulgaria	8.0	2.7	1.1	0.84	0.14	0.05	0.03	1.5	0.93	0.04	0.54	0.00
Croatia	4.4	2.9	1.2	0.78	0.37	0.00	0.06	1.6	1.57	0.03	0.00	0.00
Czech Rep.	10.3	5.0	1.9	0.91	0.67	0.14	0.14	3.0	2.71	0.02	0.24	0.00
Estonia	1.4	6.9	3.5	1.12	1.51	0.57	0.30	3.3	3.07	0.25	0.00	0.00
Hungary	10.0	3.5	1.3	0.81	0.31	0.10	0.10	2.0	1.67	0.04	0.30	0.00
Latvia	2.4	4.4	3.3	0.90	1.30	0.98	0.14	1.0	0.88	0.13	0.00	0.00
Lithuania	3.5	3.9	2.0	1.02	0.38	0.36	0.28	1.8	1.03	0.10	0.63	0.00
Macedonia, FYR	2.0	2.3	0.9	0.52	0.13	0.16	0.07	1.3	1.27	0.06	0.00	0.00
Moldova, Rep.	4.3	1.2	0.7	0.54	0.05	0.06	0.02	0.5	0.45	0.00	0.00	0.00
Poland	38.7	3.6	1.5	1.05	0.37	0.09	0.04	2.0	1.98	0.01	0.00	0.00
Romania	22.4	2.7	1.1	0.80	0.20	0.06	0.01	1.5	1.44	0.02	0.05	0.01
Russian Federation	144.9	4.4	1.5	0.81	0.30	0.21	0.20	2.8	2.52	0.06	0.20	0.01
Serbia and Montenegro	10.5	3.0	1.8	0.84	0.59	0.27	0.11	1.1	0.99	0.06	0.00	0.00
Slovakia	5.4	3.6	1.4	0.74	0.50	0.11	0.07	2.0	1.31	0.01	0.67	0.01
Slovenia	2.0	3.8	1.3	0.74	0.46	0.12	0.03	2.4	2.36	0.04	0.00	0.00
Ukraine	49.3	3.3	1.2	0.80	0.08	0.25	0.05	2.1	1.71	0.02	0.32	0.00

NOTES
World: Total population includes countries not listed in table
High income countries: Australia, Austria, Belgium/Luxembourg, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Rep. Korea, Kuwait, Netherlands, New Zealand, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America
Middle income countries: Algeria, Argentina, Belarus, Belize, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Rep., Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Gabon, Georgia, Guatemala, Hungary, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Latvia, Lebanon, Libya, Lithuania, FYR Macedonia, Malaysia, Mauritius, Mexico, Morocco, Namibia, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Russian Federation, Saudi Arabia, Serbia and Montenegro, Slovakia, Rep. South Africa, Sri Lanka, Syria, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, Uruguay, Uzbekistan, Venezuela
Low income countries: Afghanistan, Albania, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Rep., Chad, Congo, Dem. Rep. Congo, Côte

Built-up land† (global ha/person)	Total biocapacity (global ha/person)	Included in total biocapacity: Cropland (global ha/person)	Grazing land (global ha/person)	Forest (global ha/person)	Fishing ground (global ha/person)	Ecological deficit* (global ha/person)	Ecological Footprint change per capita** (% change 1991-2001)	Biocapacity change per capita** (% change 1991-2001)	Water withdrawals est.*** (thousand m³/person/year)	Water resources est.*** (thousand m³/person/year)	2001 data
0.17	**2.1**	**0.81**	**0.08**	**1.03**	**0.16**	**3.0**	**5**	**-7**	**0.53**	**5.34**	**WESTERN EUROPE**
0.07	3.5	0.71	0.10	2.64	0.00	1.1	4	-7	0.44	9.59	Austria
0.33	1.2	0.39	0.04	0.42	0.01	3.7	10	-4	0.70	2.00	Belgium/Luxembourg
0.24	3.5	2.02	0.00	0.46	0.78	2.9	7	-14	0.13	1.12	Denmark
0.13	12.4	1.08	0.00	10.93	0.24	-5.4	16	-6	0.45	21.20	Finland
0.16	3.1	1.45	0.14	1.21	0.10	2.8	4	-8	0.52	3.42	France
0.20	1.9	0.78	0.06	0.85	0.03	2.9	-3	1	0.46	1.87	Germany
0.05	1.6	1.02	0.01	0.27	0.24	3.9	19	-15	0.79	6.78	Greece
0.12	4.7	1.33	0.96	0.70	1.60	1.5	25	-9	0.28	13.45	Ireland
0.07	1.1	0.58	0.01	0.38	0.05	2.7	5	-12	0.73	3.33	Italy
0.12	0.8	0.31	0.05	0.11	0.16	4.0	7	-8	0.55	5.69	Netherlands
0.14	6.9	0.56	0.02	4.14	1.98	-0.8	11	-8	0.53	85.00	Norway
0.02	1.6	0.41	0.06	1.08	0.08	3.6	33	-7	0.73	6.85	Portugal
0.03	1.6	0.92	0.04	0.57	0.04	3.2	21	-7	0.94	2.73	Spain
0.17	9.8	1.11	0.04	8.32	0.12	-2.7	6	-3	0.30	19.64	Sweden
0.18	1.6	0.30	0.17	0.94	0.00	3.7	-6	-11	0.35	7.46	Switzerland
0.34	1.5	0.49	0.15	0.19	0.36	3.9	-1	-12	0.20	2.49	United Kingdom
0.07	**4.2**	**1.09**	**0.21**	**2.71**	**0.19**	**-0.4**	**-23**	**0**	**0.48**	**16.25**	**CENTRAL AND EASTERN EUROPE**
0.07	0.9	0.42	0.12	0.24	0.06	0.6	-13	19	0.54	13.36	Albania
0.06	3.1	0.87	0.29	1.93	0.00	0.0	-43	1	0.28	5.81	Belarus
0.06	1.8	0.26	0.30	1.15	0.01	0.5	-17	0	–	–	Bosnia and Herzegovina
0.13	2.4	1.06	0.04	1.12	0.05	0.3	-16	-8	0.82	2.65	Bulgaria
0.09	2.8	0.83	0.33	1.28	0.27	0.1	6	0	–	–	Croatia
0.15	2.8	1.06	0.02	1.56	0.01	2.2	1	0	0.19	1.28	Czech Rep.
0.11	5.7	1.06	0.09	4.22	0.22	1.2	25	1	1.04	9.47	Estonia
0.17	2.4	1.34	0.07	0.80	0.01	1.1	-10	-18	0.46	10.43	Hungary
0.06	6.5	1.97	0.19	4.21	0.09	-2.1	-21	1	0.11	15.08	Latvia
0.12	3.9	1.51	0.14	2.12	0.02	0.0	-29	1	0.90	7.15	Lithuania
0.07	0.9	0.51	0.24	0.07	0.00	1.4	-16	0	–	–	Macedonia, FYR
0.05	1.0	0.85	0.07	0.01	0.00	0.2	-79	1	0.54	2.72	Moldova, Rep.
0.07	2.0	0.97	0.08	0.86	0.01	1.6	-9	-10	0.30	1.59	Poland
0.11	2.4	0.84	0.01	1.43	0.03	0.3	-23	-2	0.32	9.45	Romania
0.05	6.9	1.18	0.35	4.95	0.39	-2.6	-21	1	0.53	31.11	Russian Federation
0.08	1.7	0.83	0.25	0.50	0.03	1.3	8	0	0.26	10.64	Serbia and Montenegro
0.15	2.9	0.81	0.04	1.94	0.00	0.6	-28	0	0.20	9.29	Slovakia
0.07	2.9	0.29	0.06	2.45	0.01	0.9	40	0	0.15	16.03	Slovenia
0.06	2.0	1.25	0.12	0.47	0.04	1.4	-40	1	0.76	2.83	Ukraine

d'Ivoire, Eritrea, Ethiopia, The Gambia, Ghana, Guinea, Guinea-Bissau, Haiti, Honduras, India, Kenya, DPR Korea, Kyrgyzstan, Lao PDR, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Rep. Moldova, Mongolia, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Tajikistan, United Rep.Tanzania, Togo, Turkmenistan, Uganda, Viet Nam, Yemen, Zambia, Zimbabwe

Table includes all countries with populations greater than 1 million, except Bhutan, Oman, and Singapore, for which insufficient data were available to calculate the Ecological Footprint and biocapacity figures.
Totals may not add up due to rounding.
† Note that built-up land is part of both Ecological Footprint and biocapacity.
* If number for ecological deficit is negative, country has an ecological reserve.
** For countries that were formerly part of Ethiopia, the Soviet Union, former Yugoslavia, or Czechoslovakia, 2001 country per capita footprints are compared with the per capita footprint of the former unified country.
*** Water withdrawals and resource estimates from Gleick 2004 and FAO 2004a.
– Withdrawals and resources data for Bosnia and Herzegovina, FYR Macedonia, and Croatia are included in the figures for Serbia and Montenegro.

Table 3: THE LIVING PLANET THROUGH TIME

See notes on pages 33-37	Global population (billions)	Total Ecological Footprint (billion global ha)	Food, fibre, and timber footprint (billion global ha)	Total energy footprint (billion global ha)	Built-up land (billion global ha)	World Ecological Footprint (number of planets)	Water withdrawals (thousand km^3/year)	Living Planet Index	Terrestrial species index	Freshwater species index	Marine species index
1961	3.08	5.21	4.04	0.94	0.23	0.49	2.04				
1962	3.14	5.37	4.07	1.06	0.23	0.51	2.10				
1963	3.20	5.67	4.19	1.24	0.24	0.54	2.16				
1964	3.27	5.92	4.23	1.45	0.24	0.56	2.22				
1965	3.33	6.24	4.38	1.62	0.25	0.59	2.28				
1966	3.40	6.41	4.34	1.82	0.25	0.60	2.34				
1967	3.47	6.60	4.39	1.96	0.26	0.62	2.40				
1968	3.55	6.93	4.50	2.18	0.26	0.65	2.46				
1969	3.62	7.35	4.64	2.44	0.27	0.69	2.52				
1970	3.69	7.81	4.75	2.78	0.27	0.73	2.57	1.00	1.00	1.00	1.00
1971	3.77	7.94	4.66	3.00	0.28	0.74	2.64	1.00	1.01	0.99	1.01
1972	3.84	8.38	4.83	3.26	0.28	0.78	2.70	1.01	1.02	0.98	1.01
1973	3.92	8.67	4.79	3.60	0.29	0.81	2.76	1.01	1.03	0.98	1.02
1974	3.99	8.80	4.91	3.60	0.29	0.82	2.82	1.01	1.04	0.97	1.03
1975	4.07	8.81	4.85	3.65	0.30	0.82	2.89	1.01	1.05	0.96	1.03
1976	4.14	9.16	4.87	3.98	0.30	0.85	2.95	1.00	1.04	0.97	1.00
1977	4.21	9.49	4.96	4.22	0.31	0.88	3.01	0.99	1.03	0.97	0.98
1978	4.29	9.66	4.92	4.42	0.32	0.89	3.07	0.99	1.04	0.98	0.96
1979	4.36	10.03	5.07	4.64	0.32	0.93	3.14	0.98	1.01	0.98	0.94
1980	4.43	10.02	5.09	4.61	0.33	0.92	3.20	0.97	1.00	0.98	0.92
1981	4.51	9.93	5.04	4.55	0.33	0.91	3.24	0.96	1.01	0.97	0.91
1982	4.59	9.84	5.00	4.50	0.34	0.91	3.28	0.96	1.00	0.98	0.90
1983	4.67	10.13	5.22	4.57	0.34	0.93	3.31	0.95	0.99	0.98	0.89
1984	4.75	10.39	5.21	4.83	0.35	0.95	3.35	0.94	0.97	0.97	0.89
1985	4.83	10.57	5.21	5.00	0.35	0.97	3.39	0.93	0.96	0.96	0.89
1986	4.92	10.90	5.39	5.15	0.36	0.99	3.43	0.91	0.95	0.92	0.88
1987	5.00	11.33	5.53	5.43	0.37	1.03	3.47	0.91	0.96	0.89	0.88
1988	5.09	11.72	5.62	5.73	0.37	1.06	3.50	0.89	0.95	0.84	0.88
1989	5.18	11.84	5.58	5.89	0.38	1.07	3.54	0.88	0.95	0.84	0.87
1990	5.26	11.80	5.54	5.88	0.39	1.07	3.58	0.87	0.93	0.82	0.87
1991	5.35	11.89	5.49	6.00	0.39	1.07	3.62	0.85	0.94	0.77	0.85
1992	5.43	11.84	5.33	6.11	0.39	1.07	3.65	0.82	0.91	0.74	0.82
1993	5.51	11.97	5.40	6.16	0.40	1.08	3.69	0.79	0.88	0.69	0.81
1994	5.59	12.11	5.49	6.22	0.40	1.09	3.72	0.75	0.86	0.64	0.77
1995	5.67	12.46	5.64	6.41	0.41	1.12	3.76	0.72	0.85	0.59	0.74
1996	5.75	12.69	5.57	6.70	0.41	1.14	3.80	0.69	0.82	0.55	0.74
1997	5.83	12.81	5.64	6.75	0.42	1.15	3.83	0.65	0.78	0.50	0.70
1998	5.91	12.85	5.61	6.81	0.43	1.15	3.87	0.64	0.76	0.49	0.69
1999	5.99	12.97	5.67	6.87	0.43	1.16	3.90	0.62	0.70	0.50	0.69
2000	6.07	13.33	5.78	7.12	0.43	1.19	3.94	0.61	0.68	0.47	0.70
2001	6.15	13.47	5.75	7.28	0.44	1.21	3.98				

TECHNICAL NOTES

LIVING PLANET INDEX

Data collection

The species population data used to calculate the index were gathered from a variety of sources published in scientific journals, literature from non-governmental organizations, or on the internet. Any data used in constructing the index had to be a time series of either population size or a proxy of population size. Some data are total population estimates such as counts of an entire species; others are density measures, for example the number of birds per kilometre of transect; some are biomass or stock estimates, particularly for commercial fish species; and others are proxies of population size, such as the number of nests of marine turtle species on various nesting beaches.

All population time series have at least two data points, and most have more than two, collected by methods that are comparable across years, so that it is possible to determine a trend. A population estimate taken at one point in time would not be used with a second estimate from another survey of the same population at another point in time, unless it was clear that the second was meant to be comparable with the first. Plants and invertebrates were excluded, as few population time series data were available. It is assumed, therefore, that trends in vertebrate populations are indicative of overall trends in global biodiversity.

Calculation of the indices

For each species, the ratio between its population in each pair of consecutive years was calculated. To calculate the index in a given year, the geometric mean of all the ratios of species populations in that year and the previous year was multiplied by the index value of the previous year. The index value was set equal to 1 in 1970. Therefore the index starts at 1 then changes from year to year in line with the geometric mean of all the changes in population of each species with population data in both years.

In cases where data were collected for more than one population of a single species, or where more than one time series was collected for the same population, the geometric mean of all ratios for that species was used in the calculations instead of multiple series of ratios.

More species population data are available from temperate than tropical regions of the world, whereas species richness is higher in the tropics. If the Living Planet Index were calculated simply as described above, then it would be unrepresentative of global biodiversity. Therefore, before carrying out any calculations, the data were divided up by biome – terrestrial, freshwater, or marine – depending on the principal habitat of the species. Where a species commonly occurs in more than one biome, its breeding habitat was used to determine its biome. Then, within each biome, species were divided up according to the biogeographic realm or ocean they inhabit: Afrotropical, Australasian, Indo-Malayan, Nearctic, Neotropical, or Palearctic realms for terrestrial and freshwater species; Atlantic/Arctic, Indian, Pacific, or Southern Oceans for marine species. For some species, different populations would occur within different realms or oceans, in which case the populations would be divided accordingly. The total numbers of species contributing to each realm/ocean and biome are given in Table 4.

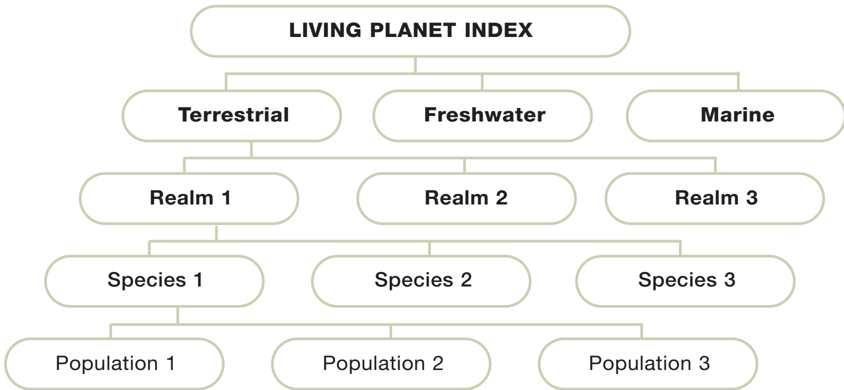
Separate indices were first calculated for each biogeographic realm (one each for terrestrial and freshwater) and ocean. The terrestrial and freshwater species indices were then calculated as the geometric mean of the six biogeographic realm indices within each biome, and the marine species index was calculated as the geometric mean of the four ocean indices. Thus the terrestrial species index includes 555 species of mammals, birds, and reptiles found in forest, grassland, savannah, desert, or tundra ecosystems worldwide. The freshwater species index comprises 323 species of mammals, birds, reptiles, amphibians, and fish living in rivers, lakes, or wetland ecosystems. The marine species index includes 267 species of mammals, birds, reptiles, and fish from the world's oceans, seas, and coastal ecosystems.

The LPI is the geometric mean of the terrestrial, freshwater, and marine species indices. The hierarchy of indices is shown in Figure 36. Each biome carries equal weight within the overall Living Planet Index. Each realm or ocean carries equal weight within each biome. Each species carries equal weight within each realm or ocean. Each population carries equal weight within each species.

Table 4: **NUMBERS OF SPECIES INCLUDED IN THE LIVING PLANET INDEX BY REALM/OCEAN AND BIOME**

Realm or ocean	Terrestrial	Freshwater	Marine
Afrotropical	72	12	
Australasian	15	11	
Indo-Malayan	28	19	
Nearctic	269	168	
Neotropical	19	12	
Palearctic	159	101	
Atlantic/Arctic Ocean			117
Indian Ocean/Southeast Asia			15
Pacific Ocean			105
Southern Ocean			30
World	**555**	**323**	**267**

Fig. 36: **HIERARCHY OF INDICES WITHIN THE LIVING PLANET INDEX**



TECHNICAL NOTES continued

ECOLOGICAL FOOTPRINT and BIOCAPACITY

1. The Ecological Footprint

The **Ecological Footprint** is a measure of how much **biologically productive** land and water **area** an individual, a city, a country, a region, or humanity requires to produce the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management schemes. This land and water area can be anywhere in the world.

This report documents national per capita footprints for 148 nations. Footprints can also be calculated for organizations, urban development projects, services, and products.

The Ecological Footprint is measured in global hectares. A **global hectare** is 1 hectare of biologically productive space with world average productivity. In 2001 (the most recent year for which data are available), the biosphere had 11.3 billion hectares of biologically productive area corresponding to roughly one quarter of the planet's surface. These 11.3 billion hectares include 2.3 billion hectares of water (ocean shelves and inland water) and 9.0 billion hectares of land. The land area is composed of 1.5 billion hectares of cropland, 3.5 billion hectares of grazing land, 3.9 billion hectares of forest land, and 0.2 billion hectares of built-up land.

In this report, the Ecological Footprint is calculated for each **country**. This includes the resources contained within the goods and services that are consumed by people living in that country, as well as the associated waste. Resources consumed for the production of goods and services that are exported to another country are added to the footprint of the country where the goods and services are actually consumed, rather than of the country where they are produced. A few consumption activities, such as tourism, are attributed to the country where they occur rather than to the travellers' countries of origin. While this distorts the relative size of some countries' footprints, it does not affect the global result.

The **global Ecological Footprint** is the area of productive biosphere required to maintain the material throughput of the human economy, under current management and production practices. Typically expressed in global hectares, the Ecological Footprint can also be measured in number of planets, whereby one planet represents the biological capacity of the Earth in a given year.

The analysis is based primarily on **data** published by the Food and Agriculture Organization of the United Nations (FAO), the International Energy Agency (IEA), and the Intergovernmental Panel on Climate Change (IPCC). Other data sources include studies in peer reviewed science journals or thematic collections.

2. Biocapacity and bioproductivity

Biocapacity (biological capacity) is the total usable biological production capacity in a given year of a biologically productive area, for example within a country. It can be expressed in global hectares.

Biologically productive area is land and sea area with significant photosynthetic activity and production of biomass. Marginal areas with patchy vegetation and non-productive areas are not included. There are 11.3 billion global hectares of biologically productive land and sea area on the planet. The remaining three-quarters of the Earth's surface, including deserts, ice caps, and deep oceans, support comparatively low levels of bioproductivity, too dispersed to be harvested.

Bioproductivity (biological productivity) is equal to the biological production per hectare per year. Biological productivity is typically measured in terms of annual biomass accumulation.

Biocapacity available per person is calculated as follows. Dividing the 11.3 billion global hectares of biologically productive area by the number of people alive – 6.15 billion in 2001 – gives the average amount of biocapacity that exists on the planet per person: 1.8 global hectares.

3. Assumptions underlying the calculations

Ecological Footprint calculations are based on the following assumptions:

- It is possible to keep track of most of the resources people consume and the wastes they generate.
- Most of these resource and waste flows can be measured in terms of the biologically productive area necessary to maintain these flows. Those resource and waste flows that cannot be measured are excluded from the assessment. As a consequence, this assessment tends to underestimate the true Ecological Footprint.
- By weighting each area in proportion to its usable resource productivity (that is, its annual production of usable resources and services), the different areas can be expressed converted from *hectares* to a (different) number of *global hectares* of average productivity. "Usable" refers to the portion of biomass used by humans, reflecting the anthropocentric assumptions of the Ecological Footprint measurement.
- Since these areas stand for mutually exclusive uses, and each global hectare represents the same amount of biomass production potential for a given year, they can be added up. This is the case for both the aggregate human demand (the Ecological Footprint) and the aggregate supply of biocapacity.
- Human demand expressed as the Ecological Footprint and nature's supply expressed in global hectares of biocapacity can be directly compared.
- Area demand can exceed area supply. For example, the footprint of forest products harvested from a forest at twice its regeneration rate is twice the size of the actual forest. Use that exceeds the regeneration rate of nature is called **ecological overshoot**.

4. What is NOT counted

The results presented tend to underestimate human demand on nature and overestimate the available biocapacity by:

- choosing the more conservative estimates when in doubt (e.g. carbon absorption estimates)
- excluding human activities for which there are insufficient data (e.g. acid rain)
- excluding those activities that systematically erode nature's capacity to regenerate. They consist of:
  - uses of materials for which the biosphere has no apparent significant assimilation capacity (e.g. plutonium, polychlorinated biphenyls (PCBs), dioxins, chlorofluorocarbons (CFCs))
  - processes that irreversibly damage the biosphere (e.g. species extinction, fossil-aquifer depletion, deforestation, desertification).

For consistency and to keep the global hectares additive, each area is only counted once as both Ecological Footprint and biocapacity, even if an area provides two or more ecological services at the same time. As mentioned, the accounts include the productivity of cropland at the level of current yields, with no deduction for possible degradation; however, if degradation takes place it will show up as reductions in future biocapacity assessments. The energy use for agriculture, including fertilizers, is included in the energy footprint.

Ecological Footprint calculations avoid double counting – that is, counting the same area twice. Consider bread: wheat is farmed, milled, and baked, then finally eaten as bread. Economic data can track these sequential processes and report the amounts and financial values at each stage. However, it is the same wheat grain throughout the production process, finally ending up as human consumption. To avoid double-counting, the wheat is counted at only one stage of the process, while energy consumed at each stage of the process is added to the footprint.

This report provides the consumption footprint. Globally, the consumption footprint equals the production footprint. At the national scale, trade must be accounted for, so the consumption footprint = production footprint + imports – exports.

5. Methodology

The Ecological Footprint methodology is in constant development, adding detail and better data as they become available. Coordination of this task is being led by the Global Footprint Network. This report uses the most current national accounts methodology, building on Monfreda et al. (2004). An electronic copy of a sample data sheet and its underlying formula is available at www.footprintnetwork.org. New features for 2004 include:

- a simplification of the pasture calculation that assumes full use of existing pasture areas unless livestock density is lower than half the carrying capacity of the pasture
- refined calculation of CO_2 sequestration and forest productivity using FAO's Global Fibre Supply Model (FAO 2000) and complementary FAO sources
- a more complete data source for CO_2 emissions (IEA 2003)
- new data sources for built-up area (FAO/IIASA 2000, EEA 1999).

A nation's consumption is calculated by adding imports to, and subtracting exports from, domestic production. Domestic production is adjusted for production waste and, in the case of crops, the amount of seed necessary for growing the crops in the first place.

This balance is computed for 148 countries since 1961, with approximately 3 500 data points and 10 000 calculations per year and country. More than 200 categories are included, among them cereals, timber, fishmeal, and fibres. These resource uses are translated into global hectares by dividing the total amount consumed in each category by its global average productivity, or yield. Biomass yields, measured in dry weight, are taken from statistics (FAO 2004b).

To relate the productivity of sea area to that of land area, the ability of fisheries to provide protein is compared with the productivity of pastures.

CO_2 emissions from fossil fuel, minus the percentage absorbed by oceans, are divided by the carbon assimilation capacity of world average forests. Some of the resource categories are primary resources (such as raw timber and milk), while others are manufactured products derived from primary resources (such as paper and cheese).

For example, if 1 tonne of pork is exported, the amount of cereals and energy required to produce this tonne of pork is translated into a corresponding biologically productive area, then subtracted from the exporting country's footprint and added to that of the importing country.

Despite these adjustments for trade and because relevant data are currently unavailable, some consumption activities, such as tourism, are attributed to the country where they occur rather than to the consumer's country of origin. This distorts the relative size of some countries' footprints, but does not affect the global result.

6. Area types of the Ecological Footprint and biocapacity accounts

The accounts include six main bioproductive area types. Once the human impacts are expressed in global hectares, these components are added together.

Cropland

Growing crops for food, animal feed, fibre, and oil occupies cropland, the most productive land type. FAO estimates that there are about 1.5 billion hectares of cropland worldwide (FAO 2004b). Using FAO harvest and yield data for 74 major crops, the use of cropland for crop production was traced (FAO 2004b). These accounts may underestimate long-term productivity, since other impacts from current agricultural practices, such as long-term damage from topsoil erosion, salination, and contamination of aquifers with agro-chemicals, are not yet accounted for. Still, such damage will affect future bioproductivity as measured by these accounts.

Grazing land

Grazing animals for meat, hides, wool, and milk requires grassland and pasture area. Worldwide, there are 3.5 billion hectares of natural and semi-natural grassland and pasture. It is assumed that 100 per cent of pasture is utilized, unless pasture produces more than twice the feed requirement necessary for the grass-fed livestock. In this latter case, pasture demand is counted at twice the minimum area requirement. This means that the pasture footprint per unit of animal product is capped at twice the lowest possible pasture footprint per unit of animal product. This may lead to underestimating pasture demand since, even in low productivity grasslands, people usually allow grazing animals full range and thus create human demand on the entire available grassland. Diet profiles are created to determine the mix of cultivated food, cultivated grasses, fish products, and grazed grasses consumed by animals in each country. Each source of animal food is charged to the respective account (crop feed to the cropland footprint, fish-based feed to the fishing ground footprint, etc.). The embodied cropland and pasture is used with FAO trade data (FAO 2004b) to charge animal product footprints to the consuming country.

The dividing line between forest areas and grasslands is not sharp. For instance, FAO has included areas with 10 per cent of tree cover in the forest categories, while in reality they may be primarily grazed. While the relative distribution between forest and grassland areas may not be accurate, the accounts are constructed to ensure no area is counted as more than one type of land.

Forest area

Harvesting trees for timber and paper-making, and gathering fuelwood require natural or plantation forests. Worldwide there are 3.9 billion hectares of forests according to FAO's most recent survey (FAO 2003). Forest productivities were estimated using a variety of sources (FAO 1997b, FAO 2000, FAO/UNECE 2000). Consumption figures for timber and fuelwood also come from FAO (2004b). The footprint of fuelwood consumption is calculated using timber growth rates that are adjusted upward to reflect the fact that more forest biomass than merely roundwood is used for fuel, and that less mature forests can be used for fuelwood production.

Fishing ground

Fishing requires productive fishing ground. Most of the ocean's productivity is located on continental shelves. Excluding inaccessible or unproductive waters, these comprise 1.9 billion hectares. Although a mere fraction of the ocean's 36.3 billion hectares, they provide more than 95 per cent of the marine fish catch (Postma and Zijlstra 1988). Inland waters consist of an additional 0.4 billion hectares, making 2.3 billion hectares of potential fishing grounds out of the 36.6 billion hectares of ocean and inland water that exist on the planet. FAO fish catch figures (FAO 2004b, FAO 2002) were used, and compared with FAO's "sustainable yield" figure of 93 million tonnes per year (FAO 1997a). The accounts include both fish catch for fishmeal and fish for direct human consumption. Also, bycatch was added to each country's reported fish catch to account for discarded fish.

Built-up land

Infrastructure for housing, transportation, industrial production, and capturing hydroelectric power occupies built-up land. This space is the least documented, since low-resolution satellite images are not able to capture dispersed infrastructure and roads. Data from CORINE (EEA 1999), GAEZ (FAO/IIASA 2000), and GLC (JRC/GVM 2000) were used to reach a global total of 0.2 billion hectares of built-up land. Built-up land is assumed to have replaced cropland, as human settlements are predominantly located in the most fertile areas of a country. For this reason the 0.2 billion hectares of built-up land appear in the Ecological Footprint accounts as 0.44 billion global hectares.

"Energy land"

Burning **fossil fuel** adds CO_2 to the atmosphere. The footprint of fossil fuel is calculated by estimating the biologically productive area needed to sequester enough CO_2 to avoid an increase in atmospheric CO_2 concentration. Since the world's oceans absorb about 1.8 Giga tonnes of carbon every year (IPCC 2001), only the remaining carbon emission is accounted for in the Ecological Footprint. The current capacity of world average forests to sequester carbon is based on FAO's Global Fibre Supply Model (FAO 2000) and corrected where better data are available from other FAO sources such as FAO/UNECE 2000, FAO 1997b, and FAO 2004b. Sequestration capacity changes with both the maturity and composition of forests, and with shifts in bioproductivity due to higher atmospheric CO_2 levels and associated changes in temperature and water availability. Other possible methods to account for fossil fuel use would result in even larger footprints (Wackernagel and Monfreda 2004; Dukes 2003).

Each thermal unit of **nuclear energy** is counted as equal to a unit from fossil energy. This parity was chosen to reflect the possibility of a negative long-term impact from nuclear waste.

The **hydropower** footprint is the area occupied by hydroelectric dams and reservoirs, and is calculated for each country using the average ratio of power output to inundated reservoir area for the world's 28 largest dams (Table 5).

The net **embodied energy in trade** (which by definition balances for the globe as a whole) is calculated using trade statistics broken down into 109 product categories. The energy intensities used for each category stem from a variety of sources (IVEM 1999, Hofstetter 1992). This calculation is based on averages for the 1990s. This segment of the Ecological Footprint accounts will be improved in the future by using more detailed national trade data and more accurate embodied energy figures. **Embodied energy** is the energy used during a product's entire life cycle for manufacturing, transportation, product use, and disposal.

Table 5: **THE WORLD'S LARGEST HYDRO DAMS**

Aguamilpa, Mexico	Guri, Venezuela	Sayanskaya, Russian Federation
Akosombo, Ghana	Ilha Solteira, Brazil	Sobradinho, Brazil
Aswan High Dam, Egypt	Itaipu, Brazil and Paraguay	Three Gorges, China
Balbina, Brazil	Jupia, Brazil	Três Marias, Brazil
Brokopondo, Suriname	Kariba, Zimbabwe and Zambia	Tucurui, Brazil
Carbora Bassa, Mozambique	Paredao, Brazil	Urra I and II, Colombia
Churchill Falls, Canada	Paulo Alfonso, Brazil	
Curua-una, Brazil	Pehuenche, Chile	
Furnas, Brazil	Rio Grande II, Colombia	
Grand Coulee, USA	Samuel, Brazil	
Guavio, Colombia	Sao Simao, Brazil	

Source: Goodland 1990 and WWF International 2000.

7. Normalizing bioproductive areas

Cropland, forest, grassland, and fishing grounds vary in bioproductivity. In order to produce Ecological Footprint results in a single measure – the global hectare – the calculations normalize bioproductive areas across nations and area types to account for differences in land and sea productivity. Equivalence factors and yield factors are used to convert the actual areas in hectares of different land types into their equivalents in global hectares. These factors are applied to both footprints and biocapacities.

Equivalence factors relate the average primary biomass productivities of the different types of land (i.e. cropland, pasture, forest, fishing ground) to the global average primary biomass productivity in a given year. A hectare with world average productivity has an equivalence factor of 1.

Each year has its own set of equivalence factors, since the relative productivity of land-use types varies due to variations in technology and resource management schemes. For example, for 2001 (see Table 6), every hectare of pasture has an equivalence factor of 0.48 since, on average, pasture in that year was about half as productive as the average bioproductive hectare of the Earth's surface. The equivalence factors are the same for all countries in a given year.

Yield factors account for the difference in productivity of a given type of land across different nations. For example, a hectare of pasture in New Zealand will produce more meat on average than a hectare of pasture in Jordan; therefore the yield factor for New Zealand pasture is higher than that for Jordanian pasture. The yield factor of world average land of any type, in this case pasture, is 1. Each country and each year has its own set of yield factors. Yield factors compare national productivity with world productivity, grouped by land type. For example, Table 7 shows that Guatemala's forests are 1.4 times as productive as world average forests.

Table 6: **EQUIVALENCE FACTORS,** 2001

Area type	Equivalence factor (global ha/ha)
World average productivity	*1.00*
Primary cropland	2.19
Marginal cropland	1.80
Forest	1.38
Pasture	0.48
Marine	0.36
Inland water	0.36
Built-up land	2.19

To calculate the **biocapacity** of a nation, each of the different types of bioproductive area within that nation's borders – cropland, forest area, inland fisheries, ocean fisheries, pasture/grazing, and built-up land – is multiplied by the equivalence factor for that type (the same for every country in a given year) and the yield factor for that type (specific for each country in a given year).

The **productivity adjusted area** is biologically productive area expressed in world average productivity. It is calculated by multiplying the physically existing area by the yield and equivalence factors, thus expressing the result in global hectares. Worldwide, the number of biologically productive hectares and the number of global hectares is the same.

8. Water withdrawals

National footprint and biocapacity accounts do not presently include freshwater use and availability because withdrawal of a cubic metre of freshwater affects local biocapacity differently depending on local conditions. Removing one cubic metre from a wet area makes little difference to the local environment, while in arid areas every cubic

Table 7: **SAMPLE YIELD FACTORS FOR SELECTED COUNTRIES,** 2001

	Primary cropland	Forest	Pasture	Ocean fisheries
World average yield	*1.0*	*1.0*	*1.0*	*1.0*
Algeria	0.5	0.1	0.7	0.7
Guatemala	1.0	1.4	2.9	0.2
Hungary	1.5	2.9	1.9	1.0
Japan	1.6	1.6	2.2	1.4
Jordan	0.9	0.0	0.4	0.7
Laos	0.8	0.2	2.7	1.0
New Zealand	1.8	2.4	2.5	0.2
Zambia	0.5	0.3	1.5	1.0

metre removed directly compromises local bioproductivity. Hence, water assessments need very specific data on local circumstances. Such data are not available.

In the current Ecological Footprint accounts, freshwater use is reflected only to the extent that overuse or lack of freshwater eventually leads to reduced biocapacity.

To indicate the importance of freshwater resources, separate data on water withdrawals per person are included in this report. Withdrawals include the use of water from sources such as rivers and lakes for agricultural, industrial, and domestic purposes. The use of rainwater for agriculture is not included. Just as the Ecological Footprint may be compared with available biocapacity, a country's water withdrawals may be compared with the size of its annual renewable water resource. These data are given, per person, in Table 2 (pages 24-31).

Water withdrawals are not fully comparable with the Ecological Footprint, however. Whereas the Ecological Footprint measures consumption of resources by the final end-user, water withdrawals may be an input to the production of a commodity which is exported and consumed in another country – some products of this sort, such as cotton, have a very heavy water demand. The data on water withdrawals and resource availability are taken from Gleick (2004) and AQUASTAT (FAO 2004a).

9. Natural accounting

Natural capital is the stock of natural assets that yield goods and services on a continuous basis. Main functions include resource production (such as fish, timber, or cereals), waste assimilation (such as CO_2 absorption, sewage decomposition), and life support services (UV protection, biodiversity, water cleansing, climate stabilization).

Ecological deficit is the amount by which the Ecological Footprint of a population exceeds the biocapacity of the population's territory. The national ecological deficit measures the amount by which a country's footprint exceeds its biocapacity. A national deficit is covered through trade or offset through loss of national ecological capital. But a global ecological deficit cannot be offset through trade; it is equal to a global **ecological overshoot**.

Ecological debt is the accumulated annual global deficit. Debts are expressed in planet-years – one **planet-year** being the annual production of the biosphere.

Ecological reserve is biocapacity in a territory that is not used for consumption by the population of that territory: the opposite of an ecological deficit. Countries with footprints smaller than their locally available biocapacity have an ecological reserve. This reserve is not necessarily unused by people – it may be occupied by the footprints of other countries (through production for export).

10. Contraction & Convergence and Shrink & Share

Contraction & Convergence (C&C) as proposed by Aubrey Meyer from the Global Commons Institute (Meyer 2001) provides a simple framework for globally allocating the right to emit carbon in a way that is consistent with the physical constraints of the biosphere. The approach rests on two simple principles:

- contraction: reducing humanity's emissions to a rate that the biosphere can absorb
- convergence: distributing total emissions so that each person ultimately gets the same portion of the "global budget".

Although C&C focuses exclusively on CO_2 emissions, which are responsible for about 50 per cent of humanity's Ecological Footprint, the C&C framework can be extended to other demands on the biosphere.

The extension of C&C to all demands on the biosphere is referred to as Shrink & Share. Shrinkage would occur when nations, organizations, and individuals reduce their footprints so that consumption, production, investment, and trade activities do not exceed the regenerative capacity of the globe's life-supporting ecosystems. Sharing would occur if these reductions were allocated in ways considered equitable by the participants. This includes many possibilities: for example, it might imply that consumption, production, investment, and trade patterns change such that the per capita footprints in various nations deviate less and less from each other, that there is a more equitable distribution of the rights to use resources, or that resource consumption rights are more closely tied to the resources a region or nation has available.

Further discussion on Shrink & Share and how this can support risk assessments and eco-insurance schemes can be found in Lovink et al. (2004).

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MAP SOURCES

Map 1
UNEP-WCMC. GIS analysis by R. Lesslie (ANU), method developed for the Australian Heritage Commission.

Map 2
WWF/UNEP-WCMC.

Map 3
WWF/UNEP-WCMC.

Map 4
Cold water coral data UNEP-WCMC, sourced from A. Freiwald from various sources. Tropical coral data UNEP-WCMC. Marine species data WWF/UNEP-WCMC.

Maps 5, 6, and 7
Global Footprint Network and SAGE, University of Wisconsin. Distribution builds on Gridded Population of the World (version 2) from CIESIN at Columbia University (http://sedac.ciesin.columbia.edu/plue/gpw/index.html?main.html&2). 1995 population distribution is scaled to each country's 2001 population.

Map 8
Data from Gleick, P H, 2004, *The World's Water 2004-2005,* Island Press, Washington, DC, USA and FAO – Food and Agriculture Organization of the United Nations, 2004, AQUASTAT, FAO's Information System on Water and Agriculture (www.fao.org/ag/agl/aglw/aquastat/main/index.stm).

THE WWF NETWORK

AUSTRALIA
GPO Box 528, Sydney, NSW 2001
Tel: +61 2 9281 5515

AUSTRIA
Postfach 1, 1162 Vienna
Tel: +43 1 488 170

BELGIUM
Bd Emile Jacqmain 90
1000 Brussels
Tel: +32 2 340 09 99

BHUTAN
Post Box 210, Chubachu, Thimphu
Tel: +975 2 323 528

BOLIVIA
PO Box 1633, Santa Cruz
Tel: +591 3 31150 41

BRAZIL
SHIS EQ QL 6/8
Conjunto E – 2° andar
71620-430 Brasilia
Tel: +55 61 364 7400

CANADA
245 Eglinton Ave East, Suite 410,
Toronto, Ontario M4P 3J1
Tel: +1 416 489 8800

CAUCASUS
M. Aleksidze str. 11
380093 Tbilisi, Republic of Georgia
Tel: +995 32 33 0154

CENTRAL AFRICA
Bastos BP 6776, Yaounde
Cameroon
Tel: +237 221 70 83

CENTRAL AMERICA
PO Box 629-2350
San Jose, Costa Rica
Tel: +506 253 4960

CHINA
Wen Hua Gong
Beijing Working People's Culture
Palace
Beijing 100006
Tel: +86 10 6522 7100

COLOMBIA
Carrera 35 No 4A-25
San Fernando, Cali, Valle
Tel: +57 2 558 2577

DANUBE/CARPATHIAN
Mariahilferstrasse 88a/3/9
A-1070 Vienna, Austria
Tel: +431 52 45 470

DENMARK
Ryesgade 3 F
2200 Copenhagen N
Tel: +45 35 36 36 35

EASTERN AFRICA
PO Box 62440, Nairobi
Kenya
Tel: +254 20 577 355

EUROPEAN POLICY
36 Avenue de Tervuren - B12
1040 Brussels, Belgium
Tel: +32 2 743 88 00

FINLAND
Lintulahdenkatu 10
00500 Helsinki 50
Tel: +358 9 774 0100

FRANCE
188 rue de la Roquette
75011 Paris
Tel: +33 1 55 25 84 84

GERMANY
Postfach 190 440
60326 Frankfurt/Main
Tel: +49 69 79 14 40

GREECE
26 Filellinon St
105 58 Athens
Tel: +30 210 331 4893

HONG KONG
GPO Box 12721, Hong Kong
Tel: +852 2526 1011

HUNGARY
Németvölgyi út 78/b
1124 Budapest
Tel: +36 1 214 5554

INDIA
172-B Lodi Road
New Delhi 110 003
Tel: +91 11 5150 4815

INDOCHINA
International PO Box 151
Hanoi, Viet Nam
Tel: +84 4 733 8387

INDONESIA
PO Box 5020
JKTM 12700, Jakarta
Tel: +62 21 576 1070

ITALY
Via Po 25/c, 00198 Rome
Tel: +39 06 844 9 71

JAPAN
Nihonseimei Akabanebashi
Building
3-1-14 Shiba, Minato-ku
Tokyo 105-0014
Tel: +81 3 3769 1711

MACROECONOMICS FOR SUSTAINABLE DEVELOPMENT
1250 24th Street NW
Washington, DC 20037-1193, USA
Tel: +1 202 778 9752

MADAGASCAR AND WEST INDIAN OCEAN
BP 738, Antananarivo 101
Tel: +261 20 22 348 85

MALAYSIA
49 Jalan SS23/15
47400 Petaling Jaya
Tel: +60 3 7803 3772

MEDITERRANEAN
Via Po 25/c
00198 Rome, Italy
Tel: +39 06 844 97227

MEXICO
Ave Mexico No 51
Col. Hipodromo Condesa
06170 Mexico, DF
Tel: +525 55 5286 5631

MONGOLIA
Khudaldaany Street 5
Ulaanbataar 46
Tel: +976 11 311 659

NEPAL
Post Box 7660, Kathmandu
Tel: +977 1 4410 942

NETHERLANDS
Postbus 7, 3700 AA Zeist
Tel: +31 30 6937 333

NEW ZEALAND
PO Box 6237
6001 Wellington
Tel: +64 4 499 2930

NORWAY
Postboks 6784
St Olavs plass
0130 Oslo
Tel: +47 22 03 65 00

PAKISTAN
PO Box 5180
Lahore 54600
Tel: +92 42 586 2360

PERU
Casilla Postal 11-0205
Lima 11
Tel: +51 1 440 5550

PHILIPPINES
LBI Building, No 57 Kalayaan Ave
Diliman, 1101 Quezon City
Tel: +63 2 929 1258

POLAND
ul. Wisniowa 38 m. 1
Magdalena Dul
02-520 Warsaw
Tel: +48 22 849 84 69

RUSSIA
From Europe:
Account No WWF 232
FLIP-Post
Suite 25
176 Finchley Road
London NW3 6BT
United Kingdom

From the USA:
Account No WWF 232
208 East 51st Street
Suite 295
New York, NY 10022, USA
Tel: +7 095 727 0939

SOUTH AFRICA
Private Bag X2
Die Boord 7613, Stellenbosch
Tel: +27 21 888 2800

SOUTHERN AFRICA
PO Box CY 1409
Causeway, Harare, Zimbabwe
Tel: +263 4 703902

SOUTH PACIFIC
Private Mail Bag, GPO Suva, Fiji
Tel: +679 331 5533

SPAIN
Gran Via de San Francisco 8
28005 Madrid
Tel: +34 91 354 05 78

SWEDEN
Ulriksdals Slott, 170 81 Solna
Tel: +46 8 624 74 00

SWITZERLAND
Postfach
8010 Zürich
Tel: +41 1 297 21 21

TANZANIA
PO Box 63117, Dar es Salaam
Tel: +255 22 27 00077

THAILAND
PO Box 4, Klong Luang 12120
Tel: +66 2 524 6168

TURKEY
PK 971, Sirkeci 34436, Istanbul
Tel: +90 212 528 20 30

UNITED KINGDOM
Panda House
Weyside Park
Godalming
Surrey GU7 1XR
Tel: +44 1483 426 444

UNITED STATES
1250 24th Street NW
Washington, DC 20037-1193
Tel: +1 202 293 4800

WESTERN AFRICA
08 BP 1776
Abidjan 08
Côte d'Ivoire
Tel: +225 22 47 20 86

ASSOCIATES

ARGENTINA
FUNDACION VIDA SILVESTRE
Defensa 251, 6° Piso
C1065 Buenos Aires
Tel: +54 11 4343 4086

ECUADOR
FUNDACION NATURA
Casilla 17-01-253, Quito
Tel: +593 22 503 385

NIGERIA
NIGERIAN CONSERVATION FOUNDATION
PO Box 74638
Victoria Island, Lagos
Tel: +234 1 26242 497

VENEZUELA
FUDENA
Apartado Postal 70776
Caracas 1071-A
Tel: +58 212 238 2930

WWF INTERNATIONAL
Avenue du Mont-Blanc
1196 Gland, Switzerland
Tel: +41 22 364 9111
Fax: +41 22 364 8836
Website: www.panda.org

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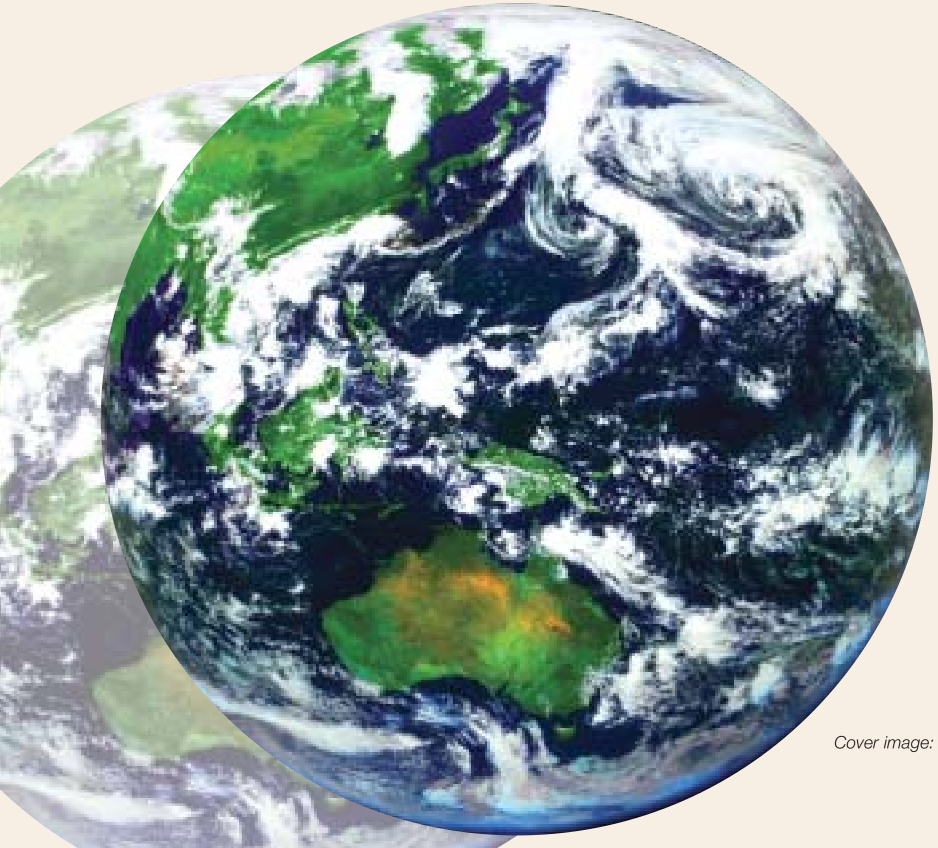
WWF International
Avenue du Mont-Blanc
1196 Gland
Switzerland

Tel: +41 22 364 9111
Fax: +41 22 364 8836

www.panda.org



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