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CENTRE FOR SUSTAINABILITY STUDIES

LIVING PLANET REPORT 2000

CONTENTS

THE UNEP WORLD CONSERVATION MONITORING CENTRE was established in 2000 as the world biodiversity information and assessment centre of the United Nations Environment Programme. The roots of the organisation go back to 1979, when it was founded as the IUCN Conservation Monitoring Centre. In 1988 the World Conservation Monitoring Centre was created jointly by IUCN, WWF-International and UNEP. The financial support and guidance of these organisations in the Centre's formative years is gratefully acknowledged. As an international conservation organisation, UNEP-WCMC provides objective, scientifically rigorous and focused information on global biodiversity.

REDEFINING PROGRESS is an Oakland, California based think-tank that works to expose the inadequacy of equating economic growth with progress; embrace's nature's limits as a path to true sustainability; promotes pricing systems that incorporate social and environmental costs; and advocates care-taking of common assets.

THE CENTRE FOR SUSTAINABILITY STUDIES of the An·huac University of Xalapa, Mexico, is a research institute that analyses human use of nature and offers workshops on sustainability.

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INTRODUCTION

While the state of the Earth's natural ecosystems has declined by about 33 per cent over the last 30 years (see Figure 1), the ecological pressure of humanity on the Earth has increased by about 50 per cent over the same period (see Figure 2), and exceeds the biosphere's regeneration rate. These are the main conclusions of the *Living Planet Report 2000*, based on two indices, the Living Planet Index (LPI) and the Ecological Footprint. This report has two principal objectives: the first is to quantify changes in the state of the Earth's natural ecosystems over time; the second is to measure the human pressures on the natural environment arising from the consumption of renewable resources and pollution, and analyse the geographic patterns in those pressures.

In this year's report we have used more data to calculate the LPI, making the index more reliable. Because the volume of data used in the LPI is much larger than before, the index is now calculated regionally, or by ocean in the case of marine ecosystems. However, the overall conclusion remains unchanged: the natural wealth of the world's forests, freshwater ecosystems, and oceans and coasts has declined rapidly, particularly in freshwater and marine ecosystems. The Living Planet Index fell by 33 per cent between 1970 and 1999.

A new feature of this year's *Living Planet Report* is the index we use to estimate the pressure on the Earth resulting from humanity's natural resource consumption. This is the "Ecological Footprint", which measures a population's consumption of food, materials, and energy in terms of the area of biologically productive land or sea required to produce those resources and to absorb the corresponding waste. The calculation of the footprint leaves out some pressures for which data are incomplete such as water consumption and the release of toxic pollutants. This means that the results are underestimates of humanity's full impact.

We have calculated the Ecological Footprint for individual countries in 1996, as well as for the world population from 1961 to 1997.

The Ecological Footprint method allows us not only to estimate the human pressures on the Earth, but also to make comparisons between humanity's demands on nature and the capacity of the Earth to supply resources and assimilate waste.

In 1997, the Ecological Footprint of the global population was at least 30 per cent larger than the Earth's biological productive capacity. At some time in the 1970s, humanity as a whole passed the point at which it lived within the global regenerative capacity of the Earth, causing depletion of the Earth's natural capital as a consequence (although locally this has occurred many times and in many places throughout human history). This is the ultimate cause of the decline in the natural wealth of the world's forest, freshwater, and marine ecosystems, as indicated by the LPI.

Secondly, the preliminary conclusion from the regional LPI analysis is that the steepest declines in all three ecosystem types have taken place in southern temperate and tropical regions. This does not necessarily mean that the state of southern temperate and tropical ecosystems is worse than that of northern temperate ecosystems, but simply that the relative decline has been greatest in tropical ecosystems over the past 30 years. The loss of natural wealth in northern temperate ecosystems largely took place more than 30 years ago. By comparing the resource consumption patterns of different countries we conclude that, in 1996, the Ecological Footprint of an average consumer in the industrialized world was four times that of an average consumer in the lower income countries. This implies that rich nations (located mainly in northern temperate zones) are primarily responsible for the ongoing loss of natural wealth in the southern temperate and tropical regions of the world.

Fig. 1:
LIVING PLANET INDEX, 1970–99

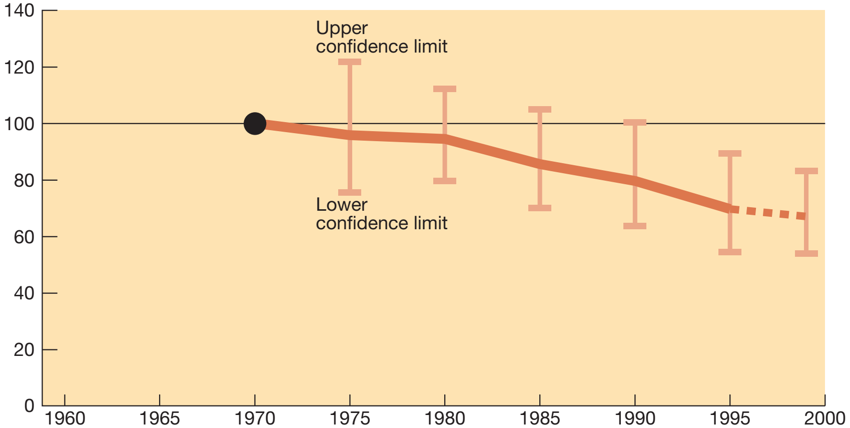
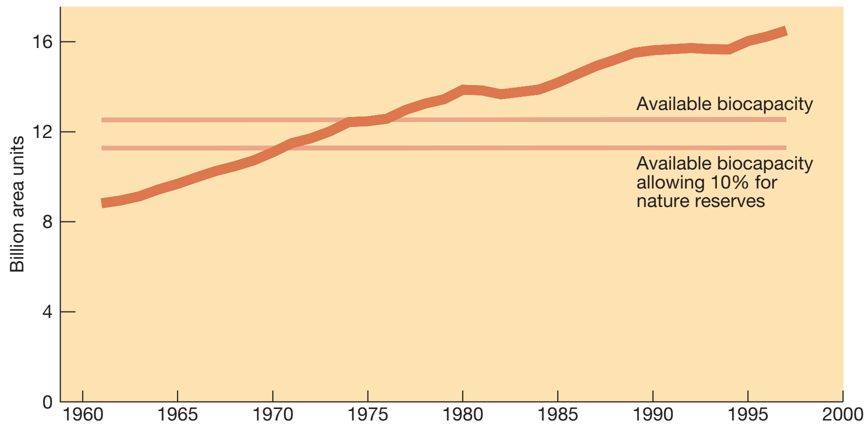


Fig. 2:
WORLD ECOLOGICAL FOOTPRINT, 1961–97



THE LIVING PLANET INDEX

The Living Planet Index is a measure of the natural wealth of the Earth's forests, freshwater ecosystems, and oceans and coasts. Figure 1 shows that the index fell by about 33 per cent between 1970 and 1999. The LPI is the average of three indices which monitor the changes over time in populations of animal species in forest, freshwater, and marine ecosystems respectively (see Figures 3-5). More details on how these indices are calculated are given on pages 4-9.

Each ecosystem index measures the change over time of a population that is typical of the sample of species in the index. The forest index includes 319 species populations, and shows a decline of about 12 per cent from 1970 to 1999. The freshwater index includes about 194 species populations and fell by about 50 per cent between 1970 and 1999. The marine index includes about 217 species populations which declined by about 35 per cent on average over the same period. These species were not selected as being the best indicators of their respective habitats, but represent all those for which time-series population data could be found.

Previous editions of the *Living Planet Report* used species populations to measure changes in freshwater and marine ecosystems, but not in forest ecosystems. Instead we used changes in forest area. In this report, all three ecosystem indexes are calculated in the same way. While this alteration improves the methodological consistency of the LPI, it does not significantly alter the overall result. The forest species population index declined by about 12 per cent between 1970 and 1999 while the forest area declined by approximately 11 per cent.

With the larger number of species included in the Living Planet Index, the three ecosystems indices are now calculated on a regional basis. The forest species population index is the average of separate trends in temperate and tropical forests. The freshwater species population index combines average trends from six continents, and the marine species population index is based on trends in six regional oceans. There is a difference between average trends of northern and southern species populations in the freshwater and marine indices, and between temperate and tropical populations in the forest indices. In all three ecosystem types, the most severe declines have been in the southern or tropical regions of the world.

This does not imply that the northern temperate ecoregions of the world are in a better state than tropical or southern temperate ecoregions, but that the northern temperate ecoregions have shown less change over the last 30 years (although there have been many examples of local declines). Much of the loss of biodiversity in northern temperate ecosystems took place prior to 1970, especially from the early 19th century onwards, and so is not recorded in the LPI. However, there are far fewer population data available for southern temperate and tropical species than northern temperate ones, and the trends shown in the regional sub-indices need to be corroborated by more data.

Boxes 1–6 on the opposite page give examples of a selection of species populations used in calculating the LPI.

Fig. 1:
LIVING PLANET INDEX, 1970–99

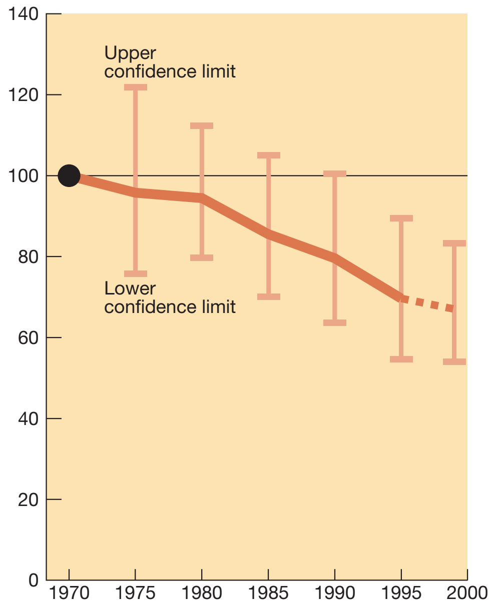


Fig. 3:
GLOBAL FOREST ECOSYSTEMS INDEX, 1970–99

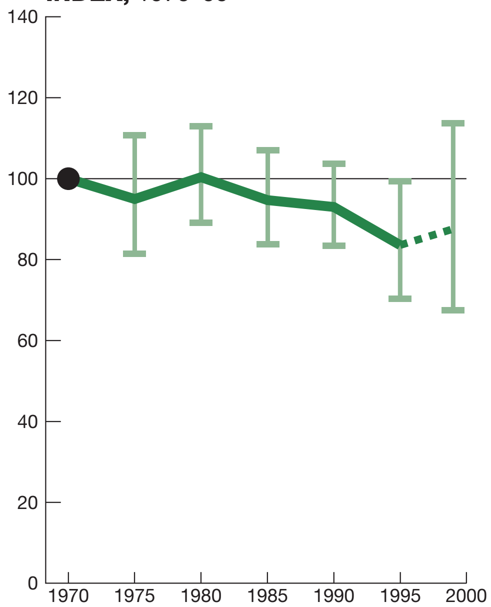


Fig. 4:
FRESHWATER SPECIES POPULATION INDEX, 1970–99

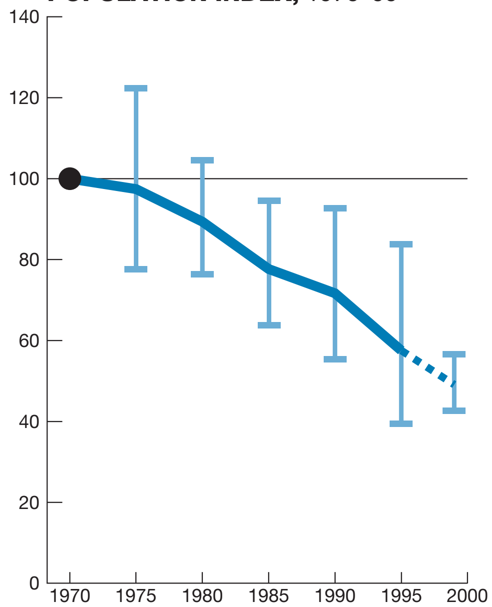
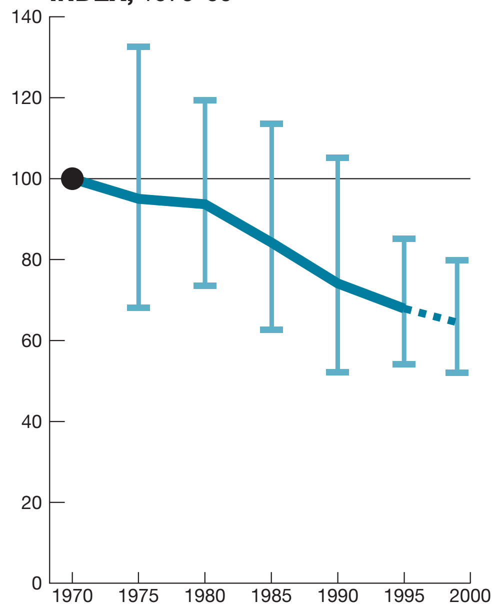
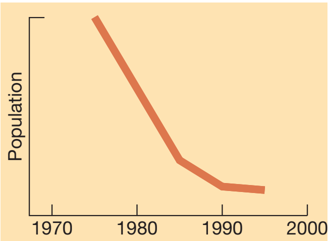


Fig. 5:
MARINE SPECIES POPULATION INDEX, 1970–99

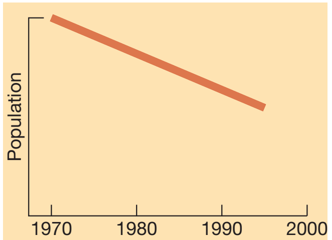


Box 1: SILVERY GIBBON
(*Hylobates moloch*) in Indonesia



The silvery gibbon is endemic to the tropical rainforests of western and central Java, Indonesia. The species has declined through severe encroachment on forest habitats by Java's human population. There are possibly fewer than 3 000 silvery gibbons remaining, many of which occur in the reserves of Ujung Kulon and Gunung Halimun.

Box 3: LESSER WHITE-FRONTED GOOSE
(*Anser erythropus*) in Eurasia



The lesser white-fronted goose breeds in the taiga and tundra zones of northern and western Eurasia and winters in the steppe zone of southeast Europe. It is believed that the main causes of its decline are the loss of its feeding habitat and hunting pressure at the staging and wintering grounds.
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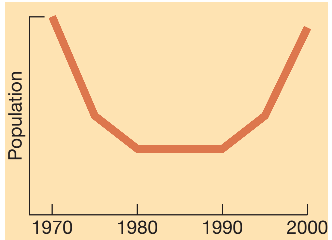
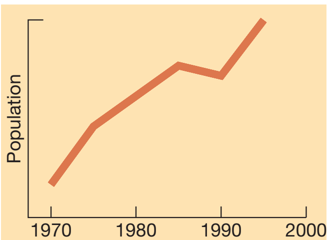
Box 5: KEMP'S RIDLEY TURTLE
(*Lepidochelys kempi*) in Mexico



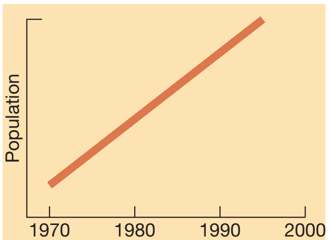
Kemp's ridley is the most endangered sea turtle species. It generally occurs in the waters of the western Atlantic and almost exclusively nests at a single beach in Mexico. Predation on eggs, catching of adults, and incidental catch in fishing gear has greatly reduced the turtle's population. Ongoing intensive conservation measures appear to have stemmed the decline and numbers of nesting females are gradually increasing.

Box 2: SPARROWHAWK
(*Accipiter nisus*) in the UK



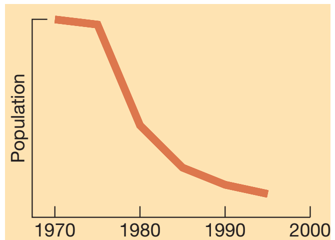
The sparrowhawk occurs throughout the forests and open woodland habitats of Eurasia and northern parts of Africa. The widespread use of organochlorine pesticides in Europe during the 1950s and 1960s killed many birds of prey and reduced their breeding success. These pesticides were banned in the 1970s in a number of countries, and several sparrow-hawk populations, such as those in the UK, have since shown a gradual recovery.

Box 4: GHARIAL
(*Gavialis gangeticus*) in southern Asia



The gharial is one of the largest living crocodilians. The species is restricted to northern parts of the Indian sub-continent where it inhabits deep, fast-flowing rivers. While the gharial remains one of the most endangered crocodilians, its population has greatly increased since the 1970s, largely because of conservation programmes initiated over much of its range.

Box 6: BLUEFIN TUNA
(*Thunnus thynnus*) in the western Atlantic



The bluefin tuna is found on both sides of the Atlantic and both the eastern and western Pacific. Overfishing has led to a decline in tuna populations throughout the range. In the western Atlantic the population of fish over ten years old may have declined by up to 95 per cent since 1970.

FOREST SPECIES POPULATION INDEX

The Forest Species Population Index measures the average change over time in 319 forest species populations, and shows a decline of about 12 per cent from 1970–99. The index is the average of two sub-indices which relate to temperate and tropical forests, respectively. Figure 6 shows that the sub-index for tropical forest has declined by about 25 per cent over the period 1970-1999 while the sub-index for temperate forests increased slightly. This closely parallels the trends in the area of tropical and temperate forests over the same period (see Figure 7). The temperate and tropical forest components are given equal weighting in the overall forest index. This is because temperate and tropical forests currently occupy approximately equal areas of the Earth's surface.

Although there has been no overall decline in the temperate forests index since 1970, this does not imply that temperate forests are in a better state than tropical forests. It means that, on average worldwide, there has been little change in temperate forests over the last 30 years, although locally there are exceptions, such as the temperate rainforests on the Pacific coasts of Canada, the United States, and Chile. Most deforestation in temperate countries took place before the 20th century.

If the forest index could be extended back over 300 or 3 000 years rather than merely 30, a large overall decline for temperate forests would become apparent (see Figure 7). Before humans began modifying natural ecosystems to grow crops and graze animals around 8 000–10 000 years ago, the world's forests would have covered twice their current area, assuming that climatic conditions then were similar to today's. Both temperate and tropical forest areas have declined by about 50 per cent since the advent of agriculture. In contrast with temperate forests, however, most of the loss of tropical forests has taken place within the last 100 years, and is still continuing.

Species used in the index include antelopes, Asian elephant, Baird's tapir, brush-tailed possum, canids, cats, deer, flying foxes, giant panda, gibbons, great apes, hares and rabbits, kangaroos, jumping mouse, lemurs, mustelids, new world monkeys, old world monkeys, pipistrelle bat, rhinoceroses, shrews, sifaka, squirrels, tamarins, voles, bustards, creepers, cuckoos, doves, dunnock, falcons, finches, flycatchers, grouse, hawks, kinglets and thrushes, kiwis, jays and crows, mockingbirds and thrashers, new world warblers, nuthatches, old world warblers, owls, parrots and macaws, pheasants, sparrows, blackbirds, cowbirds and warblers, starling, tits, tree pipit, waxwing, woodcock, woodpeckers, wren, vireos, and several invertebrate species.

Map 1 shows the location of the world's forests, which currently cover approximately 30 million km^2, about one-fifth of the Earth's land surface.

Fig. 6:
FOREST SPECIES POPULATION INDICES,
1970–99

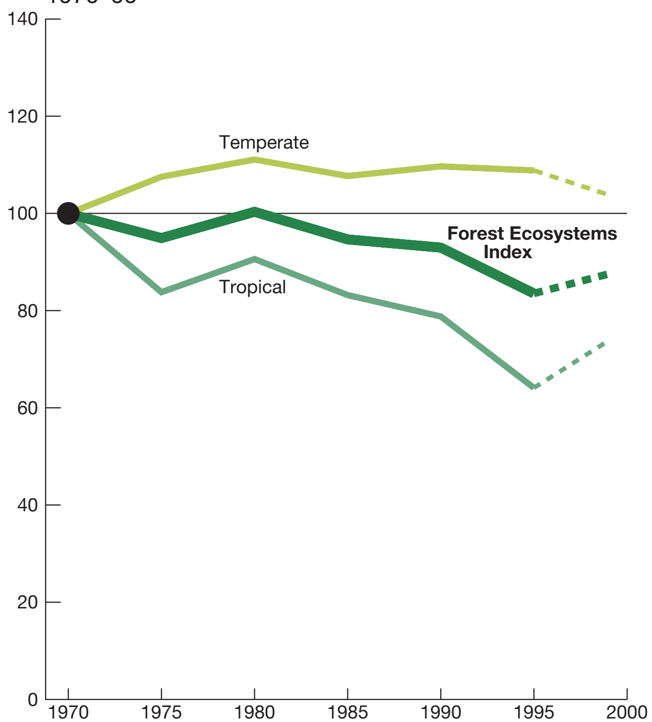
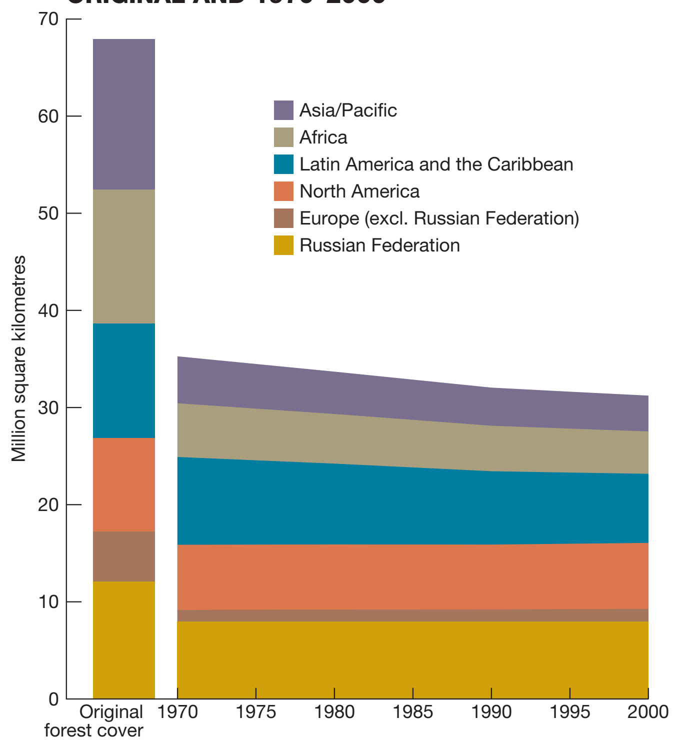
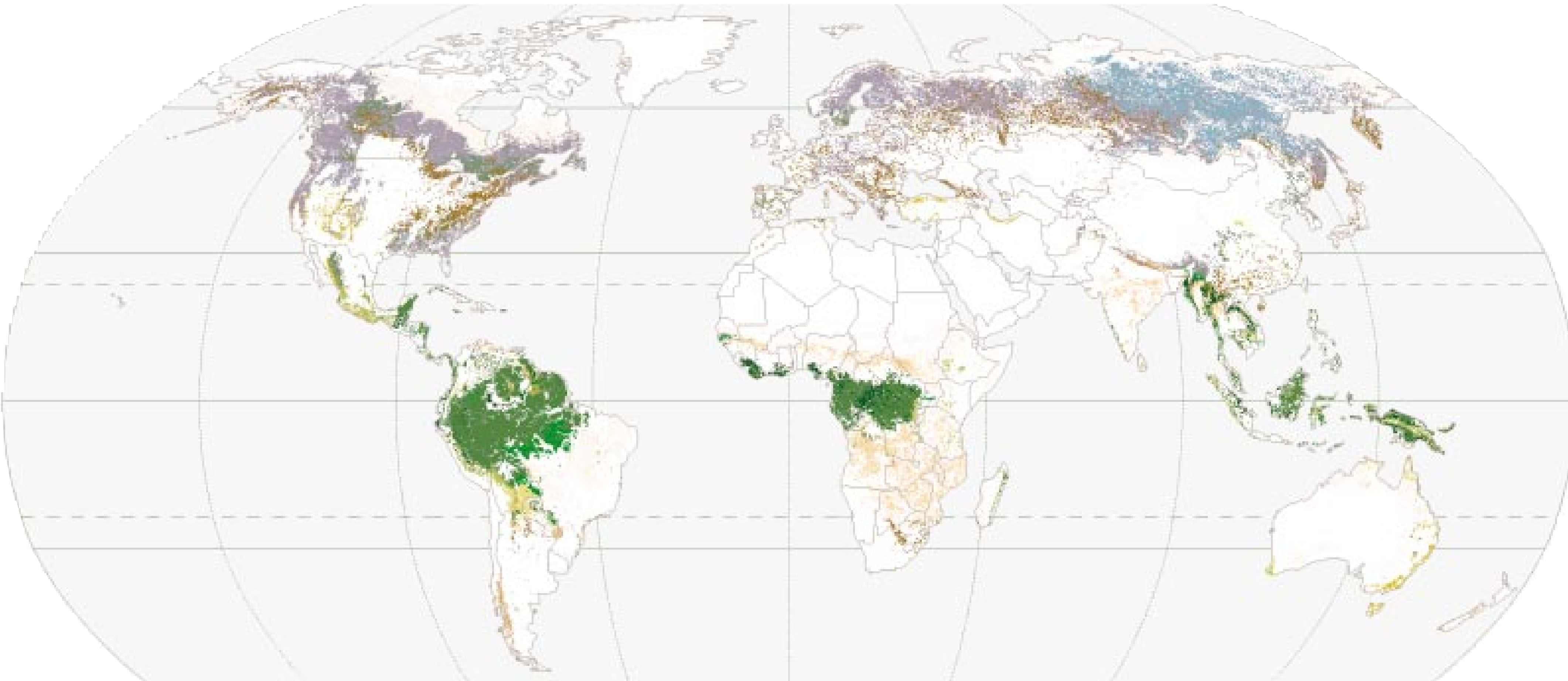


Fig. 7:
NATURAL FOREST COVER, ORIGINAL AND 1970–2000





Map 1:
CURRENT FOREST COVER

Tropical forests

- Montane forest
- Lowland evergreen broadleaf forest
- Semi-evergreen moist broadleaf forest
- Mixed needleleaf/broadleaf forest
- Needleleaf forest
- Sclerophyllous dry forest
- Deciduous/semi-deciduous broadleaf forest

Temperate and boreal forests

- Deciduous broadleaf forest
- Sclerophyllous dry forest
- Evergreen needleleaf forest
- Deciduous needleleaf forest
- Mixed broadleaf/needleleaf forest
- Broadleaf evergreen forest
- Disturbed natural forest

FRESHWATER SPECIES POPULATION INDEX

The Freshwater Species Population Index fell by about 50 per cent from 1970 to 1999 (see Figure 4), the most rapid decline of all three species population indices. It measures the average change over time in the populations of around 194 species of freshwater birds, mammals, reptiles, amphibians, and fishes. The index is the average of six sub-indices which relate to freshwater species populations from Africa, Asia-Pacific, Australasia, Europe, Latin America and the Caribbean, and North America respectively (see Figure 8).

Although the decline in European and North American freshwater species since 1970 has been much less severe than in other regions of the world, this does not imply that freshwater ecosystems in Europe and North America are in a better state than in other regions. It simply means that there has been less of a decline over the last 30 years. Much of the loss and degradation of freshwater ecosystems in the industrialized world took place prior to 1970.

The status of freshwater bird and mammal populations is better known than that of other groups, and waterfowl are among the most closely monitored of any wild species. Much less is known about population trends in freshwater fishes and amphibians, although many biologists believe these to be among the most threatened classes of species in the world. Recent evidence suggest that there has been a significant decline in amphibian populations in many parts of the world since the 1950s.

Species used in the index include European beaver, hippopotamus, Russian desman, river dolphins, saimaa seal, otter, reed bunting, cranes, ducks, geese and swans, flamingos, grebes, gulls and terns, eagles, herons and bitterns, ibises and spoonbills, common loon, pelicans, coots and swamphen, storks, snipe and redshank, South American river turtle, alligators and caimans, crocodiles, gharial, pond turtles, lungless salamanders, mole salamanders, narrowmouth toad, New Zealand frogs, newts, spadefoot toad, true toads, treefrogs, true frogs, ayu, carps and minnows, eel, galaxias, herrings and shads, perches, pike, salmons and trouts, splitfin, sturgeons, suckers, crayfish, and several other invertebrate species.

Map 2 shows the location of six major types of freshwater ecosystems around the world. Freshwater comprises only about 2.5 per cent of all water on Earth, and 99 per cent of that is locked up either in ice caps or below the ground. Freshwater ecosystems such as rivers, lakes, and wetlands occupy less than 2 per cent of the total land surface, yet they provide a wide range of habitat types for a significant proportion of the world's plant and animal species.

Fig. 4:
FRESHWATER SPECIES POPULATION INDEX, 1970–99

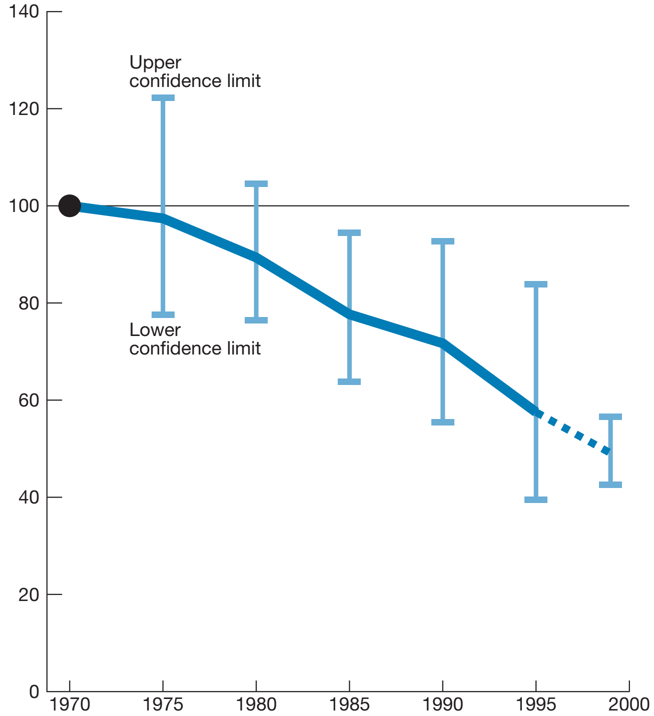
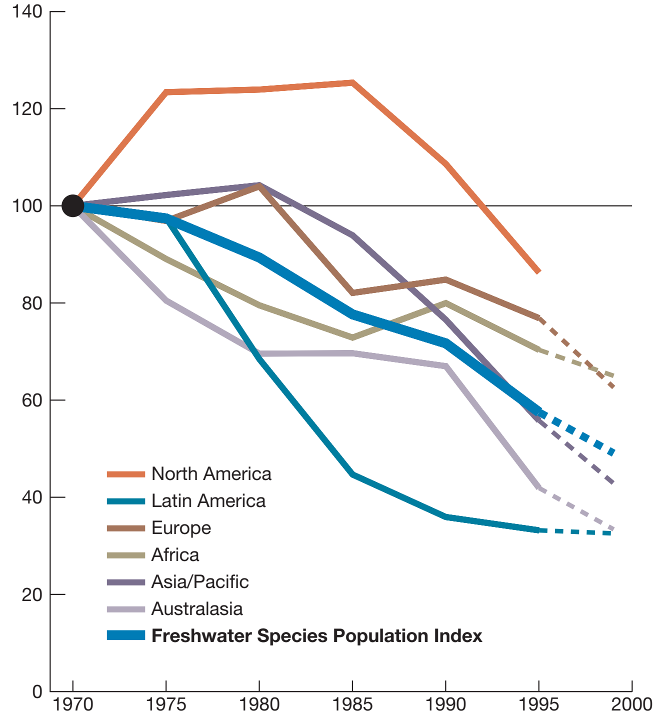
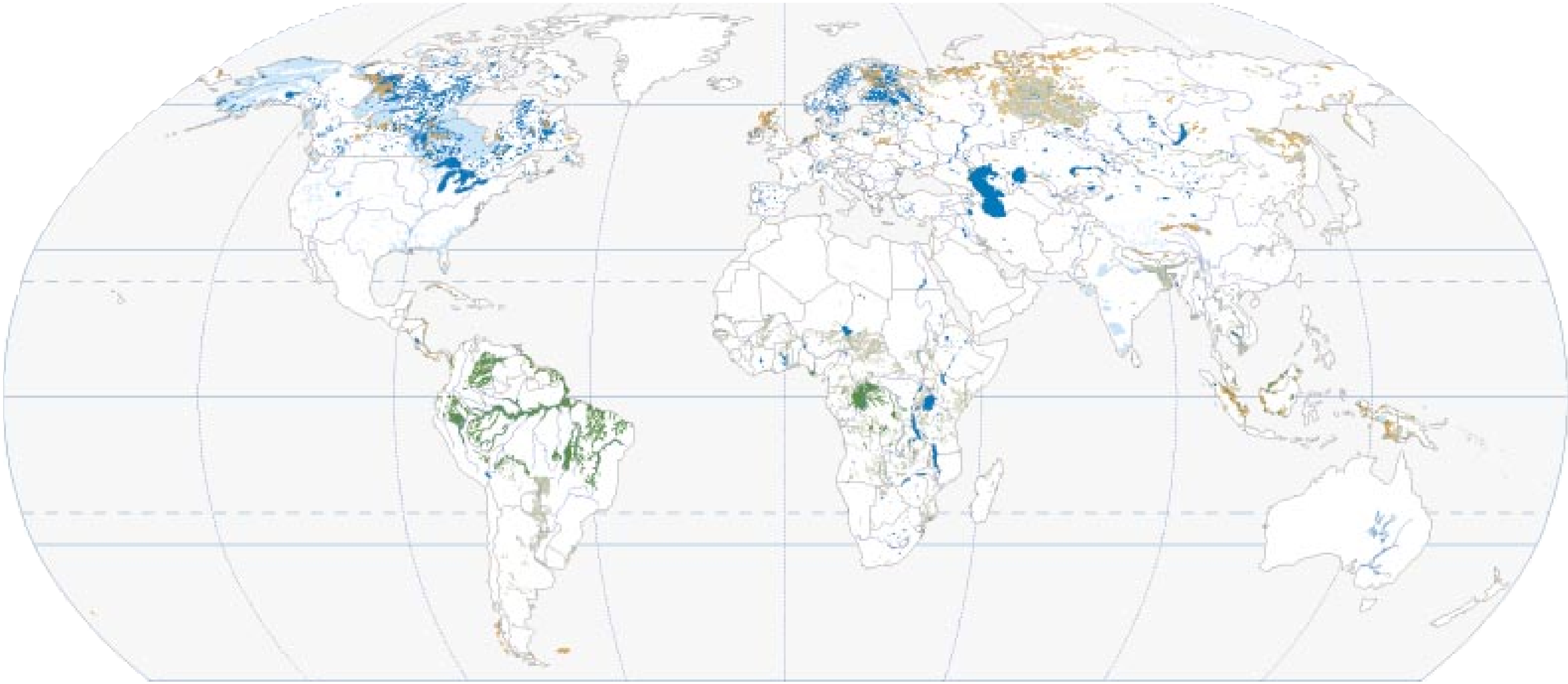


Fig. 8:
REGIONAL FRESHWATER SPECIES POPULATION INDICES, 1970–99





Map 2:
MAJOR FRESHWATER AREAS OF THE WORLD

- Freshwater marshes and floodplains
- Inland open waters
- Peatlands
- Seasonally flooding inland systems
- Swamp forest
- Unclassified wetland areas

MARINE SPECIES POPULATION INDEX

The Marine Species Population Index calculates the average changes in populations of 217 species of marine mammals, birds, reptiles, and fishes, and shows a decline of about 35 per cent from 1970 to 1999 (see Figure 5). The index is the average of six sub-indices which relate to the North Pacific, North Atlantic, Indian, South Pacific, South Atlantic, and Southern Oceans respectively (see Figure 9).

Like the forest and freshwater species, the marine species population declines have been more pronounced in the southern temperate and tropical oceans than in the northern temperate oceans. This does not mean that the northern oceans are in a better state, but simply that there has been a steeper relative decline in the southern and tropical oceans over the last 30 years than in the north.

Marine species are generally more difficult to monitor than terrestrial ones, and assessments are often based on catch sizes of harvested species. The exceptions are those species which nest or breed on land, such as seals and sea lions, seabirds, and marine turtles. Although fishes constitute over 90 per cent of marine vertebrate species, far more is known about the status of birds and mammals, and consequently these groups are over-represented in the index.

Species used in the marine index include beluga whale, bowhead whale, Caribbean manatee, dolphins, dugong, earless seals, fur seals and sea lions, grey whale, polar bear, rorqual whales, sea otter, sperm whale, vaquita, walrus, albatrosses, Bermuda petrel, boobies and gannets, brown pelican, cormorants and shags, eider duck, gulls and terns, parasitic jaeger, penguins, puffins, murrelets, auklets and guillemots, sandpipers, storm petrels, anchovies, atka mackerel, Bombay duck, capelin, cod icefishes, cods and haddocks, common sole, crocodile icefishes, dogfish, flathead mullet, goosefishes, herrings, shads, sardines and menhadens, jacks and pompanos, lane snapper, mackerels and tunas, merluccid hakes, porgies, righteye flounders, rockfishes, rockcods and thornyheads, sablefish, sandlance, scopthalmid flatfishes, summer flounder, swordfish, white hake, marine turtles, and several invertebrate species.

Map 3 and Figure 10 show the location and approximate areas of coral reef and mangrove ecosystems in the world's oceans. Coral reefs and mangroves are among the most productive, biologically diverse, and gravely threatened marine and coastal ecosystems.

Fig. 5:
MARINE SPECIES POPULATION INDEX, 1970–99

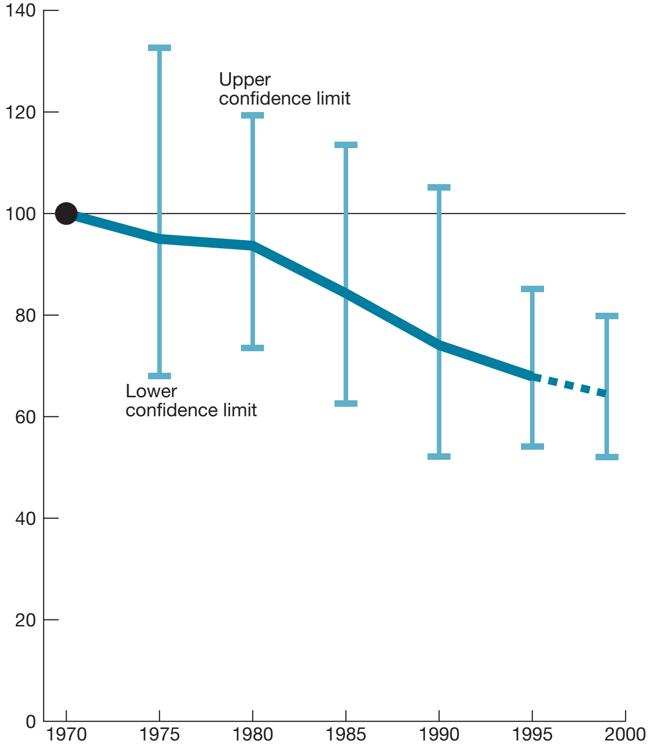


Fig. 9:
MARINE SPECIES POPULATION INDICES BY OCEAN, 1970–99

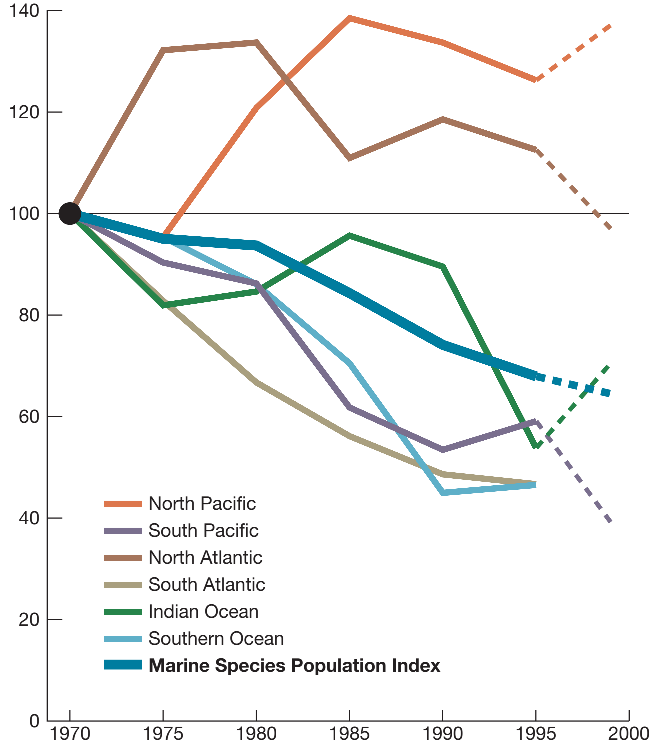
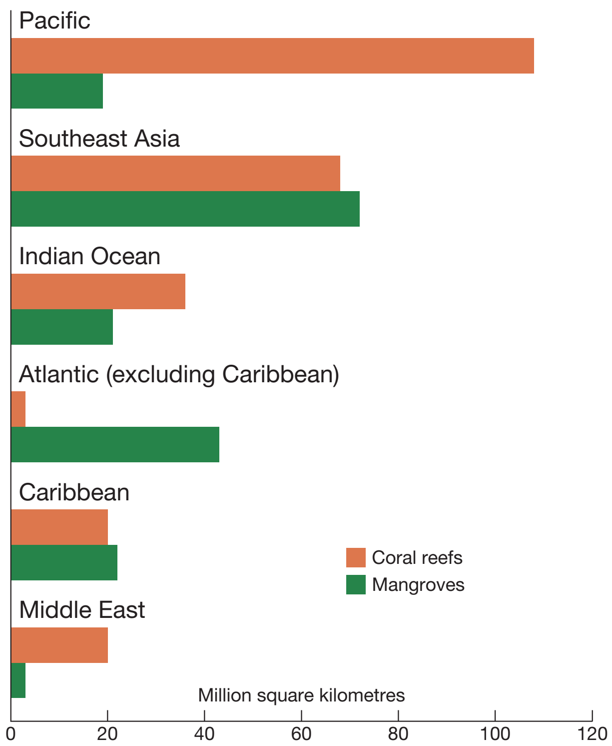
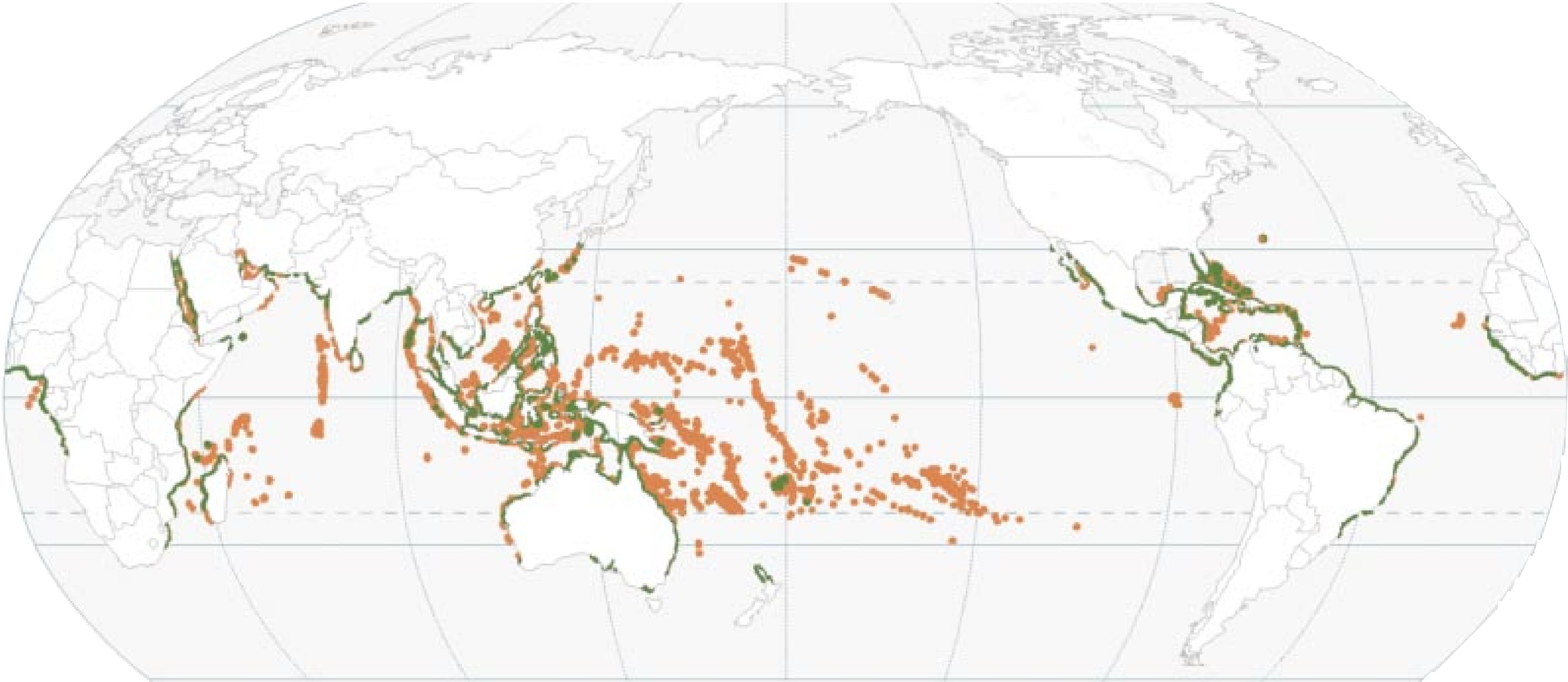


Fig. 10:
CORAL REEF AND MANGROVE ECOSYSTEMS





Map 4:
CORAL REEFS AND MANGROVE ECOSYSTEMS

Coral

Mangrove

THE ECOLOGICAL FOOTPRINT

The Ecological Footprint is a conservative estimate of human pressure on global ecosystems. It represents the biologically productive area required to produce the food and wood people consume, to give room for infrastructure, and to absorb the CO_2 emitted from burning fossil fuels, which is the primary cause of climate change, as explained further on the following pages. The Ecological Footprint is expressed in "area units". Each unit corresponds to one hectare of biologically productive space with "world average productivity" (see page 12 for a more detailed explanation). As people use resources from all over the world, and affect faraway places with their pollution, the footprint is the sum of these areas wherever they are on the planet.

The world's Ecological Footprint changes in proportion to global population size, average consumption per person, and the resource intensity of the technology being used. Technology can alter the productivity of land, or the efficiency with which resources are used to produce goods and services. The footprint calculations are conservative estimates of human impact since insufficient data are available on some uses of the biosphere. Also, the calculations assume that the technologies used in resource exploitation are the average of those prevailing in the world today, and do not make distinctions between the use of more sustainable exploitation in some places and less sustainable exploitation in others. This may distort the size of some countries' footprints, but does not affect the global result.

Figure 11 shows the growth of the Ecological Footprint of the world's population from 1961 to 1997. Figure 12 shows the size of the Ecological Footprints of seven regions of the world in 1996. The size of each box is proportional to the footprint of each region: the height of the box is proportional to the region's average Ecological Footprint per person and the width of the box is proportional to the population of the region. Figure 13 shows the size of the Ecological Footprint per person in all countries with populations greater than one million. The national and regional data relate to the year 1996, as this

Fig. 13:
ECOLOGICAL FOOTPRINT BY COUNTRY, 1996

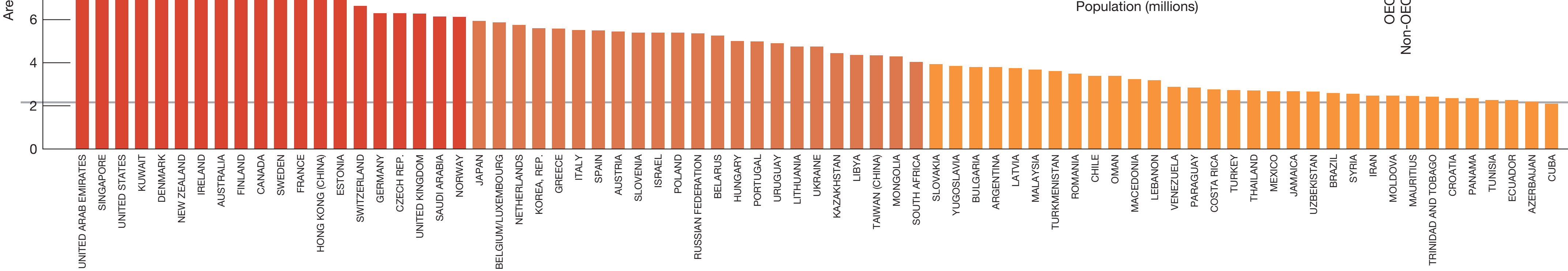


Fig. 11:
WORLD ECOLOGICAL FOOTPRINT, 1961–97

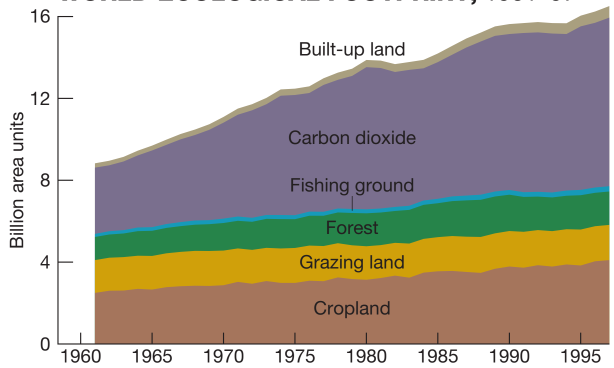
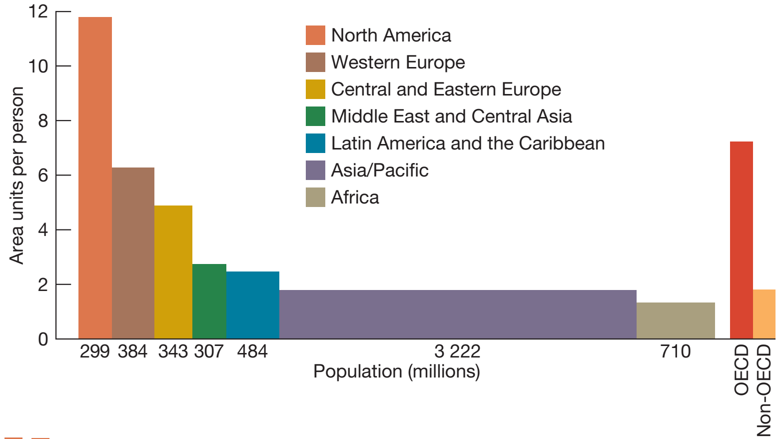
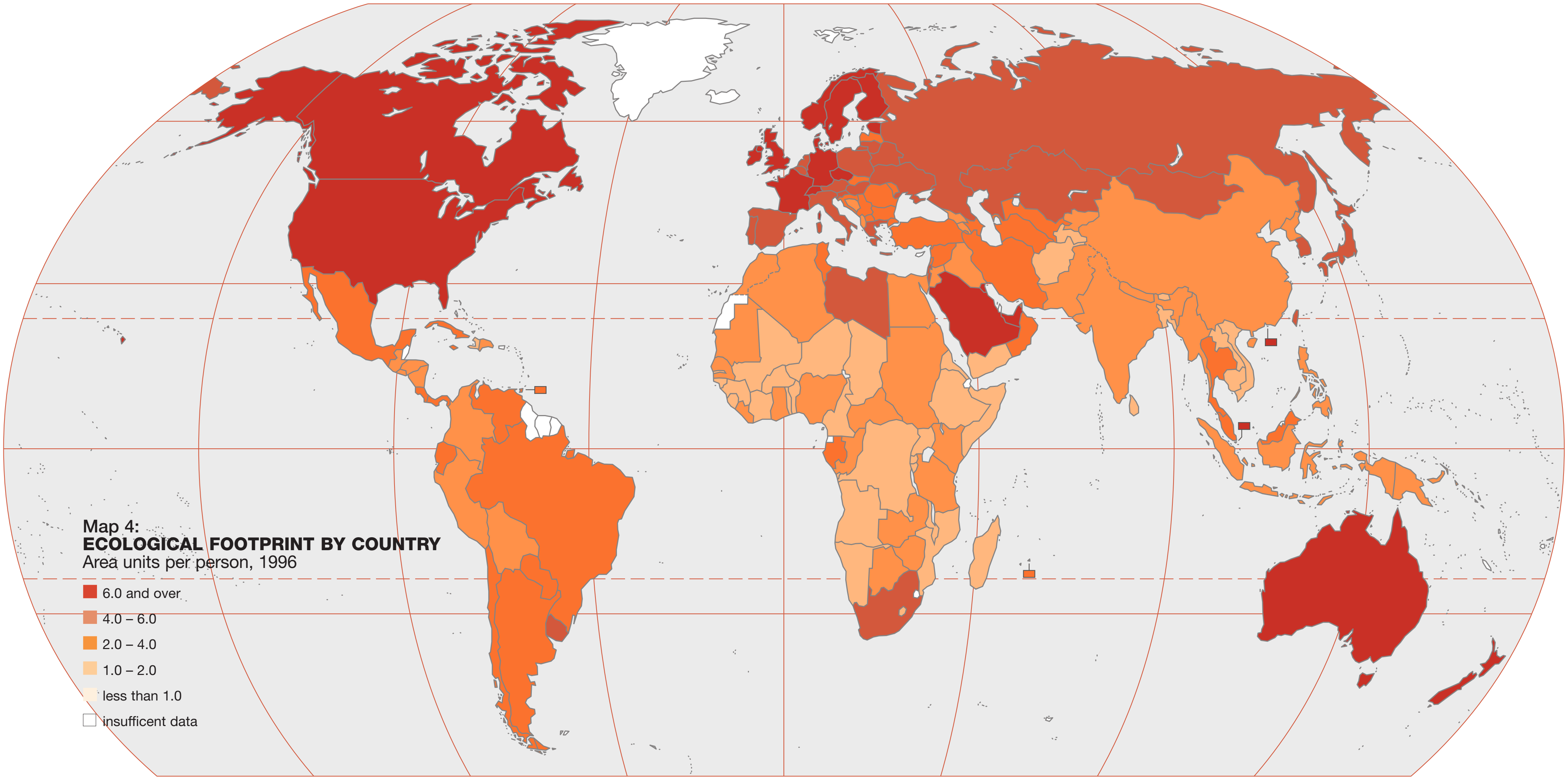
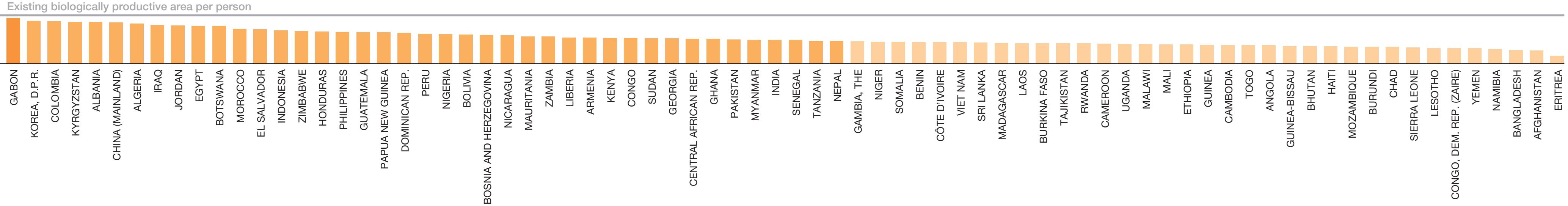


Fig. 12:
ECOLOGICAL FOOTPRINT BY REGION, 1996





Map 4:
ECOLOGICAL FOOTPRINT BY COUNTRY
Area units per person, 1996



was the most recent year for which UN statistics were available for all countries at the time of writing.

Extrapolating from the trend shows that, by the year 2000, the global footprint is likely to have increased slightly. This can be crudely estimated using population growth, assuming that the global average footprint per person has remained fairly constant (as it did from 1985 to 1996). As the world population has increased from 5.7 billion to 6.0 billion people since 1996, the global footprint is likely to have increased by about 5 per cent.

It is possible to compare the Ecological Footprint of a population with the biological capacity which is available to that population. In short, how much space does a population need compared with what is available?

In 1996 there were 12.6 billion hectares of biologically productive land on the planet, covering roughly one quarter of the Earth's surface. These consisted of 1.3 billion hectares of cropland, 4.6 billion hectares of grazing land, 3.3 billion hectares of forest land, 3.2 billion hectares of fishing grounds, and 0.2 billion hectares of built-up land (see Table 1 on opposite page). This amounts to 2.2 hectares for each of the world's 5.7 billion people in 1996: 0.2 hectares of cropland, 0.8 hectares of grazing land, 0.6 hectares of forests, and 0.5 hectares of productive ocean areas, most of which are located along coasts.

If we assume, for the sake of argument, that 10 per cent of all biologically productive space should be left undisturbed for other species, the available space per person shrinks from 2.2 to 2.0 area units. In contrast, the world average footprint was 2.85 area units per person in 1996. This exceeds the existing biologically productive space per person by about 30 per cent, or more if some space is reserved exclusively for other species. In other words, the area required to produce food and wood, to give room for infrastructure, and to absorb the CO_2 emissions associated with energy use was at least 30 per cent larger than the area available. This overshoot leads to the depletion of the Earth's natural capital stock, as reflected by the decline in the LPI.

Actions needed to reduce the Ecological Footprint: ■ Establish natural capital (or "biological capacity") accounts in each country, and set specific targets for natural capital use. ■ Phase out perverse subsidies that promote resource use, pollution, and population growth. ■ Encourage policies to incorporate environmental costs in the price of goods and services. ■ Promote the development of technologies that increase the efficiency of the use of resources. ■ Encourage educational initiatives that teach about opportunities to reduce human pressures on ecosystems. ■ Develop humane, equitable, and widely acceptable policies to reduce human population. ■ Establish international trade agreements which discourage countries from externalizing their ecological costs. ■ Redirect government procurement towards sustainable alternatives to set good examples and stimulate new markets.

key questions answered

WHAT ARE "AREA UNITS"?

The Ecological Footprint is measured in "area units". One "area unit" is equivalent to one hectare of biologically productive space with world average productivity. Land varies greatly in productivity; the most productive land is generally used to grow crops, while the least productive is used to graze animals.

One "area unit" is equivalent to about 0.3 hectares of cropland of world average productivity. It is also equivalent to 0.6 hectares of average forest, or 2.7 hectares of average grazing land, or 16.3 hectares of sea (coastal and upwelling zones) with average productivity. Thus a hectare of highly productive land represents more "area units" than the same amount of less productive land.

All land areas are scaled according to their capacity to produce biomass. Sea is measured in terms of its capacity to produce protein for human consumption. Area units allow the meaningful comparison of the Ecological Footprints of different countries, which use different qualities and mixes of cropland, grazing land, and forest.

HOW MUCH LAND IS NEEDED TO ABSORB CARBON DIOXIDE EMISSIONS?

The Ecological Footprint methodology asks how much bigger the biosphere would need to be in order to absorb the CO_2 emitted by burning fossil fuels. Alternatively we could ask how large an area would be needed to supply the same amount of energy using only biomass fuel.

Either method yields similar results (in fact, the one we use gives the lower estimate). By choosing a method that is based on present CO_2 sequestration rates, we are not advocating that forests should be planted to counteract increasing concentrations of CO_2 in the atmosphere. Rather, we show that sequestration can only be a partial solution at best, since there is not enough land on Earth available to provide this function. By expressing fossil fuel use in terms of CO_2 sequestration, we can compare the fossil fuel footprint with other human pressures on the biosphere, and aggregate them into a single index.

WHAT IS "APPARENT CONSUMPTION"?

The footprints presented in the Living Planet Report compare people's consumption in each country with the biosphere's ecological capacity. This means that a car produced in Germany, but sold in France, will be added to the French footprint. We estimate each country's consumption by adding its imports to its production, and subtracting its exports.

The resulting "apparent consumption" can be distorted since it does not distinguish between production waste and consumption. This explains irregularities, as in the case of Ireland's footprint. While consumption patterns in Ireland may be similar to those in the United Kingdom, Ireland, with a large agricultural sector and a small population compared to the UK, is charged with a footprint that corresponds to waste generated when producing food for export. But no official data exist to correct that error, or similar errors affecting other sectors. For example, in more detailed accounts, we would distinguish between types of fish imported and exported since the biological capacity needed to produce a given amount of fish protein can vary by orders of magnitude, depending whether the fish consumed are top predators such as tuna, or species that are low down in the food chain.

Tourism footprints, which are included in the destination country's footprint, should really be assigned to the tourist's country of residence. These footprint misallocations can distort national accounts and skew the distribution of the global footprint responsibility. However, these errors do not affect the overall global account (since there is no trade between the Earth and other planets).

ARE THE YIELDS BEHIND THE FOOTPRINT CALCULATIONS SUSTAINABLE?

In calculating the national footprints, we use yields for forests or fisheries that are optimistic estimates of the maximum amount of a single species stock that can be harvested without reducing the stock's productivity over time. Harvesting within this maximum level is a necessary, but not sufficient, criterion for sustainability.

Taking less can still cause ecological damage since the yield figures assume careful harvest practices with no collateral damage, no local overharvesting, and the safeguarding of protected areas.

WHICH COUNTRIES ARE SUSTAINABLE?

On pages 10–11, we compare each nation's Ecological Footprint per person with the world average biological capacity available per person. We have also compared each country's footprint with its own domestic biological capacity. The difference between a country's footprint and its biological capacity is its "ecological deficit", which is shown in Table 2. But these numbers do not indicate which countries are sustainable.

The minimum requirement for global sustainability is that humanity's footprint must be smaller than the biosphere's biological capacity. What does this mean for nations? Is Sweden, with a large footprint per person, but even larger biological capacity per person, ecologically sustainable? Is Egypt, which has a per person footprint smaller than the global average biological capacity, yet larger than its domestic biological capacity? Clearly, if everyone in the world led the same lifestyle as the average Swede, the Earth would not be able to sustain its human population for very long. Nor would humanity be sustainable if all countries ran an ecological deficit like Egypt.

Does this mean that people should live within the world's average biological capacity, or their national biological capacity? Footprint calculations do not answer these questions, but try to quantify the ecological challenges and conflicts humanity needs to resolve if it wants to achieve global sustainability.

Table 1: Biologically productive space

	Global area in 1996 (million hectares)	Area per person in 1996 (hectares/person)	Equivalence factor	Area per person in 1996 (area units/person)
Cropland	1 254	0.22	3.16	0.69
Grazing land	4 619	0.79	0.39	0.31
Forest land	3 333	0.58	1.78	1.03
Fishing grounds	3 200	0.55	0.06	0.03
Built-up land	200	0.04	3.16	0.12
Total	**12 606**	**2.18**	**1.00**	**2.18**

CROPLAND FOOTPRINT

The cropland footprint of an individual is the area (of "world average" cropland) required to produce all the crops which that individual consumes. This includes all cereals, fruit and vegetables, roots and tubers, pulses, nuts, tea and coffee, sugar, margarine, and vegetable oils, as well as tobacco, cotton, jute, and rubber. It also includes crops fed to poultry and pigs, which are converted to meat and consumed in the form of chicken or pigmeat.

To calculate the cropland footprint of a country, it is necessary to convert the dietary habits of the population into the area of average cropland required to produce this diet. This has been done for most of the world's countries and the results are shown in Figures 15 and 16, measured in both hectares of average crop land and "area units" per person (see more detailed explanation on page 12).

Figure 14 shows the growth in the world's cropland footprint since 1961. There were approximately 1.5 billion hectares of cropland available worldwide in 1996, of which about 1.3 billion hectares were used for growing crops, and the rest for grazing animals. Dividing 1.3 billion hectares by the world's population gives an average cropland footprint of 0.22 hectares, or 0.69 area units, per person.

The cropland footprint of the average North American was more than twice the world average, at 1.44 area units, whereas the cropland footprint of an average African or Asian was less than 0.60 area units. However, the cropland footprint shows less variance between nations than other components of the Ecological Footprint.

Actions needed to reduce the world's cropland footprint: ■ Move to sustainable farming systems that do not systematically degrade biological capacity; protect soil from erosion and degradation caused by intensive agriculture, overgrazing, or salinization. ■ Preserve existing croplands for agriculture, rather than urban and industrial development, road building, or non-essential crops such as tobacco. ■ Use agricultural chemicals in a way that takes account of the assimilative capacity of agro-ecosystems, stop the use of hazardous pesticides and increase the use of biological control and pest-resistant varieties. ■ Eliminate export subsidies.

Fig. 14:
WORLD CROPLAND FOOTPRINT, 1961–97

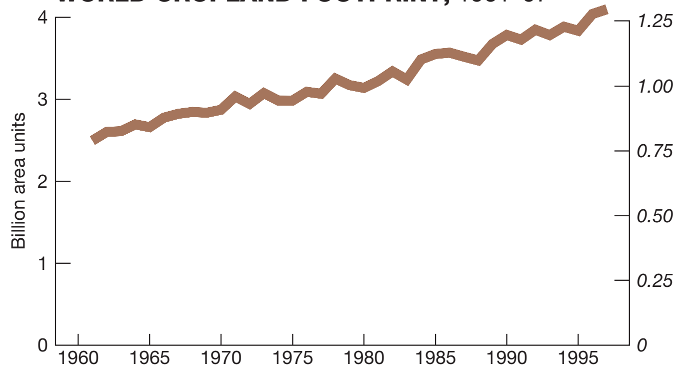


Fig. 15:
CROPLAND FOOTPRINT BY REGION, 1996

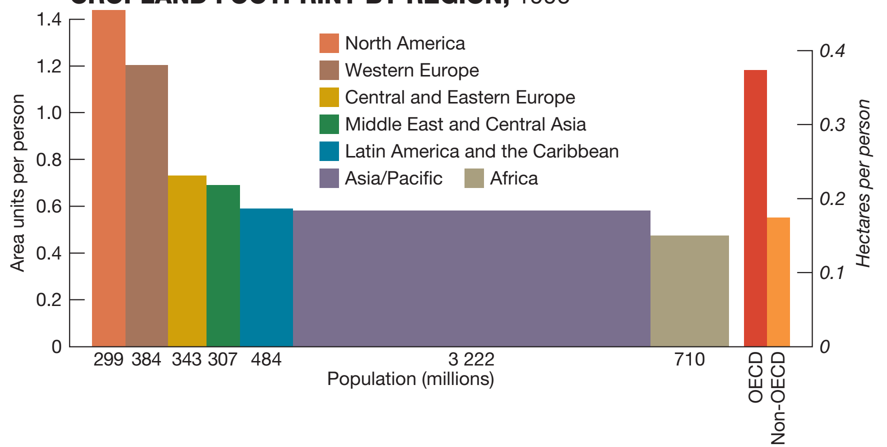
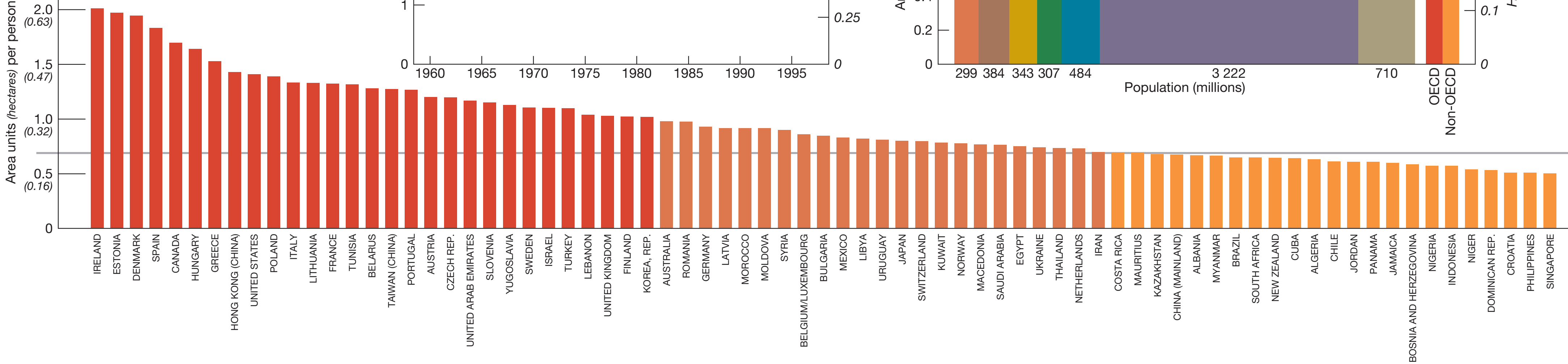
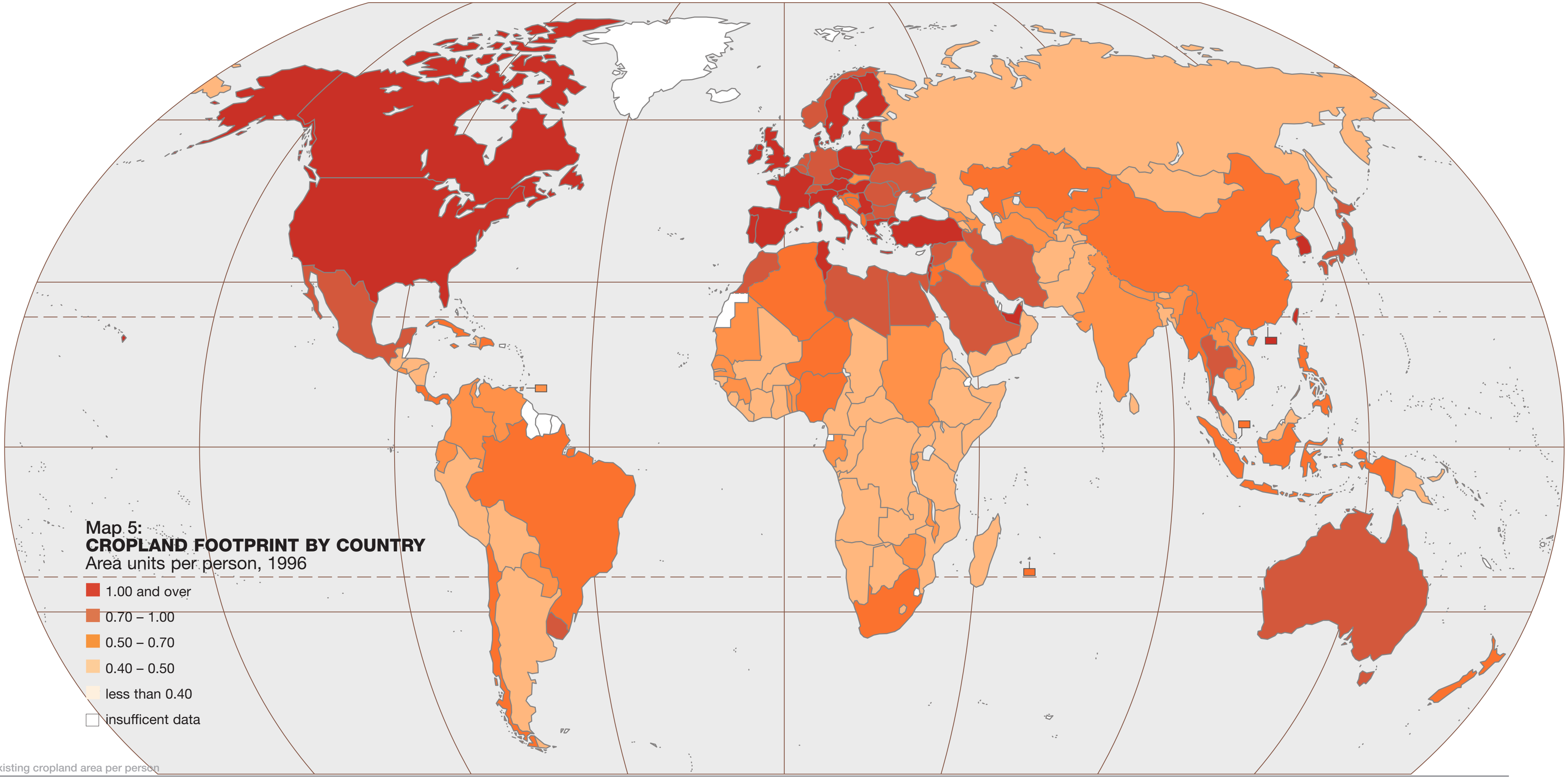
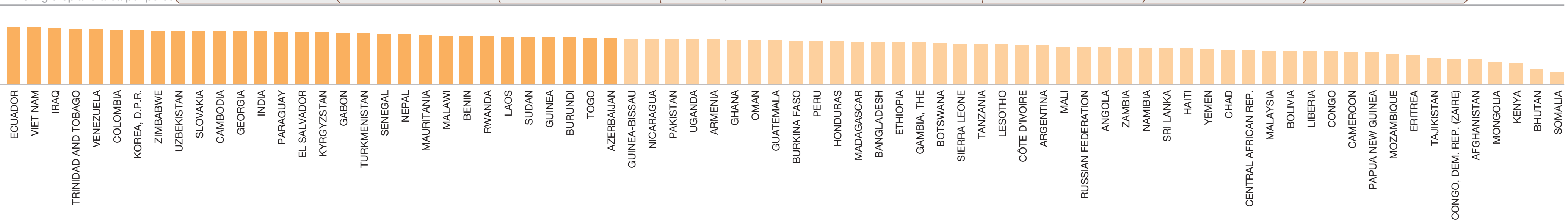


Fig. 16:
CROPLAND FOOTPRINT BY COUNTRY, 1996





Map 5:
CROPLAND FOOTPRINT BY COUNTRY
Area units per person, 1996



GRAZING LAND FOOTPRINT

The grazing land footprint of an individual is the area (of "world average" grazing land) that is required to produce the animal products which that individual consumes. This includes all meat and dairy products from cattle, sheep, and goats, as well as hides and wool (pigmeat and chicken are accounted for under the cropland footprint – see page 14).

To calculate the grazing land footprint of a country, it is necessary to convert the national consumption of animal products into the area of "average" grazing land required to produce them. The results are shown in Figures 18 and 19, expressed in hectares of average grazing land and "area units" per person.

Figure 17 shows that the size of the world grazing land has increased slowly since the 1960s. This is largely a result of clearing of forest land. There were approximately 4.6 billion hectares of grazing land on the Earth in 1996, giving a world average availability of about 0.79 hectares of grazing land, or 0.31 area units, per person. Assuming that this area was fully utilized, the world average grazing land footprint in 1996 was also 0.31 area units per person.

However, there was a fourfold disparity between the sizes of the grazing land footprints of consumers in OECD and non-OECD countries, because of the greater emphasis on meat and dairy products in the diets of the richer nations. The exceptions are the few lower-income countries, such as Mongolia, with less productive land that is only suitable for grazing.

Actions needed to reduce the world's grazing land footprint: ■ Reduce meat and dairy product consumption, especially in high-income countries. ■ Maintain traditional grazing systems that encourage and conserve biodiversity. ■ Change eating habits away from resource-intensive foods. ■ Eliminate export subsidies.

Fig. 19:
GRAZING LAND FOOTPRINT BY COUNTRY, 1996

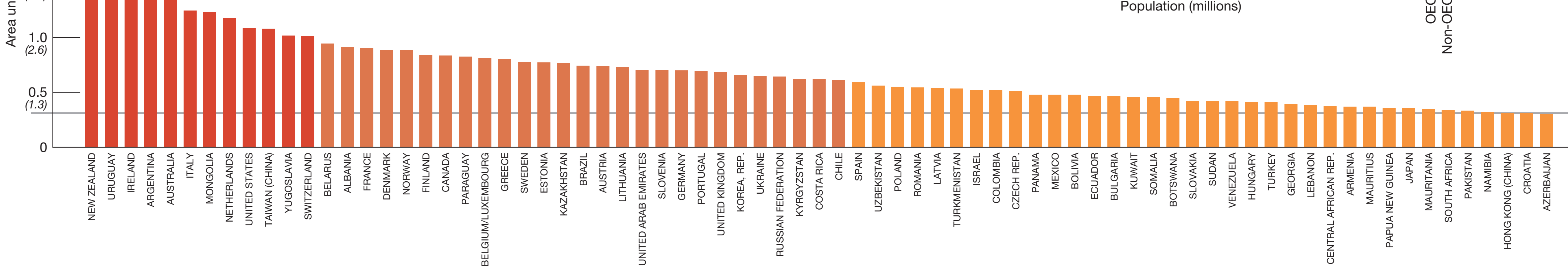


Fig. 17:
WORLD GRAZING LAND FOOTPRINT, 1961–97

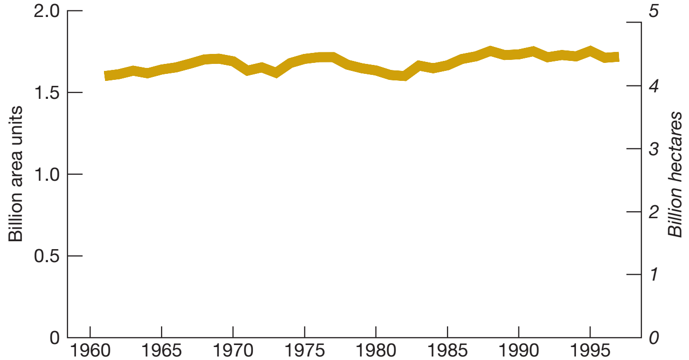
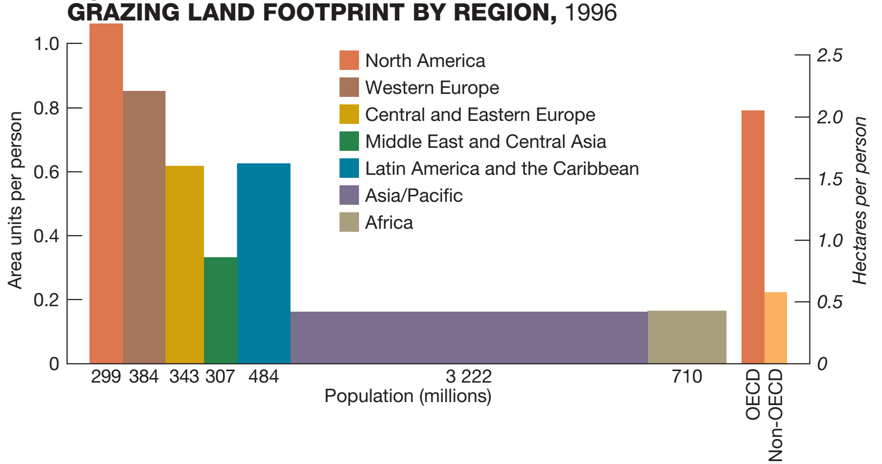
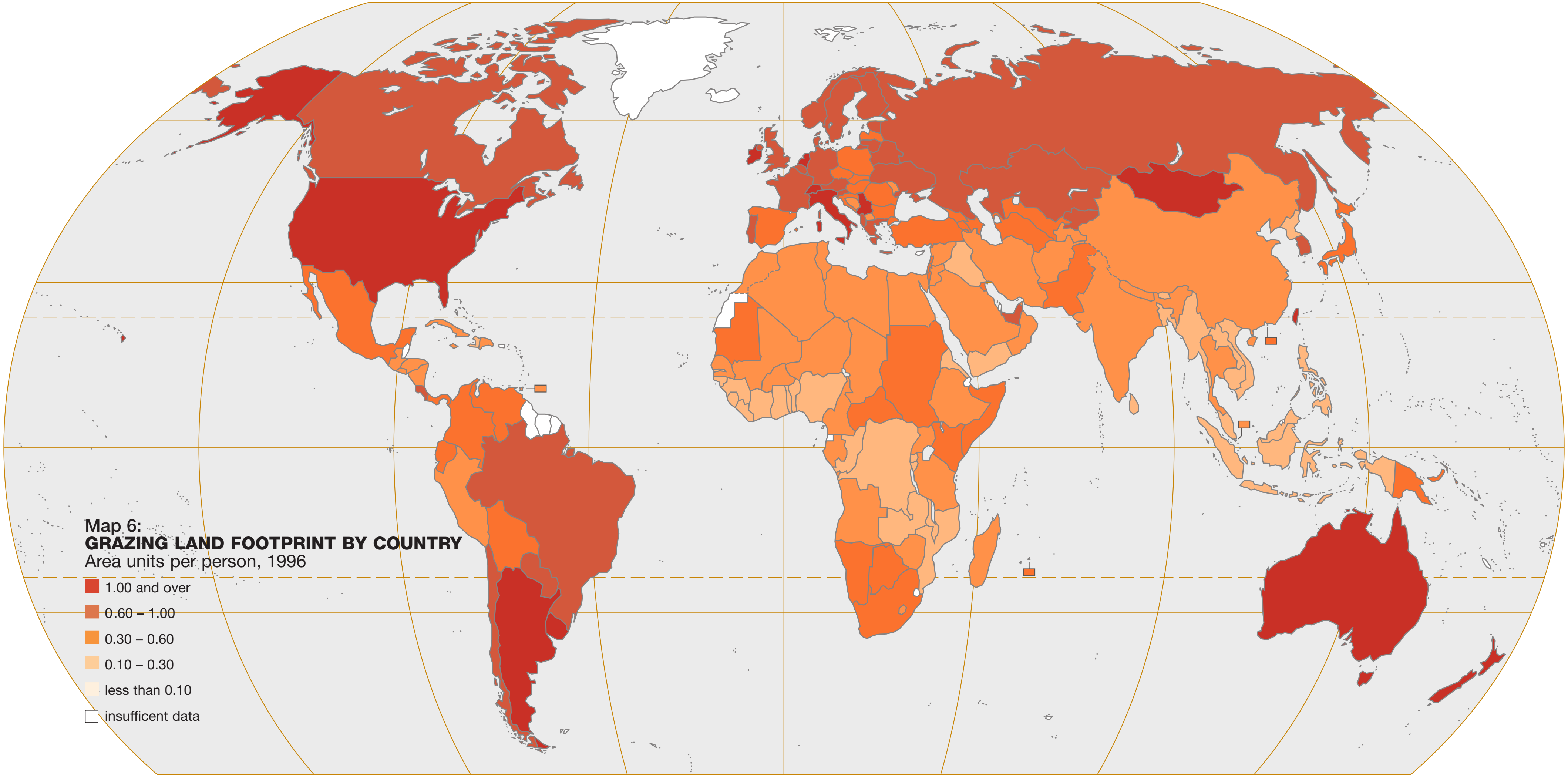


Fig. 18:
GRAZING LAND FOOTPRINT BY REGION, 1996





Map 6:
GRAZING LAND FOOTPRINT BY COUNTRY
Area units per person, 1996