CHAPTER 4

Habitat destruction: death by a thousand cuts

William F. Laurance

Humankind has dramatically transformed much of the Earth's surface and its natural ecosystems. This process is not new—it has been ongoing for millennia—but it has accelerated sharply over the last two centuries, and especially in the last several decades.

Today, the loss and degradation of natural habitats can be likened to a war of attrition. Many natural ecosystems are being progressively razed, bulldozed, and felled by axes or chainsaws, until only small scraps of their original extent survive. Forests have been hit especially hard: the global area of forests has been reduced by roughly half over the past three centuries. Twenty-five nations have lost virtually all of their forest cover, and another 29 more than nine-tenths of their forest (MEA 2005). Tropical forests are disappearing at up to 130 000 km^2 a year (Figure 4.1)—roughly 50 football fields a minute. Other ecosystems are less imperiled, and a few are even recovering somewhat following past centuries of overexploitation.

Here I provide an overview of contemporary habitat loss. Other chapters in this book describe the many additional ways that ecosystems are being threatened—by overhunting (Chapter 6), habitat fragmentation (Chapter 5), and climate change (Chapter 8), among other causes—but my emphasis here is on habitat destruction *per se*. I evaluate patterns of habitat destruction geographically and draw comparisons among different biomes and ecosystems. I then consider some of the ultimate and proximate factors that drive habitat loss, and how they are changing today.

4.1 Habitat loss and fragmentation

Habitat destruction occurs when a natural habitat, such as a forest or wetland, is altered so dramatically that it no longer supports the species it originally sustained. Plant and animal populations are destroyed or displaced, leading to a loss of biodiversity (see Chapter 10). Habitat destruction is considered the most important driver of species extinction worldwide (Pimm and Raven 2000).

Few habitats are destroyed entirely. Very often, habitats are reduced in extent and simultaneously fragmented, leaving small pieces of original habitat persisting like islands in a sea of degraded land. In concert with habitat loss, habitat fragmentation is a grave threat to species survival (Laurance *et al.* 2002; Sekercioglu *et al.* 2002; Chapter 5).

Globally, agriculture is the biggest cause of habitat destruction (Figure 4.2). Other human activities, such as mining, clear-cut logging, trawling, and urban sprawl, also destroy or severely degrade habitats. In developing nations, where most habitat loss is now occurring, the drivers of environmental change have shifted fundamentally in recent decades. Instead of being caused mostly by small-scale farmers and rural residents, habitat loss, especially in the tropics, is now substantially driven by globalization promoting intensive agriculture and other industrial activities (see Box 4.1).

4.2 Geography of habitat loss

Some regions of the Earth are far more affected by habitat destruction than others. Among the most

Figure 4.1 The aftermath of slash-and-burn farming in central Amazonia. Photograph by W. F. Laurance.

imperiled are the so-called "biodiversity hotspots", which contain high species diversity, many locally endemic species (those whose entire geographic range is confined to a small area), and which have lost at least 70% of their native vegetation (Myers *et al.* 2000). Many hotspots are in the tropics. The Atlantic forests of Brazil and rainforests of West Africa, both of which have been severely reduced and degraded, are examples of biodiversity hotspots. Despite encompassing just a small fraction (<2%) of the Earth's land surface, hotspots may sustain over half of the world's terrestrial species (Myers *et al.* 2000).

Many islands have also suffered heavy habitat loss. For instance, most of the original natural habitat has already been lost in Japan, New

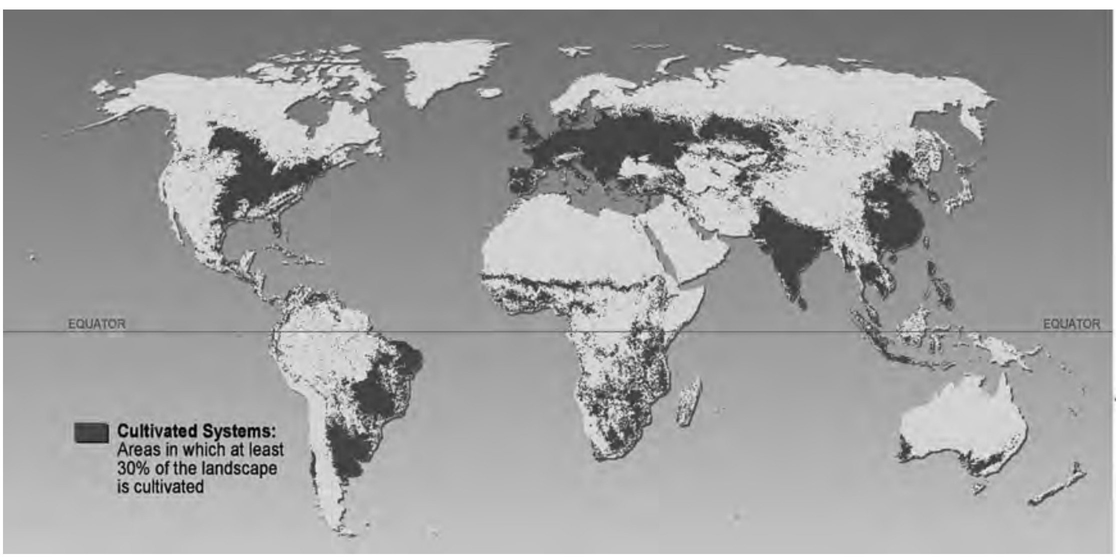

Figure 4.2 Extent of land area cultivated globally by the year 2000. Reprinted from MEA (2005).

Box 4.1 The changing drivers of tropical deforestation
William F. Laurance

Tropical forests are being lost today at an alarming pace. However, the fundamental drivers of tropical forest destruction have changed in recent years (Rudel 2005; Butler and Laurance 2008). Prior to the late 1980s, deforestation was generally caused by rapid human population growth in developing nations, in concert with government policies for rural development. These included agricultural loans, tax incentives, and road construction. Such initiatives, especially evident in countries such as Brazil and Indonesia, promoted large influxes of colonists into frontier areas and often caused dramatic forest loss.

More recently, however, the impacts of rural peoples on tropical forests seem to be stabilizing (see Box 4.1 Figure). Although many tropical nations still have considerable population growth, strong urbanization trends (except in Sub-Saharan Africa) mean that rural populations are growing more slowly, and are even declining in some areas. The popularity of large-scale frontier-colonization programs has also waned. If such trends continue, they could begin to alleviate some pressures on forests from small-scale farming, hunting, and fuel-wood gathering (Wright and Muller-landau 2006).

Box 4.1 Figure Changing drivers of deforestation: Small-scale cultivators (a) versus industrial road construction (b) in Gabon, central Africa. Photograph by W. F. Laurance.

At the same time, globalized financial markets and a worldwide commodity boom are creating a highly attractive environment for the private sector. Under these conditions, large-scale agriculture—crops, livestock, and tree plantations—by corporations and wealthy landowners is increasingly emerging as the biggest direct cause of tropical deforestation (Butler and Laurance 2008). Surging demand for grains and edible oils, driven by the global thirst for biofuels and rising standards of living in developing countries, is also spurring this trend. In Brazilian Amazonia, for instance, large-scale ranching has exploded in recent years, with the number of cattle more than tripling (from 22 to 74 million head) since 1990 (Smeraldi and May 2008), while industrial soy farming has also grown dramatically.

Other industrial activities, especially logging, mining, and petroleum development, are also playing a critical but indirect role in forest destruction (Asner *et al.* 2006; Finer *et al.* 2008). These provide a key economic impetus for forest road-building (see Box 4.1 Figure), which in turn allows influxes of colonists, hunters, and miners into frontier areas, often leading to rapid forest disruption and cycles of land speculation.

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Box 4.1 (Continued)

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Zealand, Madagascar, the Philippines, and Java (WRI 2003). Other islands, such as Borneo, Sumatra, and New Guinea, still retain some original habitat but are losing it at alarming rates (Curran *et al.* 2004; MacKinnon 2006).

Most areas of high human population density have suffered heavy habitat destruction. Such areas include much of Europe, eastern North America, South and Southeast Asia, the Middle East, West Africa, Central America, and the Caribbean region, among others. Most of the biodiversity hotspots occur in areas with high human density (Figure 4.3) and many still have rapid population growth (Cincotta *et al.* 2000). Human populations are often densest in coastal areas, many of which have experienced considerable losses of both terrestrial habitats and nearby coral reefs. Among others, coastal zones in Asia, northern South America, the Caribbean, Europe, and eastern North America have all suffered severe habitat loss (MEA 2005).

Finally, habitat destruction can occur swiftly in areas with limited human densities but rapidly expanding agriculture. Large expanses of the Amazon, for example, are currently being cleared for large-scale cattle ranching and industrial soy farming, despite having low population densities (Laurance *et al.* 2001). Likewise, in some relatively sparsely populated areas of Southeast Asia, such as Borneo, Sumatra, and New Guinea, forests are being rapidly felled to establish oil-palm or rubber plantations (MacKinnon 2006; Laurance 2007; Koh and Wilcove 2008; see Box 13.3). Older agricultural frontiers, such as those in Europe, eastern China, the Indian Subcontinent, and eastern and midwestern North America, often have very little native vegetation remaining (Figure 4.2).

4.3 Loss of biomes and ecosystems

4.3.1 Tropical and subtropical forests

A second way to assess habitat loss is by contrasting major biomes or ecosystem types (Figure 4.4). Today, tropical rainforests (also termed tropical moist and humid forests) are receiving the greatest attention, because they are being destroyed so rapidly and because they are the most biologically diverse of all terrestrial biomes. Of the roughly 16 million km^2 of tropical rainforest that originally existed worldwide, less than 9 million km^2 remains today (Whitmore 1997; MEA 2005). The current rate of rainforest loss is debated, with different estimates ranging from around 60 000 km^2 (Achard *et al.* 2002) to 130 000 km^2 per year (FAO 2000). Regardless of which estimate one adheres to, rates of rainforest loss are alarmingly high.

Rates of rainforest destruction vary considerably among geographic regions. Of the world's three major tropical regions, Southeast Asian forests are disappearing most rapidly in relative

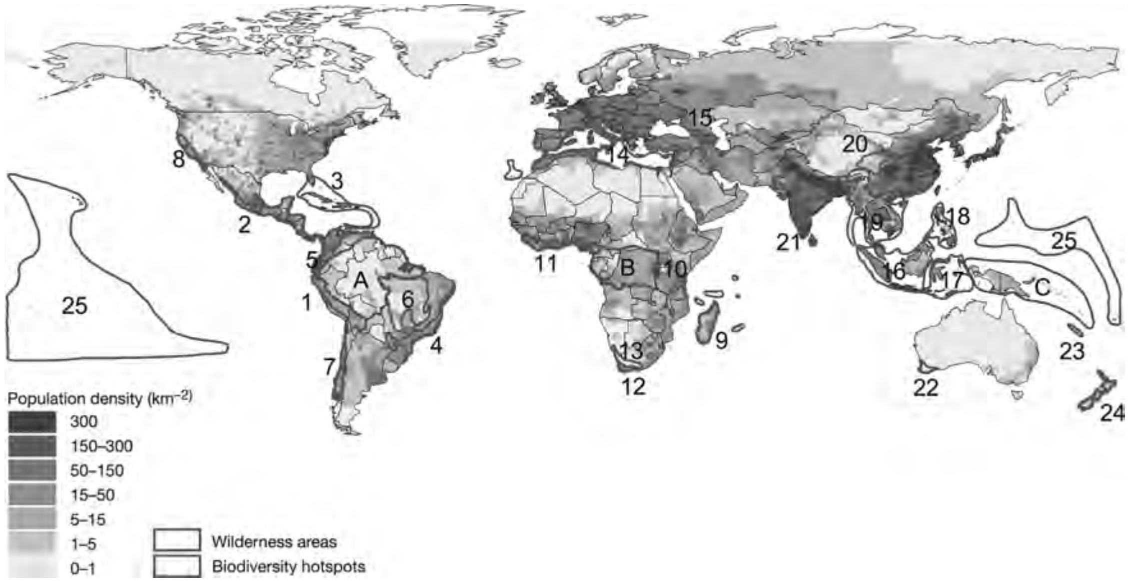

Figure 4.3 Human population density in 1995 within 25 recognized biodiversity hotspots (numbered 1-25) and three major tropical wildernesses (labeled A-C). Reprinted from Cincotta *et al.* 2000 © Nature Publishing Group.

terms (Figure 4.5), while the African and New World tropics have somewhat lower rates of percent-annual forest loss (Sodhi *et al.* 2004). Such averages, however, disguise important smaller-scale variation. In the New World tropics, for example, the Caribbean, MesoAmerican, and Andean regions are all suffering severe rainforest loss, but the relative deforestation rate for the region as a whole is buffered by the vastness of the Amazon. Likewise, in tropical Africa, forest loss is severe in West Africa, montane areas of East Africa, and Madagascar, but substantial forest still survives in the Congo Basin (Laurance 1999).

Other tropical and subtropical biomes have suffered even more heavily than rainforests (Figure 4.4). Tropical dry forests (also known as

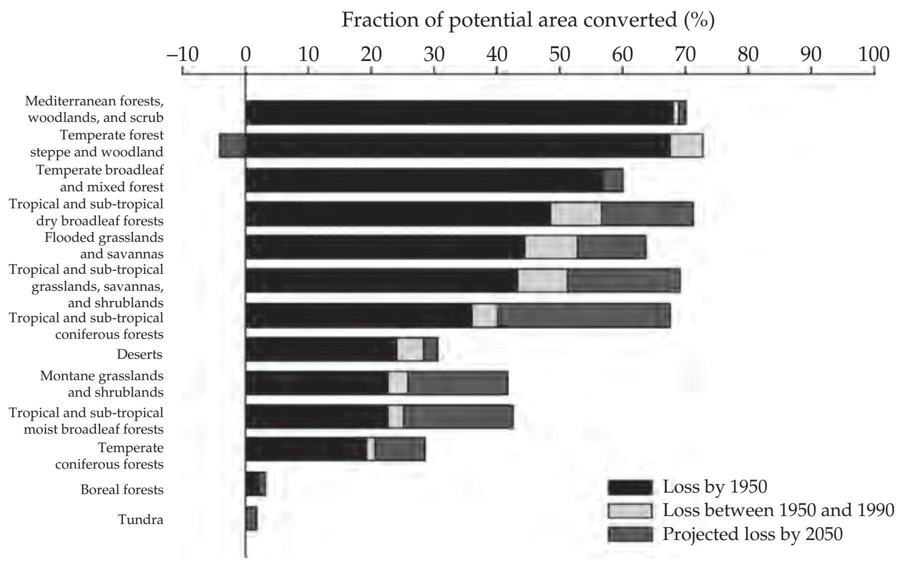

Figure 4.4 Estimated losses of major terrestrial biomes prior to 1950 and from 1950 to 1990, with projected losses up to 2050. Reprinted from MEA (2005).

Figure 4.5 Tropical rainforests in Southeast Asia are severely imperiled, as illustrated by this timber operation in Indonesian Borneo. Photograph by W. F. Laurance.

monsoonal or deciduous forests) have been severely reduced, in part because they are easier to clear and burn than rainforests. For instance, along Central America's Pacific coast, much less than 1% of the original dry forest survives. Losses of dry forest have been nearly as severe in Madagascar and parts of Southeast Asia (Laurance 1999; Mayaux *et al.* 2005).

Mangrove forests, salt-tolerant ecosystems that grow in tropical and subtropical intertidal zones, have also been seriously reduced. Based on countries for which data exist, more than a third of all mangroves were lost in the last few decades of the 20th century (MEA 2005). From 1990 to 2000, over 1% of all mangrove forests were lost annually, with rates of loss especially high in Southeast Asia (Mayaux *et al.* 2005). Such losses are alarming given the high primary productivity of mangroves, their key role as spawning and rearing areas for economically important fish and shrimp species, and their importance for sheltering coastal areas from destructive storms and tsunamis (Danielsen *et al.* 2005).

4.3.2 Temperate forests and woodlands

Some ecosystems have suffered even worse destruction than tropical forests. Mediterranean forests and woodlands, temperate broadleaf and mixed forests, and temperate forest-steppe and woodlands have all suffered very heavy losses (Figure 4.4), given the long history of human settlement in many temperate regions. By 1990 more than two-thirds of Mediterranean forests and woodlands were lost, usually because they were converted to agriculture (MEA 2005). In the eastern USA and Europe (excluding Russia), old-growth broadleaf forests (>100 years old) have nearly disappeared (Matthews *et al.* 2000), although forest cover is now regenerating in many areas as former agricultural lands are abandoned and their formerly rural, farming-based populations become increasingly urbanized.

In the cool temperate zone, coniferous forests have been less severely reduced than broadleaf and mixed forests, with only about a fifth being lost by 1990 (Figure 4.4). However, vast expanses of coniferous forest in northwestern North America, northern Europe, and southern Siberia are being clear-felled for timber or pulp production. As a result, these semi-natural forests are converted from old-growth to timber-production forests, which have a much-simplified stand structure and species composition. Large expanses of coniferous forest are also burned each year (Matthews *et al.* 2000).

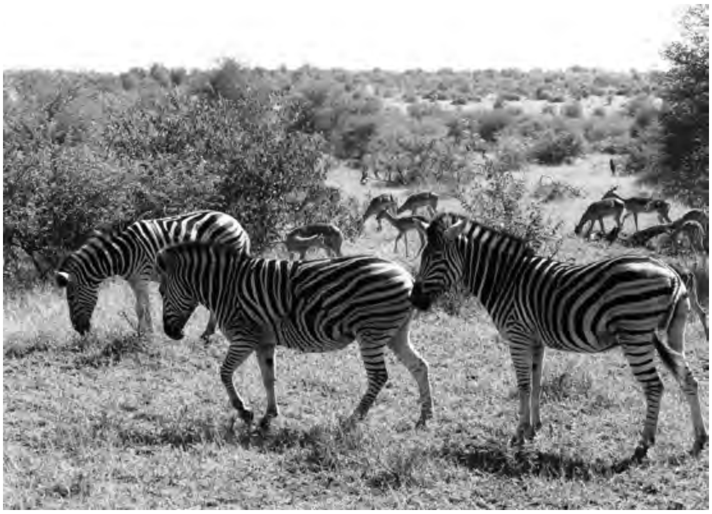

Figure 4.6 African savannas are threatened by livestock overgrazing and conversion to farmland. Photograph by W. F. Laurance.

4.3.3 Grasslands and deserts

Grasslands and desert areas have generally suffered to a lesser extent than forests (Figure 4.4). Just 10–20% of all grasslands, which include the savannas of Africa (Figure 4.6), the *llano* and *cerrado* ecosystems of South America, the steppes of Central Asia, the prairies of North America, and the spinifex grasslands of Australia, have been permanently destroyed for agriculture (White *et al.* 2000; Kauffman and Pyke 2001). About a third of the world's deserts have been converted to other land uses (Figure 4.4). Included in this figure is the roughly 9 million km^2 of seasonally dry lands, such as the vast Sahel region of Africa, that have been severely degraded via desertification (Primack 2006).

Although deserts and grasslands have not fared as badly as some other biomes, certain regions have suffered very heavily. For instance, less than 3% of the tallgrass prairies of North America survive, with the remainder having been converted to farmland (White *et al.* 2000). In southern Africa, large expanses of dryland are being progressively desertified from overgrazing by livestock (MEA 2005). In South America, more than half of the biologically-rich *cerrado* savannas, which formerly spanned over 2 million km^2, have been converted into soy fields and cattle pastures in recent decades, and rates of loss remain very high (Klink and Machado 2005).

4.3.4 Boreal and alpine regions

Boreal forests are mainly found in broad continental belts at the higher latitudes of North America and Eurasia. They are vast in Siberia, the largest contiguous forest area in the world, as well as in northern Canada. They also occur at high elevations in more southerly areas, such as the European Alps and Rocky Mountains of North America. Dominated by evergreen conifers, boreal forests are confined to cold, moist climates and are especially rich in soil carbon, because low temperatures and waterlogged soils inhibit decomposition of organic material (Matthews *et al.* 2000).

Habitat loss in boreal forests has historically been low (Figure 4.4; Box 4.2). In Russia, however, legal and illegal logging activity has grown rapidly, with Siberia now a major source of timber exports to China, the world's largest timber importer. In Canada, nearly half of the boreal forest is under tenure for wood production. In addition, fire incidence is high in the boreal zone, with perhaps 100 000 km^2 of boreal forest burning each year (Matthews *et al.* 2000).

Like boreal forests, tundra is a vast ecosystem (spanning 9–13 million km^2 globally) that has been little exploited historically (Figure 4.4) (White *et al.* 2000). Unlike permafrost areas, tundra ecosystems thaw seasonally on their surface, becoming important wetland habitats for waterfowl and other wildlife. Other boreal habitats, such as taiga grasslands (Figure 4.7), have also suffered little loss. However, all boreal ecosystems are vulnerable to global warming (see Chapter 8; Box 4.2). Boreal forests, in particular, could decline if climatic conditions become significantly warmer or drier, leading to an increased frequency or severity of forest fires (see Box 4.2, Chapter 9).

Box 4.2 Boreal forest management: harvest, natural disturbance, and climate change

Ian G. Warkentin

Until recently, the boreal biome has largely been ignored in discussions regarding the global impacts of habitat loss through diminishing forest cover. Events in tropical regions during the past four decades were far more critical due to the high losses of forest and associated species (Dirzo and Raven 2003). While there are ongoing concerns about tropical forest harvest, the implications of increasing boreal forest exploitation now also need to be assessed, particularly in the context of climate change. (Bradshaw *et al*. 2009) Warnings suggest that forest managers should not overlook the services provided by the boreal ecosystem, especially carbon storage (Odling-Smee 2005). Ranging across northern Eurasia and North America, the boreal biome constitutes one third of all current forest cover on Earth and is home to nearly half of the remaining tracts of extensive, intact forests. Nearly 30% of the Earth's terrestrial stored carbon is held here, and the boreal may well have more influence on mean annual global temperature than any other biome due to its sunlight reflectivity (albedo) properties and evapotranspiration rates (Snyder *et al.* 2004).

Conversion of North America's boreal forest to other land cover types has been limited (e.g. <3% in Canada; Smith and Lee 2000). In Finland and Sweden forest cover has expanded during recent decades, but historic activities extensively reduced and modified the region's boreal forests for commercial purposes, leaving only a small proportion as natural stands (Imbeau *et al.* 2001; see Box 4.2 Figure). Conversely, there has been a rapid expansion of harvest across boreal Russia during the past 10–15 years leading to broad shifts from forest to other land cover types (MEA 2005). Forest cover loss across European Russia is associated with intensive harvest, mineral exploitation and urbanization, while in Siberian Russia the combination of logging and a sharp rise in human-ignited fires has led to a 2.3% annual decrease in forest cover (Achard *et al.* 2006, 2008).

Box 4.2 Figure An example of harvesting in the Boreal forest. Photograph by Greg Mitchell.

The biggest challenge for boreal managers may come from the warmer and drier weather, with a longer growing season, that climate change models predict for upper-latitude ecosystems (IPCC 2001). The two major drivers of boreal disturbance dynamics (fire and insect infestation) are closely associated with weather conditions (Soja *et al.* 2007) and predicted to be both more frequent and intense over the next century (Kurz *et al.* 2008); more human-ignited fires are also predicted as access to the forest expands (Achard *et al.* 2008). Increased harvest, fire and insect infestations will raise the rates of carbon loss to the atmosphere, but climate models also suggest that changes to albedo and evapotranspiration due to these disturbances will offset the lost carbon stores (Bala *et al.* 2007)—maintaining large non-forested boreal sites potentially may cool the global climate more than the carbon storage resulting from reforestation at those sites. However, to manage the boreal forest based solely on one

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Box 4.2 (Continued)

ecosystem service would be reckless. For example, many migratory songbirds that depend upon intact boreal forest stands for breeding also provide critical services such as insect predation, pollen transport and seed dispersal (Sekercioglu 2006) in habitats extending from boreal breeding grounds, to migratory stopovers and their winter homes in sub-tropical and tropical regions. Thus boreal forest managers attempting to meet climate change objectives (or any other single goal) must also consider the potential costs for biodiversity and the multiple services at risk due to natural and human-associated change.

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In addition, tundra areas will shrink as boreal forests spread north.

4.3.5 Wetlands

Although they do not fall into any single biome type, wetlands have endured intense habitat destruction in many parts of the world. In the USA, for instance, over half of all wetlands have been destroyed in the last two centuries (Stein *et al.* 2000). From 60–70% of all European wetlands have been destroyed outright (Ravenga *et al.* 2000). Many developing nations are now suffering similarly high levels of wetland loss, particularly as development in coastal zones accelerates. As discussed above, losses of mangrove forests, which are physiologically specialized for the intertidal zone, are also very high.

Figure 4.7 Boreal ecosystems, such as this alpine grassland in New Zealand, have suffered relatively little habitat loss but are particularly vulnerable to global warming. Photograph by W. F. Laurance.

4.4 Land-use intensification and abandonment

Humans have transformed a large fraction of the Earth's land surface (Figure 4.2). Over the past three centuries, the global extent of cropland has risen sharply, from around 2.7 to 15 million km^2, mostly at the expense of forest habitats (Turner *et al.* 1990). Permanent pasturelands are even more extensive, reaching around 34 million km^2 by the mid-1990s (Wood *et al.* 2000). The rate of land conversion has accelerated over time: for instance, more land was converted to cropland from 1950 to 1980 than from 1700 to 1850 (MEA 2005).

Globally, the rate of conversion of natural habitats has finally begun to slow, because land readily convertible to new arable use is now in increasingly short supply and because, in temperate and boreal regions, ecosystems are recovering somewhat. Forest cover is now increasing in eastern and western North America, Alaska, western and northern Europe, eastern China, and Japan (Matthews *et al.* 2000; MEA 2005, Figure 4.4). During the 1990s, for instance, forest cover rose by around 29 000 km^2 annually in the temperate and boreal zones, although roughly 40% of this increase comprised forest plantations of mostly non-native tree species (MEA 2005). Despite partial recovery of forest cover in some regions (Wright and Muller-Landau 2006), conversion rates for many ecosystems, such as tropical and subtropical forests and South American *cerrado* savanna-woodlands, remain very high.

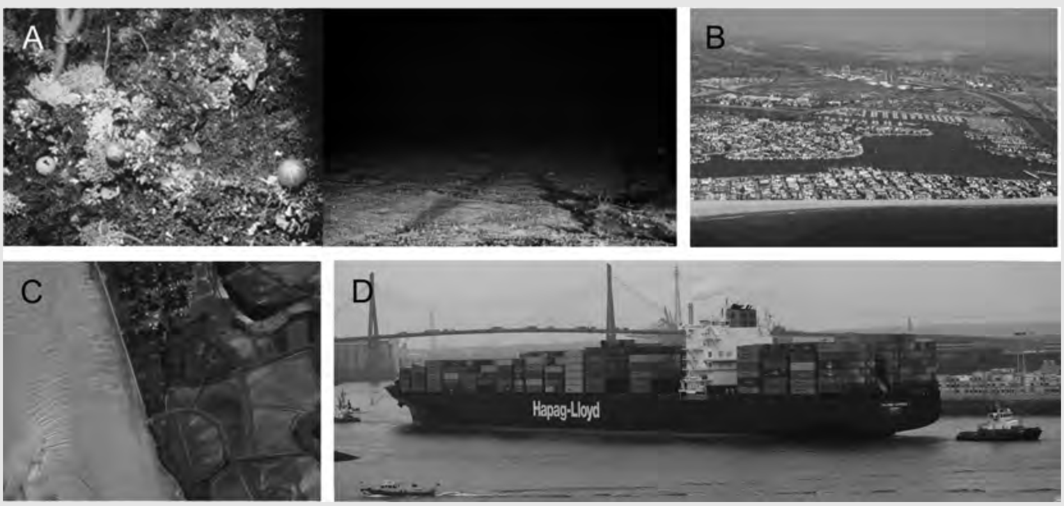
Because arable land is becoming scarce while agricultural demands for food and biofuel feedstocks are still rising markedly (Koh and Ghazoul 2008), agriculture is becoming increasingly intensified in much of the world. Within agricultural regions, a greater fraction of the available land is actually being cultivated, the intensity of cultivation is increasing, and fallow periods are decreasing (MEA 2005). Cultivated systems (where over 30% of the landscape is in croplands, shifting cultivation, confined-livestock production, or freshwater aquaculture) covered 24% of the global land surface by the year 2000 (Figure 4.2).

Thus, vast expanses of the earth have been altered by human activities. Old-growth forests have diminished greatly in extent in many regions, especially in the temperate zones; for instance, at least 94% of temperate broadleaf forests have been disturbed by farming and logging (Primack 2006). Other ecosystems, such as coniferous forests, are being rapidly converted from old-growth to semi-natural production forests with a simplified stand structure and species composition. Forest cover is increasing in parts of the temperate and boreal zones, but the new forests are secondary and differ from old-growth forests in species composition, structure, and carbon storage. Yet other ecosystems, particularly in the tropics, are being rapidly destroyed and degraded. For example, marine ecosystems have been heavily impacted by human activities (see Box 4.3).

The large-scale transformations of land cover described here consider only habitat loss *per se*. Of the surviving habitat, much is being

Box 4.3 Human Impacts on marine ecosystems
Benjamin S. Halpern, Carrie V. Kappel, Fiorenza Micheli, and Kimberly A. Selkoe

The oceans cover 71% of the planet. This vastness has led people to assume ocean resources are inexhaustible, yet evidence to the contrary has recently accumulated (see Box 4.3 Figure 1 and Plate 4). Populations of large fish, mammals, and sea turtles have collapsed due to intense fishing pressure, putting some species at risk of extinction, and fishing gear such as bottom trawls not only catch target fish but also destroy vast swaths of habitat (see Box 6.1). Pollution, sedimentation, and nutrient enrichment have caused die-offs of fish and corals, blooms of jellyfish and algae, and “dead zones” of oxygen-depleted waters around the world. Coastal development has removed much of the world’s mangroves, sea grass beds and salt marshes. Effects from climate change, such as rising sea levels and temperatures and ocean acidification, are observed with increasing frequency around the world. Global commerce, aquaculture and the aquarium trade have caused the introduction of thousands of non-native species, many of which become ecologically and economically destructive in their new environment. These human-caused stresses on ocean ecosystems are the most intense and widespread, but many other human activities impact the ocean where they are concentrated, such as shipping, aquaculture, and oil and gas extraction, and many new uses such as wave and wind energy farms are just emerging.



Box 4.3 Figure 1 A few of the many human threats to marine ecosystems around the world. (A) The seafloor before and after bottom trawl fishing occurred [courtesy CSIRO (Australian Commonwealth Scientific and Research Organization) Marine Research], (B) coastal development in Long Beach, California (courtesy California Coastal Records Project), (C) shrimp farms in coastal Ecuador remove coastal habitat (courtesy Google Earth), and (D) commercial shipping and ports produce pollution and introduce non-native species (courtesy public commons). (see plate 4).

There are clear challenges in reducing the impacts of any single human activity on marine ecosystems. These challenges are particularly stark in areas where dozens of activities co-occur because each species and each ecosystem may respond uniquely to each set of human activities, and there may be hard-to-predict synergisms among stressors that can amplify impacts. For example, excess nutrient input combined with overfishing of herbivorous fish on coral reefs can lead to algal proliferation and loss of coral with little chance of recovery, while each stressor alone may not lead to such an outcome. The majority of oceans are subject

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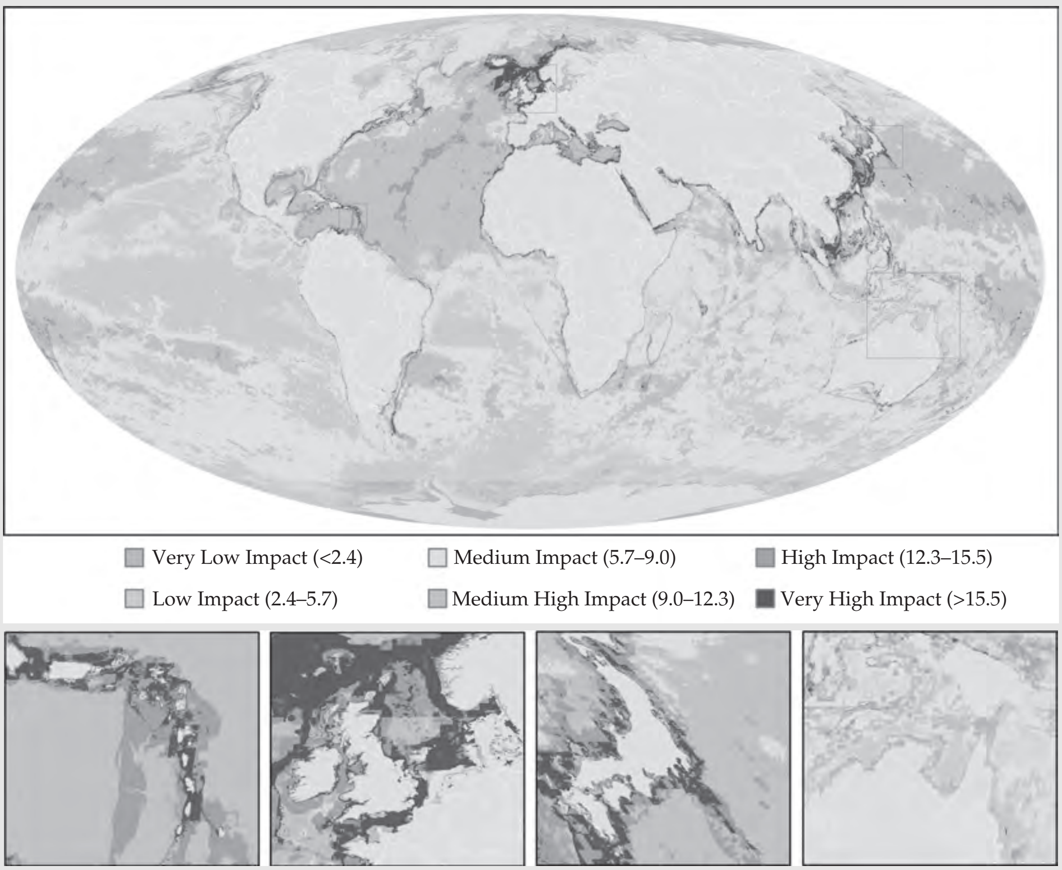
Box 4.3 (Continued)

to at least three different overlapping human stressors, with most coastal areas experiencing over a dozen, especially near centers of commerce like the ports of Los Angeles and Singapore.

The first comprehensive map of the impacts of 17 different types of human uses on the global oceans provides information on where cumulative human impacts to marine ecosystems are most intense (Halpern *et al.* 2008; see Box 4.3 Figure 2 and Plate 5). The map shows that over 40% of the oceans are heavily impacted and less than 4% are relatively pristine (see Box 4.3 Table). The heaviest impacts occur in the North Sea and East and South China Seas, where industry, dense human population, and a long history of ocean use come together. The least impacted areas are small and scattered throughout the globe, with the largest patches at the poles and the Torres Strait north of Australia. Several of the countries whose seas are significantly impacted, including the United States and China, have huge territorial holdings, suggesting both a responsibility and an opportunity to make a significant difference in improving ocean health.



Box 4.3 Figure 2 Global map of the cumulative human impact on marine ecosystems, based on 20 ecosystem types and 17 different human activities. Grayscale colors correspond to overall condition of the ocean as indicated in the legend, with cumulative impact score cutoff values for each category of ocean condition indicated. (see plate 5).

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Box 4.3 (Continued)

Box 4.3 Table The amount of marine area within the Exclusive Economic Zone (EEZ) of countries that is heavily impacted. Countries are listed in order of total marine area within a country's EEZ (including territorial waters) and includes a selection of countries chosen for illustrative purposes. Global statistics are provided for comparison. Data are drawn from Halpern *et al.* (2008).

		Impact Category					
		Very Low	**Low**	**Medium**	**Medium-High**	**High**	**Very High**
GLOBAL	100%	3.7%	24.5%	31.3%	38.2%	1.8%	0.5%
Largest EEZs							
United States	3.3%	2.0%	9.1%	21.5%	62.1%	4.4%	0.7%
France	2.8%	0.2%	36.7%	40.1%	21.6%	0.9%	0.4%
Australia	2.5%	3.7%	26.4%	42.3%	26.3%	1.0%	0.3%
Russia	2.1%	22.5%	30.8%	32.3%	13.5%	0.6%	0.3%
United Kingdom	1.9%	0.3%	25.2%	36.0%	29.0%	6.5%	3.0%
Indonesia	1.7%	2.3%	32.0%	42.4%	18.0%	3.0%	2.1%
Canada	1.5%	22.8%	18.4%	25.8%	26.5%	5.5%	1.0%
Japan	1.1%	0.0%	0.9%	9.7%	76.2%	9.9%	3.2%
Brazil	1.0%	3.1%	17.1%	32.4%	44.8%	2.1%	0.5%
Mexico	0.9%	1.2%	29.1%	32.7%	35.5%	1.2%	0.3%
India	0.6%	0.1%	7.3%	32.9%	51.4%	6.8%	1.5%
China	0.2%	0.0%	24.5%	5.7%	27.2%	20.1%	22.5%
SMALLER EEZs							
Germany	0.02%	0.4%	43.7%	2.4%	34.6%	14.4%	4.4%
Iceland	0.21%	0.0%	0.4%	10.1%	58.4%	26.3%	4.8%
Ireland	0.11%	0.0%	0.2%	2.2%	50.3%	40.8%	6.6%
Italy	0.15%	0.0%	3.5%	15.5%	64.5%	11.8%	4.7%
Netherlands	0.04%	0.0%	18.6%	3.6%	68.8%	7.7%	1.5%
Sri Lanka	0.15%	0.0%	2.5%	8.6%	45.0%	37.2%	6.7%
Thailand	0.08%	0.4%	21.9%	42.6%	22.1%	9.6%	3.4%
Vietnam	0.18%	1.1%	21.0%	26.7%	35.7%	10.2%	5.4%

Complex but feasible management approaches are needed to address the cumulative impacts of human activities on the oceans. Comprehensive spatial planning of activities affecting marine ecosystems, or ocean zoning, has already been adopted and implemented in Australia's Great Barrier Reef and parts of the North Sea, with the goal of minimizing the overlap and potential synergies of multiple stressors. Many countries, including the United States, are beginning to adopt Ecosystem-Based Management (EBM) approaches that explicitly address cumulative impacts and seek to balance sustainable use of the oceans with conservation and restoration of marine ecosystems. Ultimately, it is now clear that marine resources are not inexhaustible and that precautionary, multi-sector planning of their use is needed to ensure long-term sustainability of marine ecosystems and the crucial services they provide.

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degraded in various ways—such as by habitat fragmentation, increased edge effects, selective logging, pollution, overhunting, altered fire regimes, and climate change. These forms of environmental degradation, as well as the important environmental services these ecosystems provide, are discussed in detail in subsequent chapters.

Summary

- Vast amounts of habitat destruction have already occurred. For instance, about half of all global forest cover has been lost, and forests have virtually vanished in over 50 nations worldwide.
- Habitat destruction has been highly uneven among different ecosystems. From a geographic perspective, islands, coastal areas, wetlands, regions with large or growing human populations, and emerging agricultural frontiers are all sustaining rapid habitat loss.
- From a biome perspective, habitat loss has been very high in Mediterranean forests, temperate forest-steppe and woodland, temperate broadleaf forests, and tropical coniferous forests. Other ecosystems, particularly tropical rainforests, are now disappearing rapidly.
- Habitat destruction in the temperate zone peaked in the 19th and early 20th centuries. Although considerable habitat loss is occurring in some temperate ecosystems, overall forest cover is now increasing from forest regeneration and plantation establishment in some temperate regions.
- Primary (old-growth) habitats are rapidly diminishing across much of the earth. In their place, a variety of semi-natural or intensively managed ecosystems are being established. For example, although just two-tenths of the temperate coniferous forests have disappeared, vast areas are being converted from old-growth to timber-production forests, with a greatly simplified stand structure and species composition.
- Boreal ecosystems have suffered relatively limited reductions to date but are especially vulnerable to global warming. Boreal forests could become increasingly vulnerable to destructive fires if future conditions become warmer or drier.

Suggested reading

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Relevant websites

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