Earth's peeling veneer of life

SIR — Unprecedented losses of global biodiversity have helped motivate a rapid increase in studies of species extinction. Many ecologists have begun to address the population-dynamic and demographic causes of extinction[1–5]; others have estimated rates of species loss[6–9]. The knowledge gained from these initiatives can presumably improve conservation strategies and galvanize public opinion. Yet studies concentrating on the extinction of individual populations and species may overlook broader and more obvious losses of biodiversity.

Many species become extinct only when persecuted by humans, or when their ecosystems, communities and habitats have been dramatically and continuously degraded beyond possible persistence and restoration. The result is an inevitable time-lag between environmental degradation and extinction that highlights the value of more immediate and more easily estimated indicators of human impact.

The table, prepared with the help of S. Jaward, documents alternative metrics quantifying human influences on global biotas. These metrics of human impact, though crude, paint a sombre picture of declining global biodiversity. More than 11% of the world's terrestrial landscape has been converted to cropland. A further 25% is occupied by pastureland. Not surprisingly, the proportion of Earth's surface covered by forest and woodland has dropped by 9% since 1700. Much of what remains is becoming increasingly fragmented, and approximately 40% is either plantation or secondary forest[10]. Perhaps the most poignant metric is a catastrophic rate of soil degradation, corresponding to 17% of all vegetated land during only 45 years. Biotic functions have been completely destroyed in 9 million hectares and have been "largely destroyed" (ref. 11) in a further 300 million hectares.

Additional metrics confirm dramatic human influence on natural biotas. World exploitation of marine fishes has increased by 35% since 1979. The exploitation of freshwater fisheries has expanded 85% during the same period. Sixty per cent of the world's main fish stocks may be exploited beyond their ecological or economic optima[12]. Humans use 8% of the world's available fresh water each year. Tropical deforestation continues at a rate of 0.9% per annum. Human population size is increasing at the rate of 1.7% per year. There has been a parallel increase in the number of domestic animals.

The inescapable conclusion is that much of the planet's surface, and its veneer of life, has already been destroyed. The growth rates of humans, their domesticated mutualists and prey, their coevolved pests, and their summed demands for resources illustrate that much of remaining biodiversity is in peril. We have embarked on a trajectory of lost biodiversity whose acceleration and direction can, at most, be controlled but not reversed. Painful as it is to reconcile, our efforts toward conserving existing biodiversity need to be balanced by a greater emphasis predicting, and dealing with, the consequences of its dramatic decline.

ALTERNATIVE METRICS HIGHLIGHTING THE LOSS OF GLOBAL BIODIVERSITY

Extinction	Taxon	Species extinct 1600–1992	%	Species threatened in 1992	%
	Plants	584	0.3	22137	9
	Vertebrates	229	0.5	2212	5
	Other	256	0.02	1353	0.1
Land use	Type	Area ($\times 10^3$ ha)	% Of total	Year of estimate	
	Cropland	1,477,877	11.3	1987–89	
	Pastureland	3,322,943	25.3	1987–89	
	Forest/woodland	4,095,317	31.2	1987–89	
	Other	4,232,737	32.2	1987–89	
Land classification	Class	Area ($\times 10^3$ ha)	% Of total	Year of estimate	
	Protected areas	834,027	6	1990	
	Degraded lands	1,964,400	15	1945–1990	
	Cleared	646,300–653,500	5	1650–1978	
	Forest/woodland	6,215,000	47	1700	
	Forest/woodland	5,053,000	38	1980	
	Tropical forest	1,884,100	14	1980	
	Tropical forest	1,714,800	13	1990	
Fresh water (1987)	Availability and use	Volume ($\times$ km^3)		% Of total	
	Annual renewable water resources	40,673		100	
	Annual withdrawal by humans	3,240		8	
World fisheries	Type	Average annual catch ($\times 10^3$ tonnes) 1987–1989		Increase since 1977–79 (%)	
	Marine	84,220.3		35	
	Freshwater	13,303.2		85	
	Aquaculture	10,575.8			
Population size (1990)	Species	No. ($\times 10^3$)		Annual increase (%)	
	Humans	5,300,000		1.7	
	Cattle	1,271,279		0.5	
	Sheep and goats	1,716,749		1.3	
	Pigs	845,108		1	
	Equines	118,602		0.7	
	Buffaloes and camels	157,967		1.5	
	Chickens	10,399,000		5.3	

Estimates and calculations occasionally vary among references. Sources: extinction, ref. 8, Table 1; land use, proportions of different habitat types, ref. 11, Table 17.1; protected areas, ref. 11, Table 20.1 (does not include marine and coastal areas; the value is an overestimate because some areas are listed under both "national" and "international" protection systems in the reference); degraded lands, ref. 11, Table 8.1; forest clearing, ref. 13, Table 11–1 (low and high estimates); areas of forest and woodlands in 1700 and 1980, ref. 14, Table 10–1 (these estimates cannot be compared directly with those in ref. 11); tropical forest, ref. 11, Table 8.2; freshwater, ref. 11, Table 22.1; world fisheries, ref. 11, Table 23.4 (annual average 1987–89, aquaculture estimate includes fish and shellfish only); population size, humans, ref. 15, p.811; livestock, ref. 11, Table 18.3 (annual average 1988–90).

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