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Biodiversity Update

Humans have changed **all of Earth's ecosystems.**

- Huge areas of forest have been converted to cropland
- Between 1960 and 2000, reservoir storage capacity quadrupled, and as a result the amount of water stored behind large dams is estimated to be three to six times the amount of water flowing through rivers at any one time
- Almost half of the planet's mangroves have been lost in the last two decades
- 20% of known coral reefs have been destroyed and another 20% degraded in the last several decades

Roughly 10–20% of current grassland and forestland is projected to be converted to other uses between now and 2050, mainly due to the expansion of agriculture and the expansion of cities and infrastructure. Globally, the net rate of conversion of some ecosystems has begun to slow but in most cases this is only because little habitat remains for further conversion.

Causes

Global economic activity increased nearly sevenfold between 1950 and 2000. Per capita GDP is projected to grow by a factor of 1.9 to 4.4 by 2050. Global population doubled in the last 40 years, reaching 6 billion in 2000, and is projected to reach 8.1–9.6 billion by 2050.

The most important direct causes of biodiversity loss are:

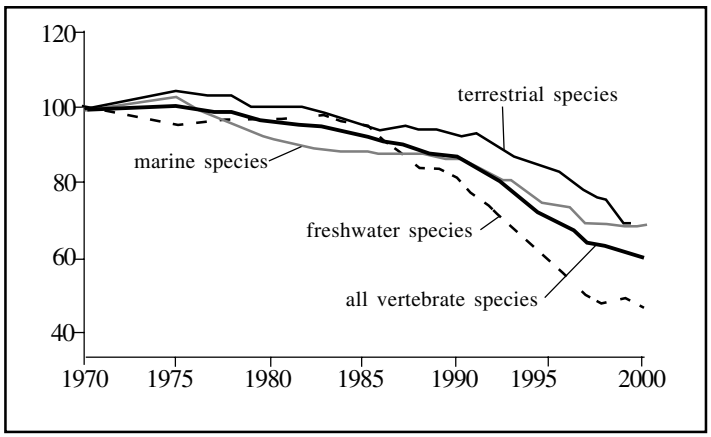
- habitat change (land use change, physical modification of rivers or water withdrawal from rivers, loss of coral reefs, and damage to sea floors due to trawling)
- climate change
- invasive alien species
- overexploitation of species
- pollution, especially nutrient loading

Across a range of taxonomic groups, the population size or range (or both) of the majority of species is declining. Over the past few hundred years, humans have increased species extinction rates by as much as 1,000 times background rates that were typical over Earth's history. Fig.1 a and b compare human population growth rate and the rise of extinctions.

Between 10% and 50% of well-studied higher taxonomic groups (mammals, birds, amphibians, conifers, and cycads) are currently threatened with extinction.

Fig.2 shows the WWF population index which includes assessments of the populations of 555 terrestrial species, 323 freshwater species and 267 marine species around the world.

Fig 2. WWF population index

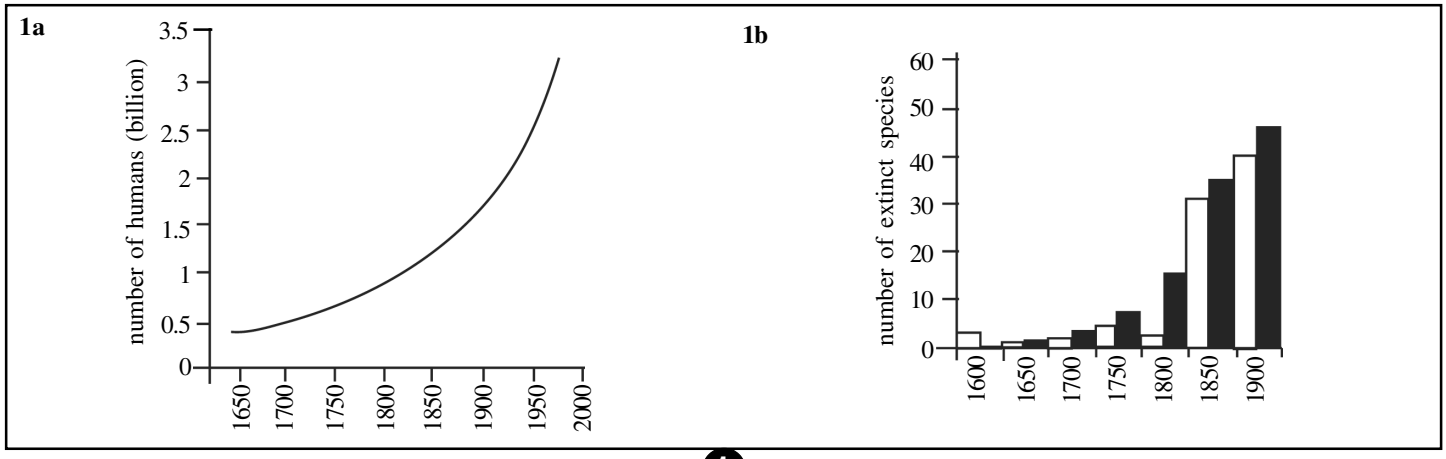


The world's species are becoming more homogenous i.e. the differences between the set of species at one location and the set of species at another location are, on average, diminishing. Two factors are responsible for this trend:

1. species unique to particular regions are experiencing higher rates of extinction
2. growing trade and faster transportation have increased species' invasion and introductions.

The impact of invasion and introductions can be dramatic. The United States, for example, spends hundreds of millions of dollars each year controlling alien species that were initially rare and of little consequence but eventually became invasive.

Fig 1. Humans are wiping out species



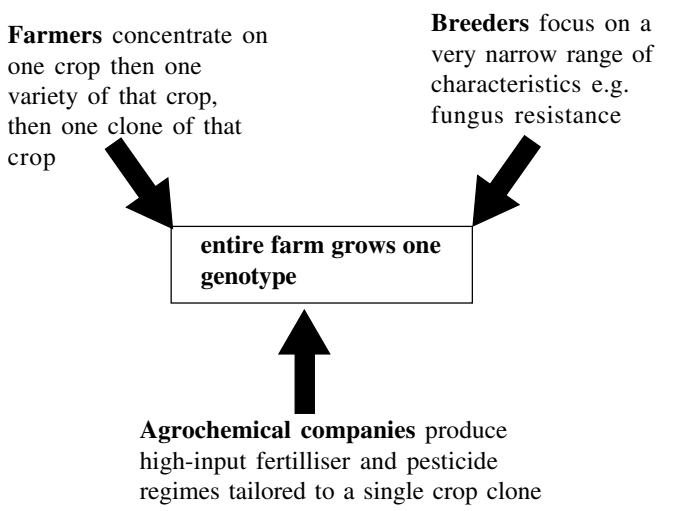
Many of our attempts to intervene in ecosystems backfire. Complete the table by suggesting explanations and consequences of each of the introductions.

Introduction	What happened?	Consequence
Introduction of brown trout (a predator) in new Zealand for angling		eutrophication
Introduction of bass in Gatun lake, Panama		Malaria increased
Introduction of pine marten in Balearic Islands, Spain	Pine marten ate fruit-eating lizards	

Answers are at the end of the Factsheet.

Intensification and specialization by plant breeders has resulted in genetic diversity declining globally, particularly among domesticated species (Fig 3).

Fig 3. Genetic Diversity is reduced by intensification & breeding



Such declines in genetic diversity lower the resilience and adaptability of domesticated species.

Typical Exam Question

How can nutrient loading threaten biodiversity? (3)

Answer

Since 1950, nutrient loading—anthropogenic increases in nitrogen, phosphorus and sulphur, has damaged terrestrial, freshwater, and coastal ecosystems;

Humans now produce more reactive (biologically available) nitrogen than is produced by all natural pathways combined;

Aerial deposition of reactive nitrogen into temperate grasslands, shrublands, and forests leads directly to lower plant diversity;

Excessive levels of reactive nitrogen in rivers and other wetlands frequently leads to algal blooms and eutrophication in inland waters and coastal areas. Similar problems have resulted from phosphorus;

Valuing biodiversity

Crops, fisheries and forests have many ecosystem functions – they all provide food and crops and forests trap (sequester) carbon and help prevent soil erosion etc. What humans have done is to tip the balance towards just one of these functions. Table 1 illustrates what this means.

Table 1 Ecosystem functions

Uncultivated wildland	Cropland
Provides little food for humans	Provides huge amount of food for humans
Rich habitat	Poor habitat
Genetically very diverse	Very low genetic diversity
Constant soil cover so protects soil	Bare soil left in fallow period or during harvest
Regulates C, N and P cycles via natural inputs and outputs	Crop removal = nutrient removal therefore needs fertilisers
Natural predator-prey relationships	Huge food source for a pest necessitates pesticides

As Table 1 shows, modifications of ecosystems to enhance one service (in this case, food production) generally come at a cost to other services due to trade-offs. Whilst food production has increased, 15 other services have been degraded, including wild fisheries, timber production, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, regulation of soil erosion.

Exam Hint: *make sure that you can explain how a forest provides each of the above functions*

Who suffers from loss of biodiversity?

The harmful impacts don't affect people equally. For example, an aquaculture farmer may end up increasing soil salinization. This then reduces the rice yields of nearby subsistence farmers – who then have to buy fish.

Poor people always suffer the most. Richer groups of people can usually purchase substitutes or simply exploit somewhere else. For example, as fish stocks have been depleted in the north Atlantic, European and other commercial fisheries have shifted their fishing to West African seas, but this has adversely affected coastal West Africans who rely on fish as a cheap source of protein.

Many of the problems associated with changes in biodiversity may be difficult to spot -the conversion of forest to agriculture in one region can affect river flows in downstream areas hundreds of kilometres away.

Exam Hint:- *Biodiversity questions can come up on both AS and A2. At A2 you are likely to be asked to explain the links between agriculture, forestry, fishing and pollution and biodiversity*

Typical Exam Question

Many tropical islands chains contain densely forested, mountainous interiors. They contain a wide variety of habitats and a very high species diversity. Many species are endemic, that is they occur only on a particular island chain. The table shows the total number of species on one group of islands in the Indian Ocean and the percentage which are endemic.

Vertebrate class	Total number of species	Endemic species / %
Mammals	53	36
Birds	223	20
Reptiles	61	16
Amphibians	17	53

(a) Suggest why islands may have a high proportion of endemic species. (2)

(b) Suggest four ways by which the endemic species could be conserved. (4)

Answers

(a) isolation (on islands);
variety of habitats / conditions different from origin/other islands;
differing pathways of natural selection;
leading to organisms too different to interbreed. 3 max

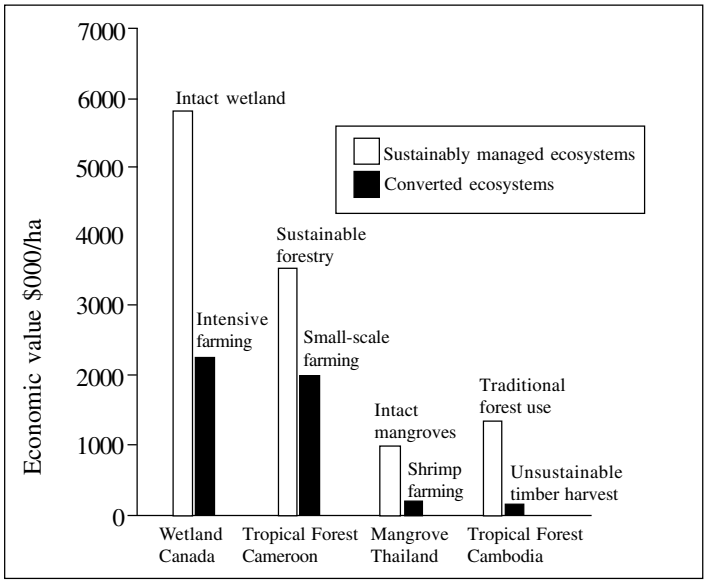
(b) 1. protection of habitat;
2. legal measures, e.g. quotas, hunting bans;
3. capture/culling of non-native species;
4. captive breeding;
5. surrogacy / artificial insemination / genetic manipulation techniques;

Stopping loss of biodiversity

The secret is to put the correct economic value on it in the first place. Forests are destroyed because people believe that the crops or the timber are worth more than the forest.

More and more studies are showing that, when we take account of all the ecosystem functions, the costs of converting mangrove forests, draining wetlands, and clear-felling of forests for exceed the benefits of the habitat conversion.

Fig 4. Economic value of original and converted ecosytems



The problem is that our economic models –the ones that the World's leaders use in their meetings –do not take proper account of global functions. A country could cut down its forests and deplete its fisheries and this would show only as a positive gain to GDP despite the loss of the resources.

Answers

Introduction	What happened?	Consequence
Introduction of brown trout (a predator) in new Zealand for angling	Trout ate all herbivores. Caused explosion of aquatic plants eutrophication	Eutrophication
Introduction of bass in Gatun lake, Panama	Bass ate all predators from lower trophic level that fed on mosquito larvae	Malaria increased
Introduction of pine marten in Balearic Islands, Spain	Pine marten ate fruit-eating lizards	Changes to dominant shrubs across islands

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