de Facto

ENVIRONMENTAL OBJECTIVES AND FUNDAMENTAL PRINCIPLES

2001

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by 2010?
by 2020?
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1. Reduced climate impact (target year 2050)
2. Clean air
3. Natural acidification only
4. A non-toxic environment
5. A protective ozone layer
6. A safe radiation environment
7. Zero eutrophication
8. Flourishing lakes and streams
9. Good-quality groundwater
10. A balanced marine environment, flourishing coastal areas and archipelagos
11. Thriving wetlands
12. Sustainable forests
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14. A magnificent mountain landscape
15. A good built environment
CURRENT TREND
Things are moving in the right direction
No clear-cut change has occurred
Things are not moving in the right direction
FURTHER ACTION
Realistic within time-frame, but further action required
Difficult within time-frame, even if further action taken
Not realistic within time-frame
RESPONSE OF ENVIRONMENT
0–5 years
5–30 years
>30 years

Environmental objectives and fundamental principles

In April 1999 the Swedish Parliament adopted environmental quality objectives relating to fifteen areas, describing what quality and state of the environment and natural and cultural resources of Sweden are ecologically sustainable in the long term. For fourteen of these goals, the environmental quality described is to be attained by 2020; for the fifteenth, the climate objective, the target date is 2050.

To provide more tangible guidance for efforts in the environmental sphere, the Government has defined interim targets for each objective, indicating the direction and timescale of the action to be taken. The Government's bill on targets, measures and strategies was passed by Parliament in November 2001.

The decision reached by Parliament defines ecological sustainability in terms of protecting the environment so that pollutants do not damage human health, the cultural heritage or nature's capacity to absorb and degrade pollutants; ensuring efficient use of energy and other resources; safeguarding long-term ecosystem productivity; and making careful use of our cultural environment.

The Government and Parliament have identified five principles as fundamental to the task of achieving the environmental quality objectives:

- promotion of human health,
- preservation of the cultural environment and cultural heritage,
- preservation of biological diversity and the natural environment,
- preservation of the long-term productivity of ecosystems and
- wise management of natural resources.

These five fundamental principles are consistent with the definition of ecological sustainability given above, and similar principles form the basis for the application of Sweden's Environmental Code. Accordingly, *de Facto 2001* describes progress towards the environmental quality objectives under five main headings, referring to the five principles.

Health and culture as important as nature

Ecologically sustainable development is not only a matter of ensuring a non-toxic environment for plants and animals and responsible management of natural resources. It is also about safeguarding our right as human beings to a healthy environment, safe food and undisturbed enjoyment of nature. In addition, our cultural heritage must be preserved, and support given to activities which help to maintain our cultural environment. Cultural heritage resources are affected in many different ways in a modern society.

Far-reaching change needed in society

To uphold the five fundamental principles, the fifteen environmental quality objectives must be achieved. Thanks to measures already implemented, many pressures on the environment have been reduced in recent decades. But the steps taken and commitments made are not enough to attain the objectives – that will require a fundamental transformation of the whole of society.

Recovery may take a long time

Although action has been taken, improvements in the environment may take some time. This is because of the built-in inertia that prevents ecosystems from reacting immediately when pressures on them ease. Soil acidification, for example, is still a problem, despite deep cuts in acid emissions. By contrast, when an acidified aquatic environment is limed, the response is immediate.

Another problem is the toxic substances incorporated in the technosphere –buildings and products – and present in the soil on former industrial and other contaminated sites. Although direct discharges of known toxic and hazardous substances have abated somewhat, concentrations in the environment can remain high owing to emissions, often of substances with unknown properties, from these diffuse sources.

The delayed effects of remedial action are particularly clear in the case of the ozone layer and climate change. Both substances affecting the ozone layer and those that drive climatic processes can remain in the atmosphere for hundreds – even thousands – of years. We therefore cannot expect to see a rapid response when emissions fall: the environment will remain affected for decades to come. It is thus all the more important to substantially reduce the emissions concerned as soon as possible.

National and international decisions needed

For several of the objectives, e.g. those relating to groundwater, wetlands and mountain areas, the progress achieved depends largely on Sweden alone. Other goals, e.g. regarding air quality, eutrophication and acidification, require action both in this country and abroad. And to tackle ozone depletion and the threat of climate change, global agreements are needed, even if the necessary measures have to be taken by each country on a national basis – and indeed, by every citizen.

Monitoring and evaluation

The fold-out diagram on the inside front cover presents an overall assessment of whether the fifteen objectives will be attained by 2020 (2050 for the climate goal). *Pressures* on the environment are assessed in terms of what has happened over the last five years; trends in the *state* of the environment over the last ten. A number of measures to create conditions for achieving the objectives have already been decided on and implemented, but *further action* is needed. The diagram shows whether such conditions can be created by 2010 or 2020 (2050). Our assessment takes into account whether the necessary action can in fact be taken, bearing in mind the likely economic and social consequences. In some cases, action within the period stated is technically feasible, but not in our view realistic, given the heavy costs or far-reaching lifestyle changes involved. An assessment of the key factors for attaining each objective will be found on pp. 29–32.

We have also assessed the timescale of the environment's *response*, i.e. how long recovery will take once conditions for meeting the objectives have been created. In the case of forests, for example, current trends in terms of pressures and action are judged to be favourable. Even so, since one forest generation spans 80–100 years, the resultant changes in the environment will not be fully visible for decades.

In the diagram, the symbol for 'no clear-cut change', a neutral face, is also used when a favourable trend (e.g. reduced acidification of surface waters) is considered to be offset by an unfavourable one (e.g. persisting/increasing soil acidification). A smiley face under 'pressures on environment' means that the latter have been significantly reduced and things are moving in the right direction.

For some of the objectives, our assessment focuses on chemical pressures, while for others the focus is on physical and biological factors. For many ecosystem types, such as lakes, seas, forests and farmland, it will only be possible to claim that every environmental problem has been solved and the quality objective achieved when the goals regarding eutrophication, acidification and toxic pollutants have been achieved. The objectives of clean air and a safe radiation environment are similarly crucial with regard to the built environment.

Indicators reveal trends

In its final report (June 2000), the Environmental Objectives Committee proposed 159 indicators to monitor progress towards the objectives. A given indicator may be linked to one or more objectives. Its main purpose is to communicate a message. It signals progress or lack of progress towards a goal, for example by describing how our need to travel is driving the turnover of hazardous products; how nitrogen oxide emissions are affecting sensitive architectural details in towns; how much hard dead wood is available in forests as habitat, promoting biodiversity; how the distribution of brown algae is changing, reflecting ecosystem productivity; or how much phosphorus is being recycled to farmland to maintain soil productivity after harvests. Of the 159 indicators, *de Facto 2001* has chosen around 35, which are presented in diagrams.

1 Human health

The Government has identified the promotion of human health as one of the five fundamental principles to be taken into account in efforts to achieve ecologically sustainable development.

Concerning the health dimension of the environmental quality objectives, three scenarios are possible:

1. Protection of health and of the environment coincide. This is true of most of the interim targets. For example, lower levels of health-damaging sulphur and nitrogen compounds in air mean better air quality and less acidification of soil and water, in turn improving aquatic habitats and drinking water quality.
2. Measures to protect health carry greater weight and benefits for the environment are less pronounced: e.g. action to tackle radon, damp and poorly ventilated buildings, spread of infection via water and sewage, or noise.
3. Human health may be less well protected as a result of environmental action. This may be the case, for example, if we switch to small-scale wood-fired heating, which can increase emissions harmful to health if the wood is not burned correctly, or if transport projects are stopped on nature conservation grounds, even though they would reduce air and noise pollution.

Action to reduce damage to health and the risks of ill health is of particular importance in six areas: (1) hypersensitivity, including allergy and asthma; (2) lung diseases such as cancer or bronchitis; (3) skin cancer; (4) diseases due to build-up of persistent substances that can cause hormonal changes, developmental disturbances or cancer; (5) noise; and (6) preventing the development of environments favourable to pathogenic micro-organisms.

Hypersensitivity, including allergies such as asthma, hay fever and eczema, has become much more common, and environmental disturbances may be one of the reasons. One key task is to alleviate symptoms in people already affected. These symptoms can be greatly aggravated by environmental factors: for example, elevated levels of certain air pollutants lead to higher mortality among individuals with asthma, bronchitis or pulmonary emphysema. The total incidence of cancer has risen over the last five years. Breast and prostate cancer are examples of increasingly common forms for which some link with environmental pollution is suspected. The number of cases of skin cancer is rising steeply as a result of increased exposure to UV radiation. Even if people spend radically less time in the sun, the long latency period of cancer means that we will have to wait some 20 years to see any effect. For the same reason, the reduction of lung cancer achieved by lower radon levels in buildings will not be clearly visible for another 50 years.

Impaired hearing and tinnitus have become more widespread. The causes have not been fully elucidated, but one reason could be a wider occurrence of noise levels harmful to hearing. Infections that have become more prevalent include *Campylobacter* bacteria from food and legionnaires' disease, a serious lung infection that can arise when *Legionella* bacteria are able to multiply or survive in water heated to less than 65°C. Aerosol formation in air, e.g. when people take showers, can result in the bacteria being inhaled. A very disturbing phenomenon is the increased prevalence in the environment of bacteria resistant to antibiotics, due to overuse of these drugs. There is a great danger that resistant strains of bacteria will not disappear even if antibiotics use is much reduced. It is vital to ensure that new resistant strains do not develop.

The direct effects of air pollution, noise, radiation, toxic pollutants etc. are not the only factors of significance for human health. Other factors, too, have an impact on quality of life and hence health. A sense of living in a clean environment and opportunities for recreation and tourism are important. These can be promoted, for example, by access to green spaces and lakes near residential areas, infrastructure favourable to an active lifestyle which does not generate harmful air pollutants, and a living cultural environment, on land and at sea.

1.1 Road traffic emissions a factor behind serious diseases

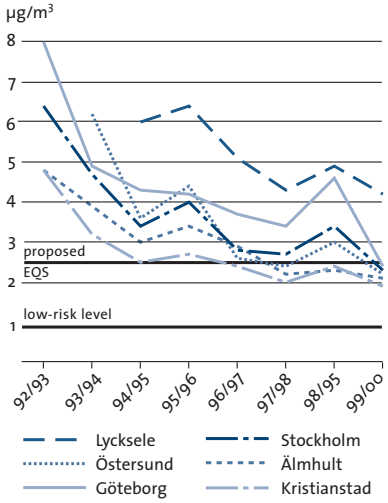
Together with inefficient small-scale burning of wood, transport is the biggest source of emissions of particulates, polyaromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), such as benzene, ethene, toluene and xylene. It is also by far the largest emitter of nitrogen oxides.

High levels of nitrogen dioxide increase the general sensitivity of the airways. Asthma sufferers are among the most sensitive and can react at low concentrations. Air pollutants can also reinforce allergic reactions to pollen. For every 10 µg/m^3 increase in particulate levels in outdoor air, hospital admissions rise by 0.4–0.9%. Air pollutants such as benzene, ethene, butadiene and propene are together estimated to cause almost 100 cancer cases in Sweden every year. The main source of carcinogens is incomplete combustion.

In the city of Stockholm, benzene emissions in 1998 were estimated at 2000 tonnes, of which road vehicle exhausts accounted for some 70%. Evaporation losses from vehicles contributed a further 8%, and wood burning about 15%. Emissions are higher in cold weather, owing to cold starts and increased heating requirements. Since wood-fuelled heating is common in small towns, benzene is not solely a problem of major cities.

At the request of the Government, the Environmental Protection Agency is preparing an environmental quality standard (EQS) for benzene. The Agency proposes a maximum concentration of benzene in outdoor air of 2.5 µg/m^3. The low-risk level of 1 µg/m^3 will still be exceeded throughout Sweden in 2010.

FIG. 1.1 Mean benzene concentrations in urban air, October–March



CLEAN AIR; GOOD BUILT ENVIRONMENT

Catalytic converters and lower benzene levels in petrol have reduced emissions of benzene, as has increased use of environmentally approved technology for small-scale burning of wood.

1.2 Hazardous emissions from wood burning can be reduced

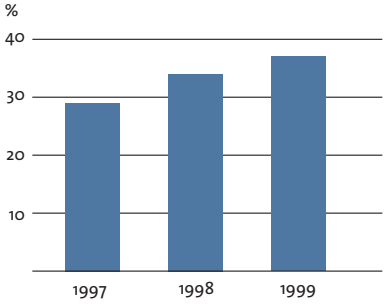
Small-scale combustion of wood in inappropriate installations causes emissions of PAHs, VOCs, particulates and other pollutants with major impacts on human health. 60% of PAH emissions are estimated to come from small-scale wood burning and around 30% from transport. Of Stockholm's benzene emissions, about 15% are due to use of wood fuels.

A national environmental health survey carried out in 1999 found that the following percentages of adults had, at least once a week, perceived smoke from wood burning to be a nuisance in or near their homes:

- 6–8% in Kalmar, Kronoberg, Jönköping and Norrbotten counties,
- 4–6% in Södermanland, Värmland, Dalarna and Västernorrland counties,
- the lowest percentage in Stockholm county.

Small-scale burning of wood accounts for 25% of the total energy used to heat houses in Sweden. In 1999 there were some 275 000 boilers that were fired with wood, and another 300 000 capable of using wood fuel. In addition, there were around 250 000 stoves and fireplaces for cooking or heating. Of the total adult population of 6 257 000,

FIG. 1.2 Percentage of private wood-fired boilers meeting environmental standards



CLEAN AIR

As new wood-burning boilers are installed, the proportion meeting environmental standards increases. National building regulations governing emissions from small wood-fired boilers etc. only impose standards in built-up areas. Wood burning produces large emissions of hydrocarbons. This is not only an urban problem.

some 524 000 live in houses heated solely by wood, wood chips, pellets or similar solid fuels. Of that number, 9.5% reside in major cities.

Some 30% of solid-fuel boilers have an accumulator tank, which reduces frequency of operation and permits efficient combustion. Retrofitting an accumulator to a log boiler based on outdated technology reduces VOC, tar and other emissions by 60–70%; for an average-sized house, the investment cost is SEK 30 000–50 000. A possible alternative to an accumulator tank is a pellet burner. Wood pellets have many advantages: for example, as a dry and homogeneous fuel, they burn more evenly and efficiently than logs.

Most boilers installed in Sweden today meet environmental standards for wood-fired appliances in built-up areas. In future, the building regulations of the National Board of Housing, Building and Planning, requiring 'environmental approval' of new boilers, are expected to apply everywhere, and not only in towns as at present.

1.3 Chemical products classified by degree of hazard

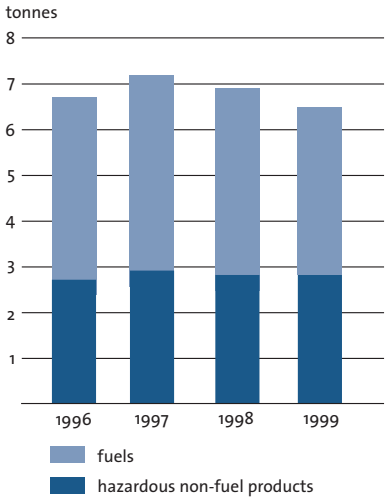
The health effects of many of the chemicals we use are still unknown. To reduce the risks, classification and labelling of chemical products on the basis of their hazardous properties need to be improved. Properties currently taken into account include carcinogenic and sensitizing characteristics. Detailed product information is needed so that users can avoid substances harmful to health or replace them with less harmful alternatives. The most hazardous substances of all, e.g. chlorinated solvents, mercury and cadmium, must be restricted or banned.

In 1998, around 75 million tonnes of chemical products were turned over on the Swedish market, of which some 14 million tonnes were exported. Of the total quantity, products classed as non-hazardous to health made up barely a fifth. Almost half consisted of toxic products, i.e. products required to carry the skull and crossbones symbol. Most of these are motor and other fuels. The remainder of the total was made up of chemicals classed as non-toxic, but harmful to health in some other way, e.g. sensitizing or corrosive.

Much attention has been paid to persistent organic pollutants such as DDT, PCBs, brominated flame retardants and dioxins, which are linked to cancer and disturbance of bodily functions, e.g. the immune system, reproduction and the endocrine system. Metals such as nickel and chromium can cause allergic reactions, eczema and other skin conditions.

Both Sweden and many international organizations are trying to develop indicators that will offer a simple way of monitoring whether the risks of harm from chemicals in our societies are increasing or decreasing. A proposed Swedish indicator is the annual per capita turnover of chemical products that entail hazards to human health.

FIG. 1.3 Turnover of chemical products hazardous to health, per capita per year



GOOD BUILT ENVIRONMENT, NON-TOXIC ENVIRONMENT

The turnover of chemical products that could endanger health has not changed appreciably in recent years. Health effects depend partly on what products contain and partly on how they are handled. The statistics give no indication of whether the situation has improved or deteriorated in these respects.

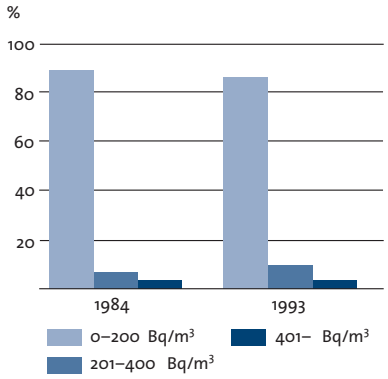
1.4 Radon in homes causes lung cancer

The average radiation dose to people in Sweden is about 4 millisieverts per year, roughly half of it due to radon in homes. Radon is a radioactive noble gas belonging to a decay series that begins with uranium-238. The main source of the radiation dose from exposure to radon in indoor air is the decay products after radon in the series, known as 'radon daughters'. Radon can come from the ground beneath a building, from building materials or in certain cases from tap water.

There are currently some 4.3 million homes in Sweden: almost 2 million houses and 2.3 million apartments. Nationwide surveys of residential radon were presented in 1984 and 1993. On the basis of the latest survey, the Swedish Radiation Protection Authority estimates that around 100 000 houses (5% of the total) and 50 000 apartments (2%) have radon levels exceeding the action level of 400 becquerels per cubic metre of air, Bq/m^3. The numbers of houses and flats with radon levels above 200 Bq/m^3 are estimated at 300 000 (15%) and 200 000 (10%), respectively. The action level for radon in existing buildings is 400 Bq/m^3; under the building regulations of the National Board of Housing, Building and Planning, new buildings are subject to a limit of 200 Bq/m^3.

Some 500 deaths from lung cancer every year may be caused by radon in Swedish homes. Because radon exposure and smoking have a synergetic effect, almost 90% of these deaths occur among smokers.

FIG. 1.4 Percentages of homes with radon levels in different ranges



GOOD BUILT ENVIRONMENT, SAFE RADIATION ENVIRONMENT

The proportion of homes with radon levels over 400 Bq/m^3 did not change between the two survey dates. The percentage in the range 201–400 Bq/m^3 seems to have increased somewhat, possibly suggesting inadequate enforcement of the 200 Bq/m^3 limit for new homes. Further action is essential.

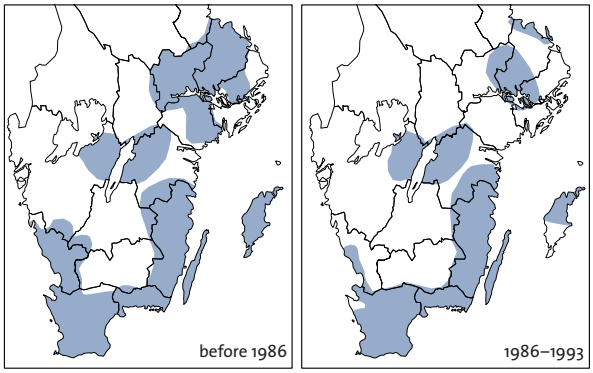
1.5 Drinking water quality important for healthy population

An environmental factor crucial to human health is the quality of drinking water. The risk of contamination with sewage, in particular, makes drinking water a potential vehicle for the spread of infections caused by various micro-organisms. Inadequate maintenance of sewers, resulting in leakage of sewage, is a growing problem. Between 1995 and 1999 waterborne infections resulted in almost 20 000 cases of illness in Sweden.

Over 5 million Swedes rely on groundwater for their water supply. There are some 400 000 wells on properties occupied all year round and the same number serving second homes. High levels of radon may be found in drinking water from drilled wells. The main health risk associated with radon in water is that the radon can be released to indoor air and inhaled. The health risk from ingestion of water with radon levels below 1000 Bq/l is estimated to be relatively small.

In intensively farmed areas, nitrate in groundwater is a health risk, especially for children. Use of pesticides, chiefly to keep

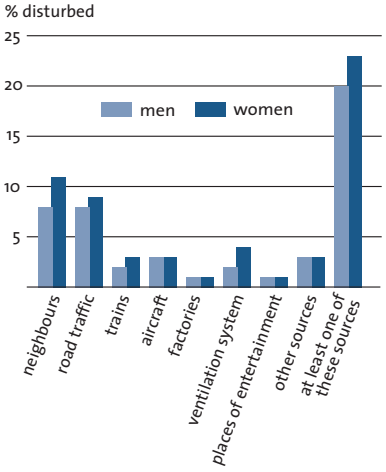
FIG. 1.5 Areas with nitrate-nitrogen concentrations exceeding 5 mg/l in more than 5% of wells



GOOD-QUALITY GROUNDWATER

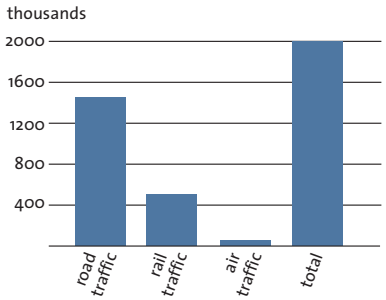
The area with an appreciable proportion of wells with over 5 mg/l of nitrate-nitrogen has decreased, although nitrate remains a problem in Sweden's farming regions. The improvement is mainly due to changes in farming methods and better sewage systems.

FIG. 1.6a Percentage of people disturbed at least once a week, in or near their homes, by noise from different sources



GOOD BUILT ENVIRONMENT

FIG. 1.6b Number of people exposed to noise in excess of guide value (55 dB(A), 24-hour equivalent sound pressure level) from different modes of transport, outdoors near their homes in 2001



GOOD BUILT ENVIRONMENT

Noise levels are affected by the volume of traffic, the amount of heavy traffic, and noise reduction measures in residential areas. When transport infrastructure is built or modified, steps are normally taken to comply with guide values for noise. In residential areas near existing infrastructure, the noise situation can be improved by building barriers, insulating buildings etc. The noise environment of residential areas is expected to improve within a number of years. However, there are no times series to show whether noise levels have increased or decreased in recent years.

asphalt, paved and gravelled surfaces and roads free from weeds, but also on farmland, can impair the quality of surface and ground waters. Landfills, air pollution and use of de-icing salt on roads can also adversely affect water quality.

Both surface and underground water sources have been affected by acidifying air pollutants. In acidified areas, leaching of mobile metals such as aluminium is increasing. Acidification of water also accelerates corrosion of water pipes, raising levels of heavy metals in tap water.

1.6 Noise affects largest number of people

'Noise' means unwanted sound, which can come from many different sources, ranging from human speech to vehicles and fans. An estimated two million people in Sweden are exposed to transport noise which exceeds existing guide values and could affect their health. Health-related effects include impaired hearing, difficulty apprehending speech, disrupted sleep, annoyance and inability to concentrate. There are also indications that noise can cause hypertension. It is particularly disturbing that children and young people are exposed more than ever before to noise levels that could damage their hearing. Hearing impairment can arise at very high sound pressure levels or after long exposure to high sound pressure levels.

Even sound waves inaudible to the human ear can affect health, via stress and irritation. The problems of low-frequency noise from fans and compressors have recently attracted attention. Low sound pressure noise does not directly damage health, but does greatly impair quality of life and can cause secondary damage and disorders. The risk of health problems increases with increasing sound pressure and period of exposure.

In a national environmental health survey carried out in 1999 (NMHE 99), 12% of men aged 19–29 reported that they had impaired hearing. The proportion increased with each age group, to 55% for men aged 70–81. Hearing loss is a serious social handicap. Elevated levels of background noise, e.g. from traffic, interfere with communication to a greater degree for the hearing-impaired than for those with normal hearing.

Estimates indicate that there has been no appreciable change over the last five years in the percentage of people disturbed by noise at least once a week in or near their homes. During that period, many of the buildings most exposed to noise have been soundproofed, but such measures make no difference to the outdoor environment. The interim target is to reduce by 5%, between 1998 and 2010, the number of people exposed to traffic noise exceeding guide values for noise in dwellings.

1.7 Accessible green space good for health

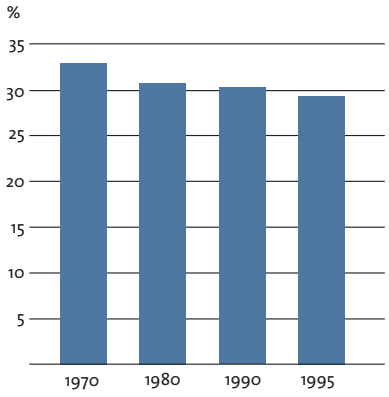
In densely built-up areas, space for exercise and recreation near people's homes is important. An active lifestyle and opportunities to unwind from the stresses of everyday life are two important factors for healthy living. Suitably located and designed

green spaces can accommodate a wide variety of activities, from quiet walks and enjoyment of nature to games and team sports.

Urban green space also promotes a pleasanter climate and a better environment. Air pollutant levels are lower in such areas, partly because activities generating air pollution are excluded from open spaces and partly because vegetation, especially large trees, can to some extent filter dust and exhaust gases from the air. Vegetation also absorbs noise from the surrounding area. Green spaces enable people to spend time in areas not directly adjacent to activities causing pollution and disturbance.

The area of green space accessible to the public in towns is constantly dwindling. Increasingly dense urban development, mainly in the form of buildings and roads, encroaches on small woods, grass areas and other open land. In 1970 green space made up 33% of the total urban area of Sweden, but 25 years later the figure had fallen to below 30%. The proportion of green space is declining most rapidly in towns with over 10 000 inhabitants, which have faster-growing populations than smaller communities. The new housing needed is often built where sewer systems, electricity networks and other services are already established, i.e. within existing built-up areas, making inroads into open spaces. In 2000, 84% of Sweden's population lived in urban areas.

FIG. 1.7 Urban green space as a percentage of total built-up area



GOOD BUILT ENVIRONMENT

When people move from small rural communities to larger towns, more and more urban green space has to make way for buildings and infrastructure. The percentage of green space in Swedish towns is nevertheless high compared with other European countries.

The cultural environment and cultural heritage

One of the five fundamental principles underlying the environmental quality objectives is the need to protect the cultural environment and the cultural heritage.

The cultural heritage goals will have been achieved if, one generation from now, cultural environments and characteristics reflecting the history of different areas and communities have been preserved. When changes occur, the identity and historical dimensions of the environments concerned must be safeguarded, and cultural heritage resources must be cared for so as to preserve features typical of different periods.

Cultural heritage is the property of both the past and the future – it is both a non-renewable resource and a starting point for development. If new developments are designed with care, they can become the treasured cultural environments of the next generation. By means of development goals to guide change, cultural assets can be safeguarded as a resource for the future.

Ever since the Second World War, small-scale, craft-based industries have made way for large-scale, highly efficient operations. As a result of restructuring, many old installations and sites no longer serve their earlier and perhaps original purposes; they have decayed, disappeared or been adapted for new uses. Cultural assets have also been damaged by pollutants and insensitive land use, e.g. in agriculture or forestry or for infrastructure.

A welcome general trend today is that the cultural heritage of different places is seen as a basis for regional and local development. Air pollution has been reduced, and acidification is gradually abating. However, sensitive building materials and rock carvings are continuing to crumble because of the accumulated effect of pollutants. Surveys of ancient and other cultural remains in forests are now under way. Agri-environmental schemes are providing substantial support for the management of culturally significant features of the farmed landscape. Our knowledge of the cultural resources of mountain areas remains inadequate, but steps have been taken to protect and manage the Sami cultural heritage. Greater account is now taken of cultural assets when new roads are planned and old settlements developed.

We still have only a limited understanding of the ecological, social and economic importance of careful management of the cultural heritage in achieving long-term sustainable development. If this heritage is to be preserved and developed, owners and users need to be aware of the cultural assets on their land and to safeguard them through careful use. Arrangements for wider involvement in planning must be developed. In addition, emissions of acidifying and other air pollutants need to be further reduced. Legislation and grant schemes offer additional means of preserving the cultural heritage.

Up to now, data on the state of cultural environments and objects have only been collected systematically in conjunction with particular projects, e.g. on the environmental effects of food policy and the impact of air pollution on rock carvings. Indicators have not previously been used to track changes in the cultural environment, so time series are not available and only general statements about trends are possible at present. Monitoring methods for the cultural environment are currently being developed.

2.1 Stone buildings damaged by air pollution

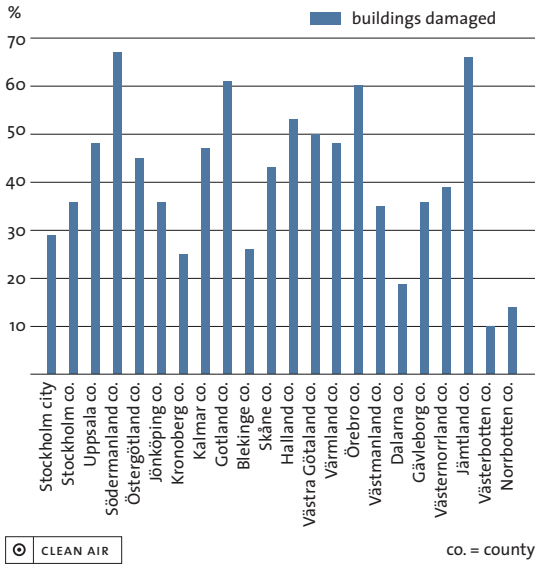
Building stone, in both towns and rural areas, is damaged by wind and moisture, chemicals in air and rain, lichens and mosses and temperature variations, as well as by human influences. The extent of the damage depends on local air quality and traffic conditions, but also on the type of stone: limestone and sandstone are more sensitive than granite. Stone can crumble, split into layers, crack, become discoloured, abraded or pitted or be affected by salt crystallization. Some of this damage can be repaired, but the historically valuable original materials and their appearance are marred irretrievably.

A nationwide survey of damage was carried out in the early 1990s, covering 4750 buildings, of which some 40% were found to be harmed. Of 14 550 details or objects, almost 50% had suffered damage. Sculptures and ornamental features are more susceptible than smooth wall surfaces. In cities, damage is concentrated in areas with heavy traffic. Many pre-1550 church doorways sculpted in Gotland limestone have been damaged, as have many figured doorways carved in the same material between 1550 and 1750, both in secular buildings in Stockholm and in richly ornamented mortuary chapels in Södermanland county. Damaged buildings from the period 1750–1860 include palaces, churches and public buildings, e.g. military installations in Skåne, Västra Götaland and Örebro counties; those from 1860–1910 include banks, apartment buildings, stations and other public buildings in Stockholm and Västra Götaland county. Most of the damaged buildings from 1910–40 are apartment buildings with limestone ornamentation in Västra Götaland.

Rock carvings and rune-stones have also been affected. In the 1960s some 30% of Bohuslän rock carvings had suffered weathering damage; in the early 1990s, around 74% of them. This damage is due to air pollution, road traffic, water and weather conditions, and characteristics of the stone, in addition to direct human disturbance. Some carved rocks are now being covered to slow the effects of precipitation and temperature fluctuations.

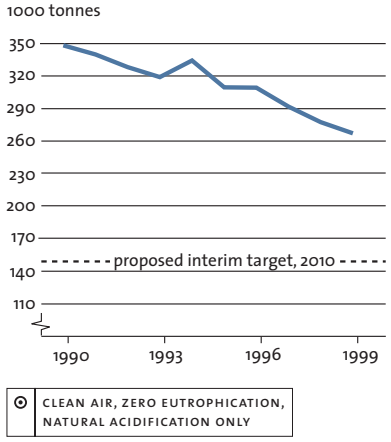
In areas with high atmospheric pollutant levels, major damage has been caused to cultural artefacts and architectural details made from all types of stone. Elsewhere, damage can be observed where very sensitive stones have been used, e.g. Jämtland limestone. Air pollutant emissions are now falling in Sweden, but many instances of damage are caused by pollutants retained inside the stone for several years.

FIG. 2.1a Damage to stone in buildings, 1992–96



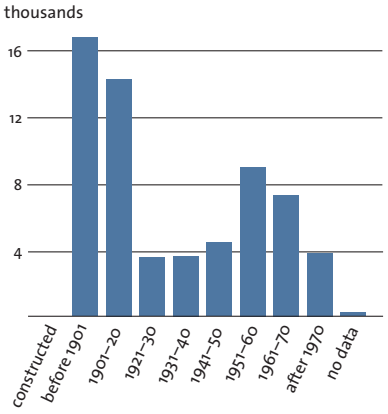
In areas with high air pollutant levels, cultural artefacts and architectural details made of all types of stone have suffered considerable damage. Where very sensitive stones have been used, e.g. Jämtland limestone, significant damage may be observed despite only moderate pollution levels. Limestone and sandstone are more sensitive than granite.

FIG. 2.1b Nitrogen oxide emissions in Sweden



Nitrogen oxide emissions are falling. Further reductions are needed, in Sweden and across Europe, to avoid damage to cultural heritage, health and the environment.

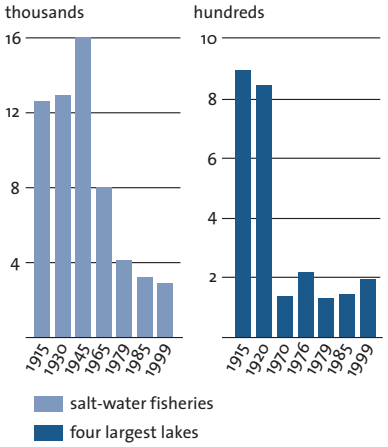
FIG. 2.2 Number of apartments in multi-dwelling buildings demolished 1961–2000, by year of construction



GOOD BUILT ENVIRONMENT

The buildings of different periods are an important part of the cultural heritage. Demolition statistics show clearly how buildings from different epochs have disappeared. The percentage of buildings in Sweden today dating from before 1900 is very small, and since 1995 modern buildings have also been demolished. For a more complete picture, data on the proportions of buildings from different years remaining and disappearing during each decade are also needed.

FIG. 2.3a Number of commercial fishermen



BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS, FLOURISHING LAKES AND STREAMS

2.2 Demolition obscures 'annual rings' of towns

When buildings are demolished, part of the built heritage disappears and with it a significant portion of the historical identity and character of a place. Buildings are pulled down for various reasons. In towns, it may be because a site can be put to other, more profitable uses; in rural areas, some old buildings are replaced with new ones, while others are left to decay when they are no longer needed.

The 1960s and 1970s saw a radical transformation of Swedish town centres. The small-scale, varied settlement patterns of the 18th and 19th centuries, with a mix of homes and industrial and commercial premises, made way for uniform blocks of shops, offices and large apartment buildings. Ring roads and multi-storey car parks were planned to cope with the traffic. In a city like Göteborg, most of the old three-storey, stone-and-timber workers' apartment buildings were lost, as were many late 19th century, stone-built workers' dwellings in Norrköping. In other towns, e.g. Nyköping and Uppsala, numerous low wooden buildings were replaced with long, three- or four-storey apartment blocks. Many backyard workshops were demolished.

Demolition statistics are only available for apartment buildings. Prior to 1985, apartment blocks built before 1920 were the main category demolished. They represented a historic heritage, but were considered of too low a technical standard to be preserved and modernized. Up to 1995, numerous buildings from 1930–50 were demolished, since at the time they were not deemed of sufficient cultural historical value. Since 1995 apartment buildings erected under the 'million homes programme' (1964–75) have been pulled down – to date, 2% of the total.

In some municipalities, projects to remedy social and technical problems and establish ecologically sustainable housing areas are under way. The Stockholm, Göteborg and Malmö regions, led by the National Heritage Board, have carried out inventories of their cultural heritage assets, in readiness for any future reshaping of these cities.

2.3 Many fishing villages have become resorts

In coastal areas and archipelagos, fishing has been an important livelihood for thousands of years. The names of shallows, channels and inlets are reminders of how fishermen and other seafarers have used these waters, while house foundations, fishermen's farms and fishing villages reveal how fishing communities have settled on the land at various times. The environments created by them on coasts, islands and lake shores can only survive if fishing itself continues.

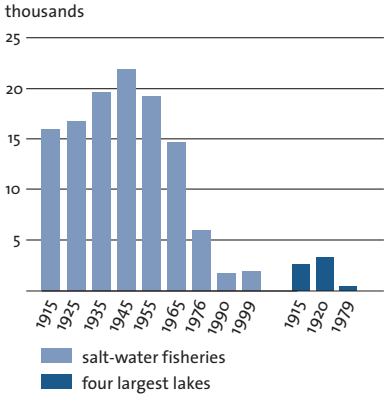
The fishing industry has changed dramatically since the beginning of the 20th century. In 1915 the Swedish salt-water fleet consisted mainly of small, unpowered open boats, but gradually they were replaced with larger, decked vessels with engines. Fishermen had to seek state assistance to build harbours and quays, having previously used simple jetties sheltered by islets and rocks. Broadly speaking, the number of

boats increased up to 1945. Since then it has fallen appreciably, owing to changes in fish stocks, the high cost of vessels and equipment, and more efficient handling of catches. In 1915 the annual catch was 75 000 tonnes; now it is 400 000 tonnes.

The Göteborg archipelago and Bohuslän have always had the largest number of salt-water fishing boats and fishermen, but fishing has also been very important in Östergötland, Småland, Blekinge, Skåne, Gästrikland, Hälsingland, Öland and Gotland. Partly because of the changes in the industry, fishing villages with harbours designed for small, shallow-draught open boats have largely become summer resorts. Fishing is still carried on from places with harbours and services geared to large vessels, with modern equipment and facilities for rapid road transport of catches.

Sweden's largest lakes have also supported significant fisheries. Small open boats still predominate, although they now have engines, and therefore harbours have not changed in the way they have on the sea coast. In the last thirty years, the number of commercial fishermen on inland waters (apart from Lake Vättern) has increased somewhat.

FIG. 2.3b Number of fishing boats



BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS, FLOURISHING LAKES AND STREAMS

Fishing, long an important industry in coastal, archipelago and lake areas, has changed dramatically since the early 20th century. Numbers of both fishermen and boats have fallen. As a result, many man-made environments based on fishing have lost their original functions and valuable cultural historical features are gradually disappearing. Living cultural environments will only be maintained if fishing continues.

2.4 Old farm buildings often stand empty

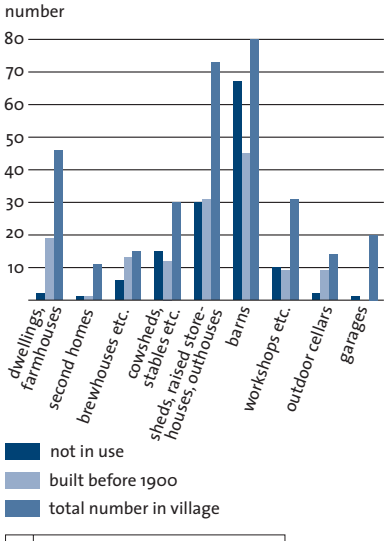
Traditional farm buildings are of great significance for our perception and understanding of the agricultural landscape. However, older ones rarely meet present-day animal welfare, environmental and health and safety standards. Over 20% of existing farm buildings are already redundant, and an estimated 0.5% of outbuildings are lost each year.

An example of a village with a valuable but threatened building stock is Vängsbo in Ovanåker municipality, Gävleborg county. Most of the main farms here have numerous buildings, 13 on average. 'Soldiers' crofts' and smallholdings have far fewer, and ordinary residential properties consist only of a house, outhouse and garage. Almost half the properties in Vängsbo are judged to be of cultural heritage interest. A third are farms, a quarter are soldiers' crofts, owner-occupied homes built with state loans in the early 20th century, or smallholdings, while the rest are used for other economic activities or are ordinary first or second homes.

In all there are some 340 buildings in the village. Most of the farm- and other dwelling houses were built in the 20th century. The farms almost always have a building that was once used as a brewhouse, bakery or summer cottage. Over two-thirds of these were built in the 19th century, and more than a third are now empty, as are half the cowsheds. The cowsheds still in use date from after 1950. Sheds, raised storehouses and barns make up the largest group of buildings (around 150). Some 40% of the sheds and 65% of the barns are disused. Half of them were built before 1800, with the oldest dating from the 1480s.

A characteristic of villages in northern Hälsingland, including Vängsbo, is their imposing farmhouses and the many other buildings on farms. The houses are still in use and will probably continue to be occupied and maintained, but it is uncertain how many of the very old, historically valuable buildings made redundant by modern agriculture will have fallen into disrepair 50 years from now.

FIG. 2.4 Buildings in Vängsbo, 1998



VARIED AGRICULTURAL LANDSCAPE

Meadow barns are a characteristic feature of the farmed landscape of northern Sweden. They recall a time when meadows were a crucial source of livestock fodder and long-distance transport was only possible in winter. No longer serving any practical purpose, these barns are gradually falling into disrepair. Surveys of Norrbotten county in 1996–97 recorded 1077 meadow barns in nine villages. A comparison with land-use maps from the 1950s showed an average decrease of 85% in the number of such barns.

2.5 Agri-environment scheme saving heritage of farm areas

The postwar transformation of agriculture has radically affected the farmed landscape. Large areas have been planted with trees or reverted to forests. Small farms and crofts have been abandoned and incorporated in larger farms. Many landscape features of cultural heritage interest, such as avenues, ditches, fences and farm buildings, have disappeared.

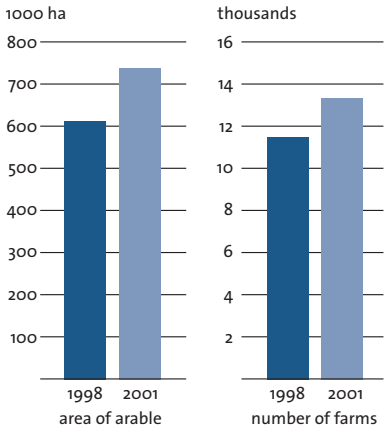
Since Sweden joined the EU and began to implement its Common Agricultural Policy, an agri-environmental scheme to promote the management of valuable natural and cultural environments has been introduced. As a result, management regimes that preserve landscape features resulting from past human activities have been practised more widely than would otherwise have been the case. The scheme has also made farmers generally more aware of the heritage value of agriculture and the farmed landscape.

As an interim target, the number of culturally significant landscape features that are managed is to increase by about 70% by 2010, compared with the 1995–99 programme period. Between 2000 and 2006, 18 000 (20–25%) of Sweden's farms (20–25% of arable land) are to be compensated for environmental managemment. Thus, a more ambitious target has been set as regards the area to be covered by the scheme, although the management criteria will be less stringent than before.

The cultural environment scheme is restricted to arable land and landscape features on and adjacent to it; it does not cover buildings. Agricultural landscapes vary significantly from one region to another, and the scheme makes little provision for forest regions and the north of Sweden, where human-modified landscape features are primarily linked to pasture land. However, payments to safeguard such features are available under a separate pasture land scheme.

By August 2001, applications for support had been submitted by 13 300 enterprises. Take-up is as low as 8% in the forest counties of central and northern Sweden, but around 20% in other parts of the country – largely the same proportions as before.

FIG. 2.5 Take-up of agri-environment payments for management of valuable natural and cultural environments (2001 figure refers to applications)



VARIED AGRICULTURAL LANDSCAPE

Owing to changes in farming, many landscape features once created by agricultural land use are no longer of economic significance and have thus been marginalized in farm operations. The introduction of a special agri-environmental scheme has broken the long-term trend for such features. Since applications for 2001 were being processed at the time of writing, there are no direct data yet on the number of features managed. However, the area and number of farms covered by the scheme can serve as indicators of the trend.

Biological diversity and the natural environment

3

One fundamental criterion of sustainable development is that biodiversity is conserved. By safeguarding plants, animals and ecosystems, we are also preserving a good living environment for people. Access to the diversity of the natural world is a source of recreation and aesthetic pleasure and contributes to our well-being.

Biodiversity is not simply a matter of maximizing the number of species; naturally species-poor environments are also important. A case in point is the Baltic, the world's largest brackish-water sea, which because of its special history supports relatively few species; at the global level, however, it contributes to ecosystem diversity.

The emphasis in efforts to promote biodiversity, though, is on protecting the growing number of species and habitats threatened by human activities. Some 10% of Sweden's plant and animal species are classed as threatened, in the sense that the long-term survival of reproducing populations is not assured. Changes in agriculture, forestry and fisheries since the Second World War are the main factors behind habitat destruction and threats to species. In addition, fresh waters have been affected by flow regulation and hydroelectric schemes. The fishing fleet now consists of a small number of highly efficient vessels. In farming, arable and livestock production are less clearly linked and larger amounts of chemical fertilizers and pesticides are being used. Fields are larger, crops less diverse, and small-scale habitats have been lost.

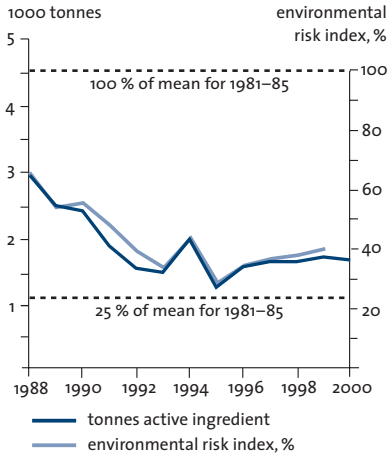
In recent years, government funding to preserve forests with high biodiversity has been greatly increased, and larger areas are being set aside voluntarily. Felling and other operations are now undertaken with greater regard for nature conservation. In addition, action has been taken in the farmed landscape. Through the EU's Common Agricultural Policy and above all the agri-environment schemes, adverse trends for various landscape features and pasture areas – which are very important for farmland biodiversity – have been halted.

Wetlands support considerable biodiversity. A study of coastal farming areas in Halland (south-west Sweden) has shown that more small bodies of water have disappeared there than have been created in the last twenty years. Changes for the better are occurring in various parts of Sweden, however: for example, many local investment programmes have included wetland projects, e.g. restoration measures, and new wetlands have been created under the agri-environment programme. Importantly, there is a growing understanding of the need to preserve wetlands.

The introduction of non-native species and genetically modified organisms that could threaten biodiversity must be avoided. When the North American signal crayfish, a carrier of crayfish plague, was released into Swedish fresh waters, many populations of noble crayfish were eliminated. There are an estimated 850 non-native species in Sweden.

For some threatened species, specific action is needed to enable populations to recover. As of November 2001, the Environmental Protection Agency had drawn up action programmes for 24 species and one habitat.

FIG. 3.1 Pesticide sales expressed as environmental risk index, calculated as percentage of sales in 1981–85



VARIED AGRICULTURAL LANDSCAPE, NON-TOXIC ENVIRONMENT

Sales have increased since 1995, owing to a larger area under cereals and larger applications of pesticides per hectare. The higher sales figure for 1994 was due to hoarding prior to a tax increase on pesticides.

FIG. 3.2 PCB levels in guillemot eggs from Stora Karlsö

BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS, NON-TOXIC ENVIRONMENT

The ban on PCBs has had an effect. However, large quantities of PCBs and other toxic chemicals are still around, e.g. in buildings.

3.1 Use of agricultural pesticides increasing again

Since the 1950s, Swedish farmers have used large amounts of herbicides, fungicides and insecticides to improve harvests. From the mid-1980s to the mid-1990s, use of these agents fell by almost 60%, thanks partly to action and phase-out programmes and an expansion of official advisory services, and also to new spraying techniques and more effective agents. Estimates by the National Chemicals Inspectorate show that this decrease was not offset by the introduction of more hazardous products.

Since 1996, pesticide use has increased again, partly because the area under cereals has expanded since Sweden joined the EU. Fields planted with cereals require more frequent spraying and larger doses per unit area than, for example, grass and clover leys. In 1998, herbicides were applied to 80% of the area under cereals and half the area under other crops. 15% of the total cereal area was treated with fungicides and 10% with insecticides.

The target for 1996 was for pesticide sales (in active ingredient terms) to be cut to 25% of the average for 1981–85. In 2000 they totalled 38% of that average.

Pesticides that end up on field boundaries and are washed into streams harm both plants and small and large animals. Several plants associated with farmland are now threatened, inter alia as a result of pesticides. Leaving crop margins unsprayed can significantly reduce the environmental risks, and also increase the food supply for farmland wildlife such as partridges and pheasants. Predacious insects also become more abundant, possibly reducing the need for pesticides.

An indirect effect of pesticides is that they allow crop production to be intensified, squeezing out wild flora.

3.2 Lower levels of toxic pollutants in wildlife

Levels of toxic PCBs and DDT in the environment have fallen continuously since use of these substances was restricted in Sweden 30 years ago, after they had been found to disturb reproduction in mammals and birds. Since then, DDT levels in guillemot eggs and fish from Swedish sea areas have fallen by 10% a year, and levels of PCBs by about 5% a year. Toxic pollutant levels have also fallen in fish-eating mammals and birds of prey; as a result, the white-tailed eagle and grey seal populations are recovering.

Environmental concentrations of brominated flame retardants, used in plastics, rubbers and textiles, began to rise in the 1970s. Since the mid-1980s, they have fallen in guillemots, but remained unchanged in pike.

Despite falling levels of the best-known toxic pollutants, though, the danger is not over yet. The substances in question are still in use around the world, and large amounts of PCBs and brominated flame retardants are incorporated in buildings and technical equipment. To prevent a new rise in environmental concentrations in the

future, decommissioned structures and equipment must be disposed of in environmentally safe ways. Already there are indications that PCBs are once again finding their way into the central Baltic Sea.

Many persistent organic pollutants induce cancer, have genetic effects or disturb the endocrine system. Changes have for example been detected in fishes' reproductive organs, even at low levels of certain pollutants. The many chemicals whose effects are still largely unknown are a particular cause for concern.

3.3 Eutrophication affects marine life

Eutrophication, due to high levels of nitrogen and phosphorus, is one of the biggest threats to Swedish sea areas. The largest input of anthropogenic nutrients reaches the sea via rivers. Coastal point sources and atmospheric deposition also provide significant inputs, and fish farms are of local significance. The main sources of nutrients are agriculture, sewage works and septic tanks, industry and transport. Inputs vary from year to year, depending on the weather: they are significantly higher in rainy years than in dry. The Bothnian Bay is the only Swedish sea area showing no signs of eutrophication, while the southern Baltic, the Sound and the Kattegat are the worst affected.

Eutrophication changes many species' habitats. Higher plankton production makes the water cloudier and filamentous green algae become more abundant in the coastal zone. Belts of brown algae – important nursery grounds for fish – contract. Heavier and more frequent algal blooms deplete oxygen and alter the competitive balance between species. Benthic fauna is eliminated from deeper areas, reducing food supplies for many fish species. The decline in fish stocks in Swedish seas in recent years is probably mostly due to overfishing, but eutrophication is assumed to be implicated in several cases.

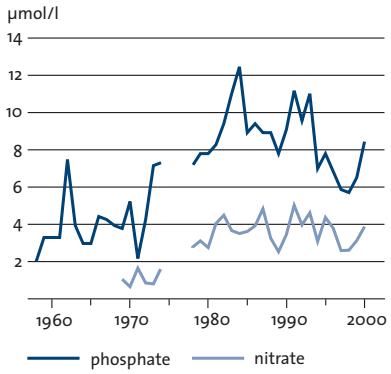
In the late 1990s, nitrogen and phosphorus levels in sea water fell and for a few years the oxygen situation also improved. When oxygen levels in bottom water rise, phosphorus, especially, binds more effectively to sediments. With oxygen availability once more reduced, nutrient levels have risen again.

3.4 Life returning to limed lakes

In recent years, Sweden has spent around SEK 200 million a year on liming to restore acidified lakes and streams. 17 000 lakes and 100 000 km of running waters have been affected by acidification. Of this total, 7000 large lakes – roughly 90% of the acidified lake area – and some 13 000 km of streams were limed in 2000. In most cases repeat liming is involved, and each treatment is designed to last 2–3 years.

The aim of liming is to restore the original water quality, thereby enabling plants and animals to survive or return. To achieve this, the water must have a pH of over 6 and a certain minimum alkalinity (capacity to resist acidification). These criteria are

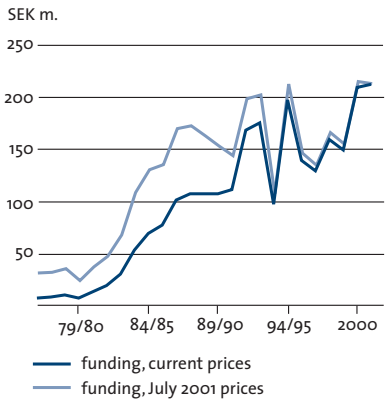
FIG. 3.3 Nitrate and phosphate levels in Baltic Sea proper (Gotland Deep)



BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS, ZERO EUTROPHICATION

High phosphorus and nitrogen levels in the sea alter the mix of species present. It is difficult to discern any trend in concentrations over the last few years: the variations are due largely to fluctuating precipitation totals.

FIG. 3.4 Funding for liming of lakes and streams

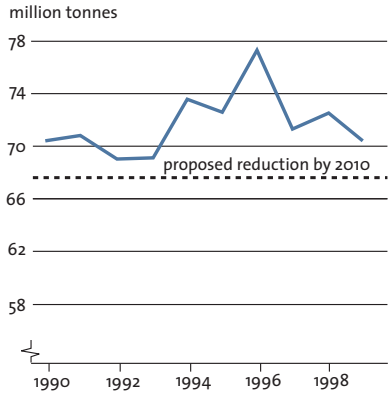


FLOURISHING LAKES AND STREAMS, NATURAL ACIDIFICATION ONLY

Although acid emissions have been reduced, liming of lakes and streams must continue. Many running waters affected by acidification have still to be limed.

NOTE TO FIG. 3.3: *The scale of an algal bloom is regulated by whichever nutrient is in shortest supply from the viewpoint of the algae. For every atom of phosphorus algae take up, they need 16 atoms of nitrogen. For this diagram, phosphorus concentrations have been multiplied by 16, making it easy to see which of these nutrients was the limiting factor for algal growth at any given time.*

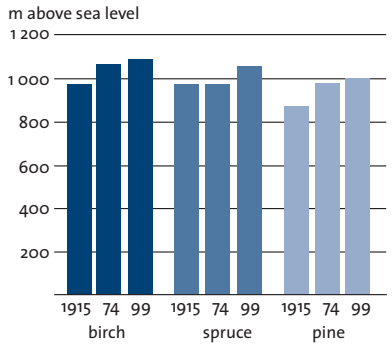
FIG. 3.5a Greenhouse gas emissions, expressed as CO_2 equivalents



MAGNIFICENT MOUNTAIN LANDSCAPE, REDUCED CLIMATE IMPACT

Emissions from energy consumption in the residential and service sectors have fallen, thanks to increased use of biofuels, but emissions from the transport sector are rising by around 2% a year. The peak in 1996 was due to the poor supply of hydroelectric power that year, which increased oil consumption.

FIG. 3.5b Change in altitude of tree line in southern part of Swedish mountain range



REDUCED CLIMATE IMPACT

Greenhouse gas emissions have caused the temperature to rise, resulting in an upward shift of the tree line and hence a reduced area of bare mountain terrain. This in turn is causing changes in fauna and flora.

met in almost all limed lakes and streams. Studies of acidified lakes that have been limed reveal significant improvements for flora and fauna. As the acidity of the water decreases – and with it metal concentrations – the abundance of acid-sensitive fish and benthic fauna increases.

State funding for liming has doubled since 1990 (at current prices). For 2002 an extra SEK 15 million has been allocated. The additional money is to be used, inter alia, to remove barriers to migration and create nursery grounds for fish, so as to facilitate their return to limed waters. Monitoring of the effects of liming is also to be improved.

3.5 Mountain habitats threatened by warmer climate

Since the early 20th century, the tree lines for birch, pine and spruce have risen by an average of over 100 m in the southern Swedish part of the Scandinavian mountain range. When trees advance to higher altitudes, the area of bare mountain terrain decreases. Tandövala in Dalarna, a mountain that was once partly above the tree line, is now completely forested. The same effect can be seen elsewhere, and the distinctive natural scenery and habitats of the mountains are rapidly changing.

The tree line has not been as high as it is now for 4000 years, and tree seedlings have not been found at such high altitudes since the last ice age. The spread of trees to once bare mountain areas is due partly to a temperature rise of about 0.6°C in the last century.

Levels of carbon dioxide in the atmosphere have been rising since pre-industrial times. Carbon dioxide and other greenhouse gases released into the atmosphere by human activities are intensifying the greenhouse effect, which warms the earth's surface. Carbon dioxide from the burning of gas, oil and coal accounts for 80% of Swedish greenhouse gas emissions. Other greenhouse gases are methane and nitrous oxide from agriculture and CFCs and other fluorinated gases.

The flora and fauna of Sweden's mountains are adapted to a nutrient-poor landscape with cold winters and short summers. When trees spread, shrubs and grasses follow, and the habitats of mountain animals and plants contract. Wavy hair-grass has for example displaced bilberry and reindeer lichens in several places, affecting reindeer grazing. A warmer climate also increases the abundance of insect pests in birch forests.

Over the last decade, Sweden's greenhouse gas emissions have been relatively constant. According to the Climate Committee, they need to be halved by 2050, and similar action is required throughout the Western world. However, global warming will continue even when emissions are reduced. By 2100 the temperature is expected to have risen by 1.4–5.8°C. In the Nordic countries, the effects on climate could be far-reaching, since here the temperature increase will be roughly twice the global rise.

3.6 Twice as much forest needs to be protected

In the 1990s, the proportion of the forest area protected in Sweden increased from 2.5% to 3.5%. At the end of 1999, almost 800 000 ha of productive forest land (according to the Swedish definition) was protected in national parks, nature reserves or crown forest reserves, and more than 70 000 ha had been safeguarded by site acquisition or compensation for felling restrictions. Some 75% of the area protected consists of montane forest. In addition, landowners had voluntarily protected over half a million hectares of productive forest land outside the montane zone, e.g. through forest certification.

Despite this protection and greater attention to nature conservation by forestry companies and private landowners, the forest landscape is continuing to change and valuable forest environments are at risk. The proportion of undisturbed old-growth forest – where species diversity is often very high – has declined by 40% in the last 70 years. This is an important reason why half of Sweden's threatened species are associated with forests.

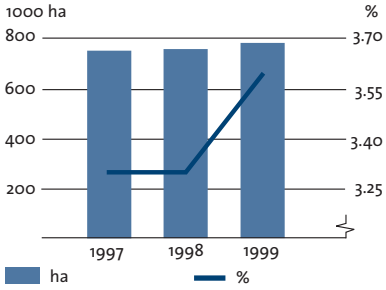
To conserve biodiversity for the future, another 900 000 ha of forest of the highest conservation value should be set aside in the next ten years. It is also important to maintain the recreational value of forests. State grants will enable 400 000 ha to be protected, chiefly in reserves. The rest is intended to be set aside voluntarily by landowners. The Government proposes to more than double funding for site acquisition in the next few years. State allocations for habitat protection areas and conservation agreements are also to increase significantly. The main thrust of site safeguard will shift towards coastal areas and the south. This will enable more small nature reserves and habitat protection areas to be created, as well as larger continuous reserves. Protection will focus on species-rich, warmth-demanding deciduous woodlands, forests in coastal and archipelago areas and around mires, and stands of a virgin-forest type.

3.7 Lack of dead wood a threat to forest diversity

A shortage of hard dead wood in forests is one of the biggest threats to forest biodiversity. Of Sweden's red-listed species, 40% depend for their survival on dead wood in various forms. Thousands of species of insects and fungi, hundreds of mosses and lichens, and many birds and mammals need it as a substrate, nest site or food source. The middle spotted woodpecker has become extinct in Sweden owing to a lack of dead deciduous trees, and the white-backed woodpecker could suffer the same fate.

An old forest contains more dead wood than a young one, and nature reserves include more old forest than commercially managed forests. On average, the latter now contain just over 2 m^3/ha of hard dead wood; a study in the mid-1990s showed there to be more than three times that amount in nature reserves. In protected, undisturbed near-natural forests, 30–100 times more hard dead wood may be found than in managed forests. Dead wood is in short supply because for a long time most of the wood in forests has been utilized by forest industries or for heating. Removing harvesting

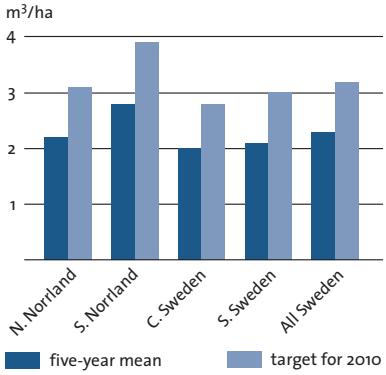
FIG. 3.6 Productive forest land protected in reserves and national parks. Area and percentage of total forest area.



SUSTAINABLE FORESTS

Sweden has an estimated 22 740 000 ha of productive forest land. The rate at which new areas are protected needs to be stepped up, as state-funded protection is to be extended to another 400 000 ha by 2010. Measures by private landowners are to protect a further 500 000 ha. Half of Sweden's red-listed species are associated with forests.

FIG. 3.7 Quantity of hard dead wood on all productive forest land, 1995–99



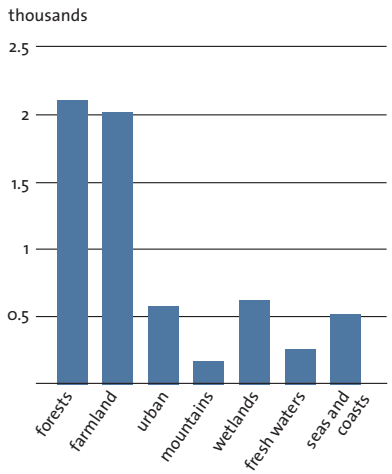
SUSTAINABLE FORESTS

The amount of dead wood in forests is an indicator of biodiversity, since numerous organisms rely on it for food, habitat, reproduction etc. The volume of hard dead wood also indicates the potential future supply of wood in varying stages of decay, which is used by many other forest organisms. By 2010, the quantity of dead wood is to have increased by an average of 40% for Sweden as a whole.

residues does not normally make things worse, however, as the main problem is a lack of larger stems and logs.

To achieve the sustainable forests objective, the quantity of hard dead wood is to be increased by at least 40% over the next ten years, by means of environmentally more sensitive forestry, with even bigger increases where biodiversity is particularly at risk. Different species have differing requirements: some, for example, require pines or deciduous trees in sunny, open positions, while others need large fallen spruces in damp, shady spots. Decayed wood from large trees is particularly scarce. Forest owners have now started to retain more dead and windthrown trees. It is important that dead wood is retained in ways that do not create a significant risk of insect infestation, especially in spruce forests in southern and central Sweden. Evaluations will need to be carried out to establish whether the right kinds of trees are being retained in the right places.

FIG. 3.8 Number of red-listed species found in different landscape types in Sweden in 2000



FLOURISHING LAKES AND STREAMS; THRIVING WETLANDS; BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS; SUSTAINABLE FORESTS; VARIED AGRICULTURAL LANDSCAPE; MAGNIFICENT MOUNTAIN LANDSCAPE; GOOD BUILT ENVIRONMENT

Red-listed species are to be found in all types of landscape. Farmland, which in terms of area amounts to roughly 10% of the forested area in Sweden, is home to almost as many red-listed species as forests. The figures for red-listed species associated with the marine and freshwater environments are probably underestimated, since far less is known about aquatic species than about terrestrial organisms.

3.8 Number of threatened species is increasing

The latest Swedish Red List of threatened and near-threatened species was adopted in May 2000. It includes 4120 species, or 21% of all species assessed. Many (61%) of Sweden's roughly 50 400 multicellular species have yet to be assessed, however, since insufficient is known about their abundance, range etc. For example, only some 3600 macrofungi have been analysed, out of 11 000 fungal species.

Immense efforts have been made in the last five years to safeguard farmland biodiversity, but the negative trend has still to be broken. Numerous species have been added to the Red List, and almost half of all listed species are associated with the farmed landscape. Many once common birds have become much rarer. Areas with disquieting trends at present include farmland in forest and mixed forest/farming regions, areas with grazed sandy soils and coastal environments.

Forests are home to the largest number of threatened species. Here many welcome changes have occurred, e.g. forest certification now covers significant areas, yet the plight of red-listed forest species is judged to be roughly as serious as when the previous Red List was prepared (1993–96). Key problems include the continuing decline in the area of forest over 160 years old, growing pressure on forests dominated by warmth-demanding deciduous trees, a limited area of middle-aged deciduous forest, heavy grazing pressure from elk (moose) and roe deer, inhibiting regeneration of deciduous trees, and a continuing significant shortage of dead wood.

In the marine environment, mountain areas and fresh waters/wetlands, too, many species' habitats are contracting. Several changes for the better have admittedly occurred in lakes/wetlands, but much less is known about the threats to aquatic flora and fauna than those facing terrestrial organisms.

The green toad, Arctic fox, lesser white-fronted goose and wels are among well-known animal species that could soon be extinct in Sweden. Others have recovered and no longer appear on the Red List, e.g. hedgehog, marsh harrier and brown trout.

NOTE TO FIG. 3.8: *Any one species may occur in more than one environment. The sum of the columns therefore exceeds the total number of red-listed species (4120).*

4 Long-term productivity of ecosystems

If development is to be ecologically sustainable, it must preserve the capacity of ecosystems to produce both commodities for people and biological diversity. Human activities can have both favourable and unfavourable impacts on this capacity. During the 20th century, for example, inputs of phosphorus and nitrogen to arable land, forests and surface waters generally made these environments more productive. However, increases in productivity which adversely affect ecosystems must be avoided.

Most threats are due to chemical/biological pressures. Over many years, atmospheric deposition of sulphuric acid has reduced the acid-neutralizing capacity and nutrient pools of forest soils. In the worst affected areas, in southern and southwest Sweden, runoff now has such low pH and such high levels of toxic aluminium that many animal and plant species have been eliminated from streams and unlimed lakes. If nutrient removal due to felling is high in relation to natural compensatory processes, the situation could get worse, unless nutrients are replenished by applying wood ash to the soil. Acidification and nitrogen deposition may make forests more sensitive to climate change, disease and insect attack. Forestry is a staple industry in Sweden, and the country cannot afford to put forest health at risk. However, most of the evidence suggests that, so far, acidification has not appreciably affected the productivity of forest soils.

Deposition of metals can also threaten forest productivity. Lead and mercury levels in forest soils over much of Sweden are now so high that they could affect microbial activity. This could reduce the release of essential nutrients, disturbing the entire forest ecosystem.

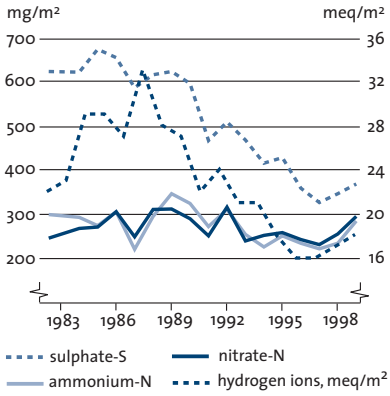
When arable soil receives inputs of cadmium from deposition and fertilizers, and only small amounts are removed, the soil pool of this metal increases, possibly reducing the soil's usefulness for food production.

An example of a physical disturbance is the use of heavy machinery on farmland, which can compact the soil and inhibit growth of plant roots. Very severe compaction of the soil to a depth of 50 cm can reduce above-ground plant productivity by up to a third.

The Baltic herring fishery provides another example of a threat to long-term ecosystem productivity. In 2000 the spawning stock of herring (i.e. fish 3–6 years old) south of the Åland Sea was only a third of what was needed to sustain the fishery in the long term. 40% of the fish in these age classes were caught. To ensure a sustainable fishery, only 15% should be harvested.

Agriculture and forestry are among the factors affecting the production of biodiversity. Climate change could also influence the distributions of many plant and animal species. In mountain areas, arctic-alpine species could be displaced by others requiring warmer conditions, and higher river flow into the Baltic could displace marine species in favour of freshwater species. In addition, a northward shift of climatic zones will enable new species to spread into northern Sweden, while others could disappear from the south. Immigration of new species to southern Sweden could also be significant.

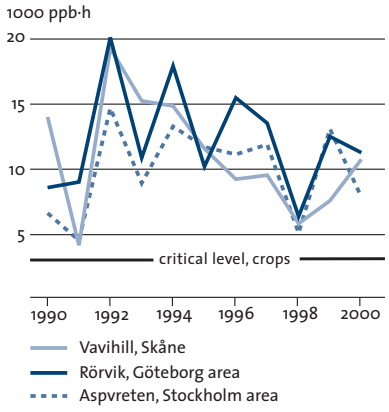
FIG. 4.1 Deposition of acidifying substances



GOOD-QUALITY GROUNDWATER; FLOURISHING LAKES AND STREAMS; ZERO EUTROPHICATION; NATURAL ACIDIFICATION ONLY; SUSTAINABLE FORESTS; MAGNIFICENT MOUNTAIN LANDSCAPE

In an environment that is already acidified, acid deposition is continuing, delaying recovery. In surface waters, acidification can be reduced by liming.

FIG. 4.2 Ground-level ozone at three sites in southern/central Sweden, AOT40, May–July



CLEAN AIR

High concentrations of ground-level ozone in summer harm vegetation. To limit damage to farm crops, the accumulated exposure to concentrations above 40 parts per billion (ppb) – AOT40 – should not exceed 3000 ppb-hours. During the 1990s, the critical level for crops was exceeded at all three sites shown.

4.1 Acid deposition still too high

The most important sources of acidifying sulphur and nitrogen compounds are transport, the energy sector and industrial processes. Most of the acid deposition occurring in Sweden derives from sources outside the country. Deposition is decreasing, but rain and snow are still ten times more acidic than in pre-industrial times. In much of southern and central Sweden, acid deposition exceeds the maximum input the soil is able to neutralize.

In forests, soil horizons to a depth of a metre have become up to five times more acidic in recent decades. Deciduous and coniferous forests in the far south and on the west coast of Sweden are most seriously affected. It takes decades or centuries for forest soils to recover by natural processes. For recovery to be possible, acid emissions must be reduced and further changes made in forestry practices so that they do not contribute to acidification.

Soil acidification results in less favourable conditions for many species: common dog violet, wood sorrel, gastropods and earthworms, for example, have declined. In addition, the fertilizing effect of nitrogen deposition alters the species composition.

Certain nutrients in soils have a neutralizing effect, but in some areas acidification has halved available pools of nutrients other than nitrogen. This has reduced the soil's ability to neutralize deposition, resulting in acidic water and leached aluminium entering streams and lakes. This poses a threat to crayfish, bivalves, roach and salmonids, for example, and eliminates many plankton species, reducing the base for the food chain.

4.2 Ground-level ozone damages crops and forests

Ground-level ozone is formed by emissions of volatile organic compounds and nitrogen oxides, which are converted to ozone in the presence of sunlight. The highest ozone concentrations in air are found in southern Sweden, with peaks occurring in spring and summer. Levels have roughly doubled since the 1940s, but in Sweden they stabilized during the 1990s. Here, the problem of ground-level ozone is due largely to transport and energy sector emissions in neighbouring countries, especially south of the Baltic.

High concentrations of ozone ('ozone episodes') in spring and summer interfere with plant photosynthesis, causing visible injuries in vegetables and clover, for example. In the longer term, harvests of wheat and other crops decline: yield losses in Sweden are estimated at one billion kronor a year.

Research has also shown that young spruces exposed to ozone for four seasons have a lower productivity than unexposed trees. It is uncertain how applicable these findings are to entire forests, but current ozone levels in southern Sweden are probably affecting forest growth. Deciduous trees such as birch are regarded as more sensitive to ozone than conifers. High levels can cause poorer drought tolerance and premature leaf fall. Other plants, such as grasses and herbs, vary in their sensitivity to ozone, but generally insufficient is known about the effects on wild plants of these types.

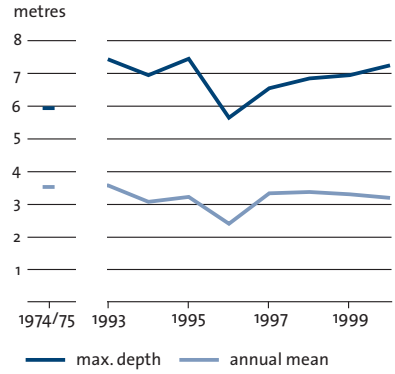
4.3 Brown algae important for marine ecosystems

Bladderwrack, an ecologically important brown alga, has been declining in the Baltic Sea for several decades. Reduced water transparency, due to eutrophication, is preventing it from growing in deeper water. Meanwhile, closer to the shore, competition from fast-growing algae has increased: both in the Baltic and on the west coast of Sweden, belts of brown algae have disappeared from shallow waters.

Bladderwrack plays a key role in marine ecosystems, not least for fish populations. The belts which it forms provide habitats for the small animals that constitute the main diet of various fish. Herring spawn and lay their eggs there. The fry then live in the shelter of the algae, along with cod and sprat fry.

The use of toxic anti-fouling paints on boat hulls threatens the reproduction and hence the regeneration and spread of bladderwrack. The principal reason for its decline, however, is severe eutrophication, caused by nutrients from farmland, untreated sewage and atmospheric deposition. Locally, the situation has improved in recent years: off Askö, south of Stockholm, for example, water transparency has increased by a metre over the last decade. An amelioration of the pollution situation is important if brown algal belts and marine ecosystems are to recover.

FIG. 4.3 Depth distribution of bladderwrack in Askö area, mean and maximum



BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS

Bladderwrack is a key species that serves as an indicator of marine biodiversity. Among other things, it provides shelter for cod and herring fry. Its depth distribution is roughly the same now as 25 years ago, but – owing to eutrophication – 4–5 m shallower than in the 1940s.

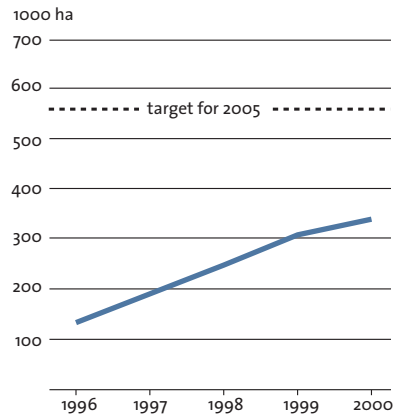
4.4 Organic farming on the increase

In the last five years, the scale of organic farming in Sweden has doubled. The agri-environmental scheme to promote organic production now covers 13% of arable land, and organic livestock rearing is also expanding rapidly. The Government wants to see a continued increase: by 2005, organic methods are to be used in one-fifth of crop production and one-tenth of milk, beef and lamb production. There should also be further growth in organic rearing of pigs and poultry.

In 1999, SEK 350 million was paid out under the agri-environment scheme for organic production, most of it to farms in the north of Sweden, with a smaller share going to the south. In 2000, rates of payment for different crops were changed, to boost cereal production and thus promote a wider range of organic produce.

Potential benefits of organic farming include pesticide-free crop growing and a ban on worming agents in livestock rearing. At the same time, continued management of certain types of land may prove difficult if measures to control livestock parasites are not permitted. Reduced use of chemicals in agriculture should help to prevent a deterioration of groundwater quality and avoid disturbance of the natural insect fauna of farming areas.

FIG. 4.4 Area covered by agri-environmental scheme to promote organic production



VARIED AGRICULTURAL LANDSCAPE

Organic crop and livestock production can help to sustain the long-term productivity of farmland. The target is for 20% of arable land to be farmed organically by 2005.

Wise management of natural resources

Wise management of natural resources is crucial to achieving an ecologically sustainable society. This fundamental principle calls for careful use of land, forests, water and the physical environment, i.e. buildings and infrastructure. It also requires us to be economical in our use of minerals, water, energy and other resources, including natural and cultural assets which cannot be re-created. Another dimension is sustainable use of materials, based on conservation, reuse and recycling. In addition, wise management includes avoiding exposing natural resources to harmful emissions and other adverse pressures.

Yet another aspect of wise management is using the same land or infrastructure for several purposes, e.g. forests for recreation and timber production, railways for local and long-distance transport, or the same districts of towns for homes, services and workplaces, to reduce travel. There is a link between careful use of substances, materials and energy and what it costs to acquire and dispose of them.

Conflicts can often arise between the five principles underlying the environmental quality objectives. Returning the valuable nutrients in sewage sludge to farmland is a way of conserving natural resources, but – since the sludge may also contain heavy metals – it may conflict with the aim of protecting human health or the long-term productivity of the soil. On the other hand, upholding one principle may simultaneously promote another: careful use of gravel preserves the capacity of the ecosystem (the esker from which it is extracted) to store groundwater, and also safeguards the natural beauty of the landscape.

It is important to ensure that not only finite, but also renewable natural resources are used wisely. Naturally, forests should not be harvested at a rate that exceeds regeneration, nor should fishing be carried on in such a way as to endanger stocks.

Wise management of land and water and the development of appropriately designed settlements and infrastructure call for long-term physical planning. Overall responsibility for this rests with central government, while implementation is a function of local government. To achieve the environmental quality objectives, a common view on goals relating to land and natural resource use needs to be developed.

5.1 Returning phosphorus to the soil

Phosphorus is an essential element that is in very short supply. Some plants (e.g. potatoes) require large amounts of readily available phosphorus, while others can make greater use of the soil's own phosphorus pool.

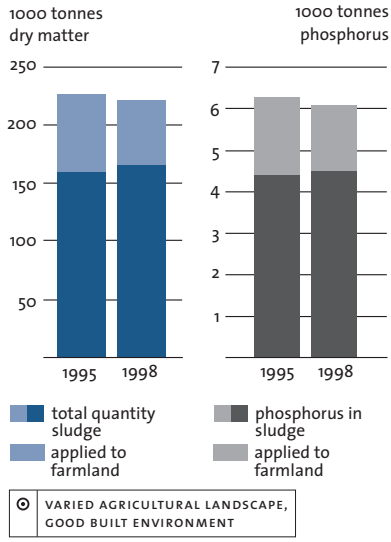
Phosphorus is 'exported' from agriculture in crops, meat and milk. These losses have to be made good by inputs of chemical fertilizers, animal manure or other organic fertilizers.

Chemical fertilizers are produced from phosphate minerals. From the standpoint of sustainability, it is desirable to reuse the phosphorus that ends up in sewage and other waste products in an environmentally sound, resource-efficient way. Since the 1950s, the amount of phosphorus in Swedish arable soils has increased by 30–40%. Use of phosphorus-based fertilizers has therefore fallen appreciably in recent years.

The sludge generated at Sweden's sewage works in one year contains some 6000 tonnes of phosphorus, about a third of the annual amount of soluble phosphorus applied to arable land in chemical fertilizers. Sludge may contain heavy metals, and can only be used on farmland if contamination levels are below defined limits. Around 60% of Swedish sludge meets the required standard. There are also recommendations on quality assurance for sludge intended as an agricultural fertilizer. In 1998, an estimated 25% of sludge was used on arable land, while 50% was disposed of to landfill.

At present, the food industry does not accept the use of sludge as a fertilizer for Swedish raw materials, so very little of it is now spread on arable land. This is due to concerns about contamination with heavy metals and other substances. Sludge is still used as a soil conditioner in parks and on golf courses and for landscaping.

FIG. 5.1 Quantity of phosphorus recycled to arable land in sludge



VARIED AGRICULTURAL LANDSCAPE, GOOD BUILT ENVIRONMENT

Use of sludge on farmland is decreasing, owing to concerns about toxic contaminants. As a result, less of the valuable phosphorus it contains is being returned to farmland than before.

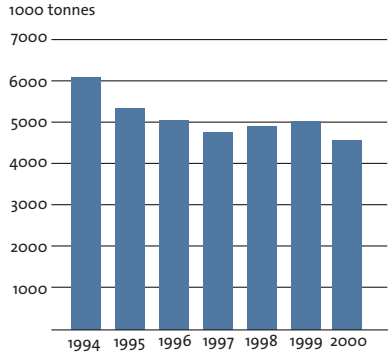
5.2 Less waste going to landfill

Waste disposed of to landfill causes a number of environmental problems. Pollutants, some of them toxic, can disperse from landfills into soil and groundwater. In addition, decomposition of organic waste generates landfill gas, which contains methane and carbon dioxide and thus contributes to the greenhouse effect.

These are some of the reasons for curbing landfill disposal. Also, by landfilling less waste and reusing and recycling more, we can reduce our consumption of materials and natural resources. For example, more demolition waste is now being used as fill, e.g. in noise barriers. Furthermore, less energy tends to be needed to produce new products from recovered materials than from virgin materials.

Measures to improve resource use include increased presorting of waste and producer responsibility. The latter, which requires manufacturers to ensure that their products are recycled, has the aim of promoting more resource-efficient products. Presorted metal, paper and glass can more easily be used as raw materials for new packaging and other products.

FIG. 5.2 Quantity of waste disposed of to municipal waste landfills

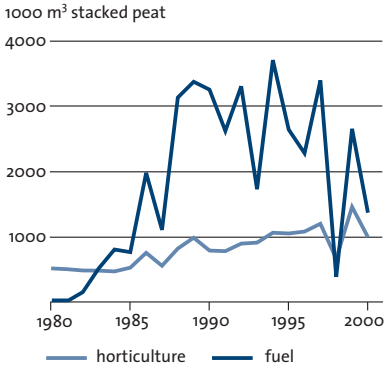


GOOD BUILT ENVIRONMENT, REDUCED CLIMATE IMPACT

Since 1994 the amount of waste going to landfill has decreased. This is due partly to more widespread presorting and producer responsibility, and partly to a landfill tax introduced on 1 January 2000.

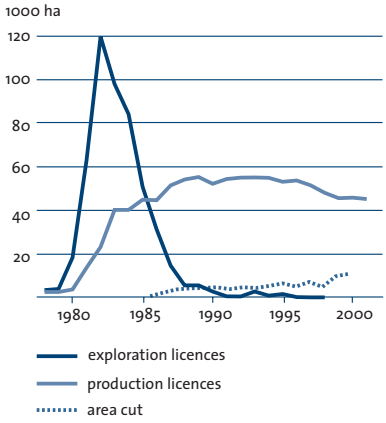
NOTE TO FIG. 5.2: *As from 1998 the total includes approx. 100 000 tonnes/year placed in closed cells for anaerobic digestion and later recovery as a soil conditioner.*

FIG. 5.3a Extraction of peat for horticulture and fuel



THRIVING WETLANDS

FIG. 5.3b Licences for peat extraction



THRIVING WETLANDS

Extraction of fuel peat was resumed in Sweden in the early 1980s after a break of some 20 years, in response to rising prices for imported fuels and state support to the peat industry from 1981 to 1986. During that period many exploration and production licences were awarded. In the 1990s the area being worked gradually increased, but since peat production is weather-dependent the amount harvested varies widely from year to year. Peat workings are normally operated for about 20 years. If extraction continues at the present rate, many new or extended licences will be needed over the next 10 years, to allow new workings to replace those started in the 1980s.

The target for 2005 is to halve the quantity of waste going to landfill, compared with 1994. The same year, a ban on landfilling of organic waste is to take effect. The landfill tax introduced in 2000 has reduced the amount of waste disposed of by this route, although overall the volume of waste arising is increasing. At the same time, increases can be noted as regards incineration, materials recovery and biological treatment of waste.

5.3 Wetlands serve many functions

Wetlands make up a significant part of Sweden's last remaining wilderness areas. They are also very important for flora and fauna, for the hydrology of forest areas, and as cultural environments and nutrient sinks in farming regions. In addition, they are a source of peat, for fuel and horticulture.

Sweden has a large area of wetlands – some 10 million ha, or almost a quarter of its land surface. In the last 200 years, an estimated 12% of the original wetland area has been destroyed by drainage, conversion to farmland or peat extraction. In the farming regions of the south, less than 10% of the original area remains and many of the wetlands left are affected to varying degrees by drainage or other forms of disturbance.

New forest roads, peat cutting, eutrophication and to some extent drainage are currently the main threats to wetlands. Peat is being extracted from around 10 000 ha, i.e. 0.1% of the total area. Some 350 000 ha of wetlands are judged to be commercially exploitable for peat. Many of the areas concerned are mires of great biological interest.

On any given site, peat extraction continues for about 20 years. If a forest is subsequently planted on the site, it ceases to be a functioning wetland. Trials are in progress to restore peat workings as wetlands.

5.4 Balance between many functions of forests

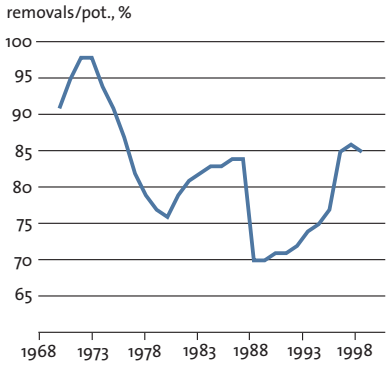
Forests provide renewable raw materials for sawnwood and paper, as well as wood and pellets for energy production. At the same time they are of considerable nature conservation interest, in that they are home to numerous species. Forests also contain valuable cultural environments and provide areas for outdoor recreation, berry picking and hunting. These different functions have to be carefully balanced if forest management is to be sustainable in the long term.

A forest's capacity to serve as a long-term resource is dependent on the total amount of timber removed from it, which is in turn determined both by the demand from industry and by the quantities forest owners need to fell. Currently, just over 70 million cubic metres of timber (stem volume overbark) is removed from Swedish forests every year. Roughly half of it goes to sawmills. The pulp industry buys just over a third directly, plus large amounts of chips and shavings from sawmills. Wood fuels have doubled in the last decade and now account for 10% of total stemwood removals.

Apart from this amount, forest-based fuels consist largely of residues from the forest products industry (e.g. bark, spent liquors) and harvesting residues ('lop and top').

For any given forest management programme, a 'felling potential' – a level of felling compatible with sustainable production – can be calculated. A lower level of harvesting means that the forest is not being fully exploited as a source of raw materials; there is thus greater scope to meet other needs, e.g. to protect forests and conserve the natural environment and cultural heritage. Timber removal in excess of the felling potential puts both forest regeneration and natural and cultural assets at risk. Where and how felling is carried out and what types of forest are harvested also decisively affect the long-term development of forests. At present, removals amount to around 85% of the potential. Since the 1980s the felling potential has increased somewhat, and annual removals have risen by 3–4 million cubic metres.

FIG. 5.4 Removals of timber as percentage of felling potential. Moving five-year average



THRIVING WETLANDS; SUSTAINABLE FORESTS

Rates of timber removal reflect the business cycle. When a high percentage of the felling potential is utilized, there is a risk that less account will be taken of other functions of forests.

5.5 Fishing and fish stocks in the Baltic Sea

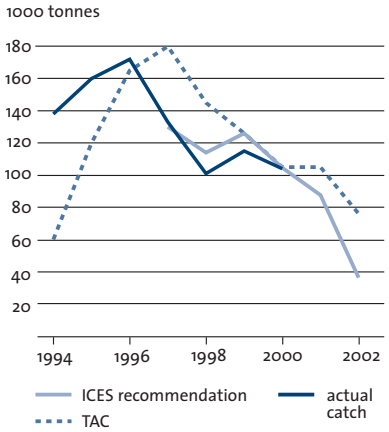
To ensure that marine fish stocks are utilized in a sustainable manner, catches are regulated by international agreements. The normal means of regulation in both the North Atlantic and the Baltic is to agree on annual total allowable catches (TACs), which are shared among the countries concerned in the form of national quotas. The International Council for the Exploration of the Sea (ICES) has defined reference levels for 'safe biological limits', and for many species management plans based on such limits and thresholds have been adopted.

TACs are decided on the basis of biological advice. However, the TACs agreed for cod, herring and sprat in the Baltic have regularly been higher than ICES recommendations, the biggest disparities occurring in the case of herring and sprat.

Almost all the Baltic stocks of cod, herring and sprat are overfished. This is true of the herring stocks of the Bothnian Sea and central Baltic and the cod stocks west and east of Bornholm. Two of these stocks have been reduced below their threshold levels: the eastern cod stock and the herring of the central Baltic. At present, only the sprat stock is within 'safe biological limits'.

The two Baltic cod stocks are managed through a joint TAC, the figure for 2002 being 76 000 tonnes. If the two populations develop differently, it will be impossible to achieve effective management. The recommended catch levels are zero for the eastern and 36 000 tonnes for the western stock. According to estimates, if the catch from the eastern stock in 2002 is 40 000 tonnes, the spawning population will be unable to increase. The risk of the stock collapsing thus remains high.

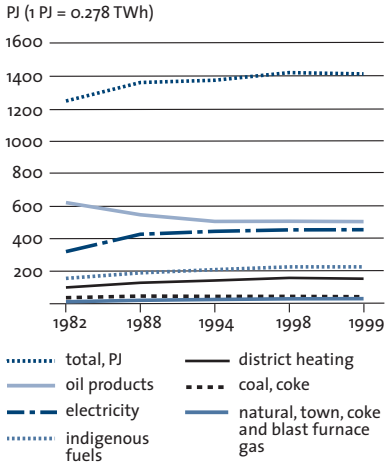
FIG. 5.5 Actual, recommended and total allowable catches of cod in Baltic Sea



BALANCED MARINE ENVIRONMENT, FLOURISHING COASTAL AREAS AND ARCHIPELAGOS

In recent years, Baltic cod catches have been too high in relation to the spawning population. If fishing pressure is not appreciably reduced there is a great risk of the cod stock collapsing.

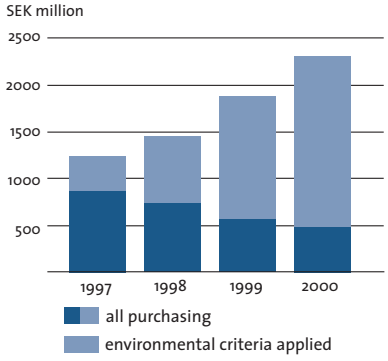
FIG. 5.6 Energy consumption



CLEAN AIR; FLOURISHING LAKES AND STREAMS; THRIVING WETLANDS; NATURAL ACIDIFICATION ONLY; GOOD BUILT ENVIRONMENT; SAFE RADIATION ENVIRONMENT; REDUCED CLIMATE IMPACT

The climate objective requires a reduction of fossil fuel use. If extraction of biofuels (indigenous fuels) increases substantially, it could conflict with other uses of forests.

FIG. 5.7 Value of purchasing of products and services by Gävleborg County Council, and proportion to which environmental criteria applied



NON-TOXIC ENVIRONMENT, REDUCED CLIMATE IMPACT

A larger volume of products meeting environmental criteria may mean wiser use of natural resources and smaller impacts on the environment than would be the case if such products were not chosen.

5.6 Energy consumption must be reduced

Human use of energy is consuming finite natural resources. Several of our key energy sources, e.g. oil, are finite and could become exhausted in the foreseeable future. Other resources, e.g. wood fuel and wind energy, are renewable, but in the long term using wood as a fuel could divert raw materials from the pulp and sawmill industry and also undermine conditions for biodiversity.

To achieve a sustainable energy supply, a shift away from finite sources is essential. In the last few decades, oil's share of total energy use has fallen from a half to a third. An expansion of hydroelectric and nuclear power has made higher electricity consumption possible, and Sweden is now one of the largest per capita users of electricity. As nuclear power is phased out, however, the need to turn to alternative energy sources will become more pressing. Greater use must therefore be made of bioenergy for heating. Wind turbines can replace some of the present electricity generating capacity, but may disturb local residents and encroach on natural and cultural assets. In the longer term, more direct use of solar energy may prove important.

To take some of the pressure off natural resources, energy consumption needs to be reduced. Over quite a long period, energy use in Sweden has become more efficient, but the total net consumption has remained much the same. Increasingly large homes, more electrical appliances and greater use of cars have offset the gains in efficiency.

5.7 Green purchasing drives development

Central and local government in Sweden purchase some SEK 400 billion worth of goods and services every year. Contracts often extend over long periods. The public sector is thus a significant customer that can put pressure on markets to develop environmentally sound products – provided there is no conflict with competition rules. 'Greener' goods and services can reduce energy consumption and pollutant emissions and halt the cycling of hazardous substances in society. A larger market for organic foods will promote organic methods of farming.

The demand created by the Swedish Association of Local Authorities for chlorine-free paper, which persuaded Swedish paper producers to begin to phase out bleaching based on elemental chlorine, is an early example of a successful public procurement exercise involving environmental criteria. The specifications for personal computers laid down by the Agency for Administrative Development, relating to energy use and environmentally hazardous substances, have also had an impact on the market.

The Government has set up a committee to promote green purchasing in the public sector. The committee has, among other things, created an Internet-based tool to assist in defining environmental purchasing criteria. It is uncertain how widely used it is, but Swedish local authorities are currently believed to apply environmental criteria of some kind in 60–80% of their purchasing. The legal status of such criteria is unclear, however.

They may constitute a barrier to competition on the EU's internal market and hence contravene legislation.

The European Commission is currently reviewing the rules on public procurement and the possibility of taking environmental factors into consideration, and issued an interpretative communication on the subject in July 2001. The communication recognizes that it is permissible to require certain manufacturing processes to meet environmental specifications and to insist on products meeting ecolabel criteria. But it also notes that the award criteria applied must generate an economic advantage for the purchasing entity; advantages for the wider economy, such as reduced carbon dioxide emissions, cannot be taken into account. A revision of the public procurement directives is under way.

The EU is also developing an Integrated Product Policy, which is among other things intended to stimulate demand for and promote environmentally sound products and production.

Progress towards the objectives

1. Reduced climate impact

Carbon dioxide emissions fell sharply in Sweden in the 1980s, mainly thanks to gains in energy efficiency, industrial restructuring and greater use of nuclear power. In the 1990s, fossil fuel use increased in the transport sector, but decreased for domestic heating. Sweden's per capita CO_2 emissions are among the lowest in the OECD. Under the Kyoto Protocol, the EU is to cut its greenhouse gas emissions by 8% from 1990 levels by 2008–12. The distribution of emission quotas among the EU states allows Sweden to increase its emissions by 4%.

The Environmental Protection Agency's view is that the industrial nations' CO_2 emissions need to fall by 60% by 2050 from 1995 levels. Longer term, an 80–90% reduction is needed. In 2000 the Climate Committee called for a halving of Swedish greenhouse gas emissions from 2000 to 2050. Sweden needs to be active internationally, within the Climate Change Convention and the EU, if these targets are to be met.

2. Clean air

Sweden has ratified the UN Convention on Long-Range Transboundary Air Pollution and, as an EU member state, complies with EC directives. Under the recent Emission Ceilings Directive, Sweden has pledged to reduce annual nitrogen oxide and hydrocarbon emissions to no more than 148 000 and 241 000 tonnes by 2010. It has also drawn up minimum air quality standards. A new ozone directive is currently being finalized.

To reduce nitrogen oxide emissions, action must be taken in the areas of transport, energy and mobile machinery. The interim target for nitrogen dioxide will probably be largely met by 2010, with vehicle emissions reduced by more efficient catalytic converters. However, there will still be local effects on human health where nitrogen oxide levels are high, e.g. near busy streets and roads, particularly for already hypersensitive individuals, e.g. asthma sufferers.

The targets for 2010 for particulates smaller than 10 micrometres (PM10) and for carcinogens will probably be met in terms of roof-top concentrations, but not street-level concentrations, which are a major factor for human exposure to these pollutants. Where small-scale burning of wood is widespread, the target is unlikely to be met by 2010.

By 2020, the target for ground-level ozone with respect to corrosion of materials is expected to be met, but levels with effects on crops will probably still be exceeded. Health effects will be appreciably reduced.

Sulphur dioxide levels already meet existing environmental quality standards. In most places they are also below the even more stringent long-term target proposed to protect cultural artefacts and materials.

3. Natural acidification only

Acid deposition in Sweden has fallen substantially in the last 20 years, but international agreements to achieve further emission cuts are needed. In December 1999 the 'multi-pollutant, multi-effect' protocol to the Convention on Long-Range Transboundary Air Pollution was signed, and within the EU an Emission Ceilings Directive has been finalized. These measures could reduce the area of forests and lakes exposed to deposition exceeding critical loads, from 6.3 million ha in 1990 to 1.4 million ha in 2010. The directive is expected to reduce deposition of acidifying substances by the following percentages between 1995 and 2010:

Region	Sulphur	Nitrogen oxides	Ammonia
S Sweden	50	35	20
C Sweden	35	30	10
N Sweden	25	30	0

Natural recovery of acidified forest land will be aided by forestry practices which counteract further acidification.

Even if acid loads are significantly reduced, recovery of soils and waters could take decades. Some areas may never be fully restored. In the soil system, recovery will take a long time; in surface waters, it has already begun. Some 90% of the lake area still acidified is being limed, along with 15% of the total length of acidified streams.

4. A non-toxic environment

The environmental and health risks of many existing chemicals are unknown at present. It is unclear whether environmental levels of certain known toxic pollutants have continued to fall in recent years; in some cases, e.g. certain flame retardants, they have risen.

In spring 2001 the European Commission presented a chemicals strategy that will be decisive to chemicals management within the EU and hence to achieving this environmental quality objective. The measures proposed include registration of a wide range of chemicals and compilation of information on their hazardous properties. Data on the hazardousness of chemicals and where/how they occur and are used are crucial to risk reduction. The strategy also proposes a permit system for particularly hazardous substances, e.g. those that are carcinogenic, persistent and bioaccumulating.

Many substances degrade very slowly and can therefore travel long distances. Some of them bioaccumulate, i.e. become concentrated in plant and animal tissues. In various international forums, e.g. the UN and the Oslo-Paris Convention, measures to curb the use of such hazardous substances are being developed. Under the Stockholm (POPs) Convention, adopted by 127 states in May 2001, it was decided that, as a first step, 12 persistent, bioaccumulating substances/groups should be phased out, including PCBs and DDT.

Many hazardous substances are incorporated in existing products or have accumulated in the environment from past emissions. Emissions and long-range transport have resulted in large areas being polluted. Some 22 000 sites are so badly contaminated that they require remediation. Industrial emissions have now fallen appreciably, but it is more difficult to stem the flow of different substances in manufactured and imported products. Companies that ask questions and look for substitutes for hazardous substances are an important driving force for progress towards a non-toxic environment.

The goal of eliminating substances that threaten human health or biodiversity will not be achieved by 2020.

5. A protective ozone layer

Chlorofluorocarbons (CFCs) and other persistent ozone-depleting substances have an atmospheric life of 50–300 years. Concentrations will therefore remain well above their natural levels for a long time.

Existing international agreements permit some use of the substances regulated, so emissions are still occurring. Assuming full compliance with the Montreal Protocol, stratospheric levels of ozone depleters are expected to have fallen to around 2 ppb chlorine by 2050; it will thus take at least 100 years to reach the natural level of about 0.7 ppb Cl. Since these gases end up in the stratosphere wherever they are emitted, international efforts are crucial.

In Sweden, the use of ozone-depleting substances can be virtually eliminated within one generation.

6. A safe radiation environment

In 2001 the Swedish Radiation Protection Authority began to develop a monitoring programme to follow the state of the environment and protect biodiversity. It is intended, inter alia, to provide a basis for calculating human exposure to radiation in different parts of Sweden and for meeting EU reporting requirements. At present, protection criteria exist with respect to human health, but not the environment; national and international efforts to fill this gap are now under way.

Further research is needed to clarify the possible risks of electromagnetic fields. So far, no evidence of heightened risks has emerged from epidemiological studies.

A key element in achieving a safe radiation environment is creating a greater awareness of the risks of exposure to UV radiation. Since the time lag between exposure and the appearance of any cancers is almost 20 years, information efforts must be long-term and alternative means of evaluating their effects need to be developed.

According to a situation report presented by the Radon Committee in 2000 (SOU 2001:7), the interim target for radon in indoor air will be very difficult to meet in the case of houses, but can presumably be achieved for day nurseries, schools and apartments. The Committee proposes an environmental quality standard for indoor radon based on a maximum acceptable level of 400 Bq/m^3. Very substantial efforts will be needed to identify and remediate all of the almost 100 000 houses exceeding this level. In view of the Committee's findings, it is unlikely to be possible to find and deal with the roughly 200 000 houses with radon levels of 200–400 Bq/m^3 over the same period.

7. Zero eutrophication

Over many decades, large amounts of nitrogen and phosphorus have accumulated in soils and sediments. Given the inertia of natural systems, it will take a long time for concentrations of these nutrients to return to acceptable levels. In the marine environment the timescale of recovery is very long, and the zero eutrophication objective may not be attained until several decades after 2020. What is more, it is only achievable if further action is also taken by other countries.

International agreements and EC directives now exist to reduce atmospheric emissions of nitrogen compounds. However, these reductions will not be sufficient to reduce nitrogen deposition to forests to acceptable levels by 2010; critical loads will still be exceeded in just over 10% of the forest area. Further action across Europe is therefore essential.

Sweden's action programme on nutrient losses from farmland is expected to reduce nitrogen leaching to water by about 8000 tonnes between 1995 and 2010. This programme, combined with action in industry and the sewage sector, will probably reduce the anthropogenic load to the sea by 25–30% by 2010, although this may be difficult. To achieve zero eutrophication, the total load to the Baltic,

Kattegat and Skagerrak from all sectors must fall by 40% compared with 1995. The effects of various measures on phosphorus losses from sewage treatment and agriculture cannot be assessed as yet. The action programme on nitrogen from farmland ought to reduce phosphorus losses, too, but the scale of the reduction remains unclear. Additional measures to curb losses from individual sewage systems will probably be needed.

8. Flourishing lakes and streams

Growing attention is being paid to nature and cultural heritage conservation in and around lakes, rivers and streams. Most Swedish inland waters, though, have been affected by flow regulation, fragmentation, canalization, land use or development on their banks or shores, and many need restoring.

Conflicts may arise between the functions of lakes and running waters in terms of biodiversity, fisheries and recreation and their value for energy production. Other sectoral interests (e.g. agriculture, forestry, tourism) may also be difficult to reconcile with adequate attention to nature and heritage conservation. In certain cases, a balance will have to be struck between preserving cultural environments and restoring rivers for fishing.

To achieve this objective, central and local government must give priority to safeguarding valuable environments in and by lakes and watercourses, but it is also important to involve others (landowners, organizations etc.) in conserving and restoring freshwater environments. Greatly improved knowledge and data are needed to support the planning of conservation measures.

Success in attaining this goal is dependent on the objectives for eutrophication, acidification and toxic pollutants also being achieved.

9. Good-quality groundwater

The EU's Water Framework Directive will give groundwater a more prominent place in physical planning. This directive and those on nitrates, drinking water and landfill will be powerful tools in achieving this objective. At the national level, an environmental quality standard for nitrate in groundwater is planned.

Changes in the soil- and groundwater system are slow, and efforts to reduce pollutant levels will therefore take a long time to produce results. The goal for groundwater quality will thus not be met by 2020. To achieve it, the goals relating to eutrophication, acidification and a non-toxic environment must also be met. The objective of a safe and sustainable supply of drinking water is judged to be achievable within one generation, provided that swift and effective steps are taken to prevent contamination of groundwater by road salt.

10. A balanced marine environment, flourishing coastal areas and archipelagos

In Sweden's coastal and sea areas, eutrophication, toxic pollutants and overfishing have increasingly been found to disturb biodiversity and marine productivity. In addition, coastal ecosystems and cultural environments are threatened by infrastructure, settlements, shipping, use of recreational craft, dredging and other activities that can disturb benthic flora and fauna. Baltic cod stocks are currently well below the levels needed to safeguard recruitment. The dramatic decline of various species, e.g. in Kalmarsund, remains unexplained. In addition, brown algal belts and eel-grass meadows – important spawning and nursery grounds for fish and other animals – have contracted in several coastal waters around Sweden.

The prospects of achieving this objective are dependent on the many conflicting interests affecting coastal areas. The natural beauty, distinctive cultural environments and diversity of coasts and archipelagos endow them with considerable recreational value. Their cultural heritage has been adversely affected, both by the disappearance of traditional industries in areas with declining populations and by increased development pressures in attractive areas.

As regards open sea areas, international cooperation has a crucial part to play. Sweden is involved in research collaboration and efforts under international conventions, with the aim of improving the marine environment around its coasts.

The interim targets concerning the protection and conservation of important habitats and species are difficult to quantify on the basis of current knowledge. Research, methods development and survey work are therefore in progress and need to continue.

To achieve this objective, the zero eutrophication and non-toxic environment goals must also be attained. As regards land use in coastal and archipelago areas, there are also links with the objectives for lakes and streams, wetlands, forests, the agricultural landscape and the built environment.

11. Thriving wetlands

Several international conventions and EC directives are relevant to the protection of wetlands. By international standards, a large proportion of Sweden's wetland area has been preserved. Especially in upland forest areas in the north, many wetlands remain undisturbed.

New drainage schemes are now prohibited in most of southern Sweden and in some northern coastal areas. Peat extraction is regulated by law, and agri-environment payments are available to promote the re-creation of historically documented haymaking mires. One of the interim targets for this objective is to establish or restore at least 12 000 ha of wetlands and ponds in farming areas by 2010. This will

also promote biodiversity. The national mire protection plan will safeguard 6% of the total mire area. In addition, a certain area of mire habitat in Norrbotten county, not covered by the plan, will be protected.

Although a conflict exists with energy production and more efficient agriculture and forestry, the assessment is that this environmental quality objective can be achieved by 2020.

12. Sustainable forests

Greater attention is now paid to site-specific constraints and nature conservation in commercial forestry than only 10–15 years ago. More forest land is being set aside voluntarily for conservation, thanks to a major advisory effort, current work on landscape ecology and 'green' plans, and certification. Awareness of the need to safeguard cultural environments and archaeological remains in forest areas has also improved somewhat, partly as a result of education, information and joint projects.

In the areas hardest hit by acidification, soils will take a long time to recover. Here, critical loads of nitrogen and sulphur may continue to be exceeded, despite internationally agreed emission reductions.

To attain this objective, significant resources need to be invested by the state and forest owners alike. To ensure long-term conservation of biodiversity, another 900 000 ha of productive forest land, most of it below the montane zone, should be protected by government and voluntary measures. In managed forests, the proportion of deciduous stands should be increased and more dead wood retained.

To achieve the sustainable forests goal, the acidification objective must also be met.

13. A varied agricultural landscape

The feasibility of attaining this objective depends partly on agriculture throughout Sweden developing favourably from the point of view of the natural and cultural environment, and on high take-up of agri-environment payments under the Environmental and Rural Development Programme. Analyses of current agricultural policy up to 2006 suggest that this policy is promoting change in the right direction. In the last five years, the proportion of arable land in receipt of payments to promote organic farming has increased from 3% to 13%.

Management of meadow and pasture land improved in the 1990s, thanks to agri-environment payments. Some 90% of the valuable meadows and pastures identified at the beginning of the 1990s are still in agricultural use (80% in northern Sweden). Agricultural policy has ensured that cattle rearing has remained profitable and thus maintained grazing in forest and mixed forest/farming regions.

From the standpoint of cultural heritage and nature conservation, the current withdrawal of land from arable production in inland areas of northern and central Sweden is a cause for concern. In the rest of the country, a decrease in the number of farm enterprises is adversely affecting cultural heritage assets, e.g. traditional farm buildings.

The EU Common Agricultural Policy is and will remain an important source of funding for action to achieve this environmental quality objective. For it to be met, the goal of a non-toxic environment must also be attained.

14. A magnificent mountain landscape

The Environmental Protection Agency's assessment is that this objective can be achieved within one generation. Conflicts exist with land use, outdoor recreation and physical planning, but these can be resolved within Sweden and are dependent to only a limited extent on developments outside its borders.

A survey method for reindeer pastures is being developed. Owing to wind power projects, among other things, it may be impossible to increase the area of mountain country that is of significant amenity, nature conservation or cultural heritage interest and free from noise and other forms of disturbance.

Large mountain areas are protected by national park or nature reserve status.

15. A good built environment

Local authorities are the key players in achieving this objective, and physical planning (e.g. in the form of comprehensive plans) is an important instrument. In several municipalities, a shortage of planners and staff to handle biodiversity, cultural heritage and transport issues could impede progress towards the objective.

The state (e.g. through county administrative boards) plays an important role in implementing national environmental policy and funding remediation of contaminated sites and measures to tackle noise and radon problems. Success in increasing the use of renewable energy and creating greater willingness to save energy will depend partly on energy prices, taxes and other policy instruments, but also on lifestyle choices.

Buildings and other structures have a long lifespan. One generation from now, some 90% of existing buildings will still be there. To conserve the built heritage while improving the environmental performance of existing settlements, a balanced, knowledge-based approach is needed. The interim target for energy efficiency in buildings may be difficult to meet by 2020.

All five fundamental principles are highly relevant to achieving a good built environment, from promotion of human health to wise management of natural resources.

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The articles in *de Facto 2001* are based principally on texts by Michael Ressner, National Board of Health and Welfare (*Human health*), Ann Mari Westerlind, National Heritage Board (*The cultural environment and cultural heritage*), Hans Hellberg and Andreas Nilsson, Vetenskapsjournalisterna (*Biological diversity and the natural environment*, *Long-term productivity of ecosystems* and *Wise management of natural resources*).

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de Facto 2001: Environmental objectives and fundamental principles In many cases, although far-reaching action has been taken, appreciable improvements in the state of the environment have yet to be seen. This may be because ecosystems have a high degree of inertia: nature has simply not had time to respond to the easing of the pressures on it.

de Facto 2001 provides an outline survey of the environmental situation in Sweden and of when the environmental quality objectives adopted by the Swedish Parliament may be expected to be achieved. The *de Facto* series is the result of a Government-commissioned project in which the Swedish Environmental Protection Agency is monitoring overall progress towards these objectives.

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