

Preface

At present mankind is exterminating at least 50 species of plants or animals daily. This enormous loss of biodiversity is mostly occurring in the tropics, where the tropical forests (which are the habitats of between 50 and 90% of the world's species) are being deforested at a rate of 4 times the area of Denmark annually.

Breaking this trend is not just a moral duty to our fellow creatures. In the long term, it is a condition for the survival of mankind as a species.

The Convention on Biological Diversity, which was signed by 155 countries at the U.N. Conference on the Environment and Development in Brazil, 1992, represented a vital step in the right direction.

This convention, which came into force on 29 December 1993, has now been ratified by more than 120 countries, including Denmark, which acceded to the Convention around the new year of 1994.

We who dwell in the rich part of the world cannot in all conscience demand that the Third World preserve its enormous biodiversity unless we put our own house in order. In the Western World's concern over biodiversity in the tropics it is often forgotten that neither is the biodiversity of the industrialised nations in the best of condition. There is hardly a country in the world where mankind has influenced biodiversity as heavily as in Denmark. We have ourselves destroyed the virgin forest of this country that we think it so vital to preserve in the tropics.

There will be no return to the Danish nature of earlier times, when almost the entire country was covered in forests.

Danish biodiversity has been influenced by our culture and will continue to be so in the future. Mankind will always be a part of biodiversity. But we must also watch over diversity, so that economic growth does not take place at the expense of impoverishing our flora and fauna.

Denmark has implemented some of the world's most extensive nature conservation legislation in an effort to ward off the effects of harsh exploitation of natural resources. The State, county councils, local councils, voluntary organisations and many individual citizens have all made great efforts. The challenge of the future will be to integrate to a still greater extent consideration for biodiversity into the utilisation of natural resources on the part of the various sectors of Danish society and industry.

Even though we have helped to slow the downward trend of development through our efforts on behalf of nature and the environment, there still remain many areas in which the road is long to recovering the biodiversity lost over the last 50 years.

This strategy is thus concerned with how we Danes can maintain and expand a dawning upward trend in the preservation of our biodiversity. We do this as our contribution to global biodiversity and to enable our children and grandchildren also to experience a variegated Danish flora and fauna.

Svend Auken
Minister of Environment and Energy

Chapter 1

Introduction

Why Danish status and strategy?

This is a report of how Denmark fulfils Article 6 of the Convention on Biological Diversity, which states that countries shall prepare national strategies for the protection and sustainable exploitation of biodiversity; see Box 1.1.

The strategy is also mentioned in "Agenda 21", the Global Action Plan that was adopted at the U.N. conference in Rio de Janeiro in 1992. As far as the EU countries are concerned, recognition of this obligation was also confirmed by the European Council in 1992.

To a great extent, the Convention on Biological Diversity is a framework convention that emphasises the efforts of the individual countries, for instance, in the form of national strategies. The attainment of the broadest objectives of the Convention also requires regular reporting to the Conferences of the Parties

to the Convention by the individual countries, on their launched and planned measures.

The purpose of this report is to describe the Danish Government's policy for protecting biodiversity - in Denmark and in relation to the Conferences of the Parties to the Convention.

Agenda 21 requests that countries conduct national *country studies* of biodiversity, as the point of departure on which to base national strategies. This is a consequence of the fact that many countries lack the requisite knowledge of prevailing conditions and, therefore, also lack one of the basic requirements for taking effective action against detrimental factors.

It has not been the opinion of the Ministry of Environment and Energy that such a country study is a requisite for a Danish strategy. The Danish flora and

Box 1.1

Article 6 of the Convention on Biological Diversity, 5 June 1992:

"Each Contracting Party shall, in accordance with its particular conditions and capabilities:

- (a) develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned; and**
- (b) integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.**

fauna, and the conditions that affect them, have been studied relatively thoroughly and reports on these topics are published regularly, for instance, in such publications as *"Facts and Figures on Nature and the Environment"* prepared by the Ministry of Environment and Energy and the Danish Bureau of Statistics, and *"The Environment and Society - a review of environmental development in Denmark"* (Danish National Environmental Research Institute, 1994), together with many other more specific status reports prepared by the Ministry of Environment and Energy and, at the regional level, by the regional authorities.

However, this does not mean that we know enough about the status of biodiversity in this country. As will be seen in many places in the individual chapters below, there is an urgent need for more comprehensive knowledge - not least on the status of marine biodiversity.

Concept of biodiversity

Biological diversity only made its debut as a scientific concept in recent years. It has, however, become widely used, even in contexts where we would previously have used such concepts as *nature* and *flora and fauna*. Regardless of the fact that this concept was previously used only seldom, consideration for biodiversity has in practice been an important goal of Danish nature and environmental protection policy. Thus, the preambles of our nature and environmental protection legislation reflect consideration for the protection of our flora and fauna.

Biodiversity is an extremely broad concept. In the final analysis, it can be said that the goal of our entire nature and environmental protection effort is the preservation of our biodiversity. For the sake of clarity, and in order to limit its scope in relation to the Report on Denmark's Nature and Environmental Policy, which is to be published by the Minister of Environment and Energy during 1995, this report mainly deals

with the conditions that have the most direct influence on biodiversity.

Society's production and consumption patterns, together with other economic, cultural and social factors that have a less direct impact on the environment, are only discussed to a limited extent.

Origins, form and content

The form and content of this report, and its structure and limits in particular, were discussed by a consultative committee that included participants from the Danish Forest and Nature Agency, the National Environmental Protection Agency, the National Environmental Research Institute, the Ministry of Agriculture & Fisheries, the Nature Conservation Council, the Association of County Councils in Denmark and the Danish Society for the Conservation of Nature. The Danish Forest and Nature Agency was responsible for the editing.

A draft of *Status and Strategy* was submitted to a wide circle of authorities, organisations, etc., for comments and discussion in July 1994. The Danish Forest and Nature Agency then edited and otherwise completed the preparation of this report. Many of the comments received in the approximately 70 responses to its submission were incorporated at that time.

Any report on status and strategy relating to biodiversity can be organised in many ways. We have chosen an organisation based on the Convention's definition of biodiversity, i.e. as diversity expressed on the ecosystem, species and genetic levels; see Chapter 2. After the general chapters, 2 and 3, the ecosystems (seas, coasts, fresh-watercourses, open countryside, forests and urban areas) are discussed in Chapters 4 to 9. Species and genetic diversity are discussed in Chapters 10 and 11, whereas the remaining three chapters are concerned with the acquisition of knowledge, information and an understanding of Nature, together with a discussion of internatio-



nal efforts. The report ends with a summary of the individual chapters.

The individual chapters are normally organised into a status section, which attempts to give a general review of current biodiversity and the causes of impacts thereon, a section that describes conservation efforts to date and a section that looks to the future. Each chapter is concluded with a list of proposed target areas.

In view of the organisation described above, and of the fact that it should be possible to read each chapter as an individual unit, it has been impossible to avoid repetition.

The factual information of this report has been gathered from published material. For the sake of legibility, however, no source references or footnotes have been given, although there is a list of literature. For the same reason, the formal titles of Acts are not given - their popular titles have been used instead. The Acts mentioned in the various chapters are listed in Annex 1 at the end of this report.

Follow-up

The target areas indicated should be considered as a catalogue of the activities considered necessary or appropriate, and economic perspectives should obviously also be considered when assessing and assigning priority to these activities. This will be done to some extent in conjunction with our strategical environmental planning.

This report covers biodiversity in Denmark in general. In part, this is a con-

sequence of the fact that it is to form the foundation of the Danish report to the Conferences of the Parties to the Convention. Because of the breadth of its approach, it cannot in itself be considered as an action plan. It describes the status of our biodiversity, reveals problems and indicates forthcoming target areas.

These target areas will be manifested in more tangible measures and in any action plans for the areas covered by this report, for instance, for the sectors that utilise and affect biodiversity. It will also be necessary to give consideration to costs in this context.

Moreover, this report will be followed up in cooperation with the relevant organisations.

Unless otherwise stated, the target areas are areas for which the *Government* is responsible, i.e. the Ministry of Environment and Energy, together with the ministries of the other sectors. In many cases, however, their manifestation will demand the cooperation of the local authorities - usually the county councils - which are therefore requested to organise their efforts in conformity with this report to the greatest possible extent.

Greenland and the Faroe Islands

With its ratification on 21 December 1993, the whole of the Kingdom of Denmark is covered by the Convention. However, nature conservation is a matter for home rule in Greenland and the Faroe Islands. The report therefore applies only to Denmark.



Chapter 2

On biodiversity

Biodiversity is defined as follows in the Convention:

“Biodiversity” means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

It is easiest to understand this if biodiversity is assessed on three levels:

The first is diversity in the interaction between species and their surroundings in *ecosystems*.

The second is the diversity of different *species* of plant and animal.

The third is the *genetic diversity* or *hereditary variation* that exists between different individuals and populations of the same species.

Ecosystems

An *ecosystem* includes the living organisms and their interactions with their physical surroundings.

The boundaries of ecosystems can be demarcated in many ways, for instance, the planet Earth can be considered as a single large ecosystem, a forest can also be considered as an ecosystem that can contain other, or parts of other, ecosystems, such as deciduous forests and coniferous forests.

Within an ecosystem, all living organisms are affected by and dependent on other organisms, as well as the climate and soil of their surroundings.

Dynamic interactions take place between the living (*biotic*) and non-living (*abiotic*) elements of ecosystems. Ecosystems constitute the functional units in which biological, physical and chemical processes, such as the water, oxygen and nutrient cycles, soil formation and control of the microclimate and local climate, are all examples of such interactions.

Species

As a simplification, a *species* can be defined as a group of individuals that are capable of reproducing and yielding offspring that can also procreate.

The total number of the world's species of flora and fauna is not known. Various calculation methods have yielded estimates that vary as widely as from 5 up to 100 million.

Science has named and classified about 1.6 million different species, of which half live in the tropics. New species are described daily. But regardless of which estimate we accept, by far the greater number of species probably still remains unknown to science. It has been estimated with significantly less uncertainty that about 30,000 different species of flora and fauna live in Denmark.

Species adapt and change in constant interaction with the ecosystems of which they are a part. Some species are so generally adapted that they can be found in most parts of the world. On the other hand, there are species so specialised that they can only live in restricted areas in which very special conditions prevail. Moreover, the distribution of the

individual species depends on its ability to spread and its possibilities of procreation. Many species have migrated beyond the areas over which they originally ranged, partly through the aid of man.

New species have emerged throughout the course of the Earth's history, in part as a result of adaptation to changed living conditions brought about by the geological and climatic changes to which the planet has been subjected. Some species have been unable to adapt to these changes or to compete against the competition of new species and are, therefore, extinct. The constantly increasing scope of man's influence on the Earth's ecosystems has resulted in the extinction of species at a rate that far exceeds the evolution of new species.

Genetic diversity

Due to the differences in hereditary material (*the genes*), two completely identical individuals of the same species will occur only rarely. Procreation results in offspring that possess new combinations of their parents' genetic material. New genetic material can also be generated spontaneously through mutation.

Thus, the offspring will possess characteristics that differ to a greater or lesser extent from those of their parents. Some of the offspring will possess hereditary characteristics that render them less suitable for survival and reproduction, and these characteristics will, therefore, be transmitted to the next ge-

neration less frequently. Others will possess characteristics that make them especially suitable and these characteristics will, therefore, be transmitted more frequently.

Under stable ecological conditions, deviant offspring will normally be eliminated by natural selection. This means that species can remain almost unchanged over extremely long periods. However, if changes take place in living conditions it is possible that the process of natural selection will make the deviant offspring into those best suited to survive and reproduce under the new conditions. This can result in modifications to the genetic composition of the species. Over long periods, it can also result in the appearance of new species. The appearance of geographical barriers that divide the areas over which species range can lead to the emergence of new species as a result of the differing effects of the ecological conditions prevailing in the separated areas.

Thus, genetic diversity is a fundamental requirement for species to adapt themselves in step with the changes that occur in their living conditions. The greater the level of diversity, the greater the chance that genetic material is available that can ensure the continued existence and evolution of a species.

As the numbers of species decrease, their total genetic variation will also decrease. Species represented by only a few individuals living in isolated groups are especially susceptible to loss of ge-

Fig. 2.1

The diversity and distribution of species in Denmark is constantly changing

Successful species	Species in decline	Extinct species
Grasshopper warbler	Partridge	Elk
Grey lag-goose	House martin	Irish elk
Roe deer	Sparrow	Lynx
Cormorant	Wood lark	Wolf
Collared dove	Lapwing	Aurochs

netic diversity due to random causes. Inbreeding can result in the loss of genetic diversity and can finally lead to extinction.

Thus, we do not reduce biodiversity solely when we exterminate species but also when we reduce the populations of species and the areas over which they range so that genetic diversity is lost; see Fig. 2.1.

Biodiversity endangered

There is a growing awareness that the world's ecosystems are being exposed to the most extensive and rapid changes ever. Virgin forests are being felled and natural grasslands and wetlands are

Fig. 2.2
Annual world production of the most important crops (1985) and of the most important domestic animals (1995), together with fish catch (1992).

	Production (millions of tonnes)
Wheat	450
Maize	400
Rice	395
Potatoes	295
Barley	155
Sweet Potatoes	115
Cassava	105
Soya beans	105
Wine	80
Oats	65
Durra	60
Sugar cane	55
Millet	50
Fish	98
Pork	72
Beef, veal and buffalo meat	53
Poultry meat	43
Sheep and goat's meat	10

(Source: FAO 1992, Juma 1989 & the Danish Ministry of Agriculture and Fisheries, publ. 1995.)

being cultivated. Rivers, lakes and seas are rubbish dumps, and the composition of the atmosphere is being changed by the emissions of industry, transport, construction and other human activities.

In temperate latitudes, most of the original forests, grasslands and wetlands have been transformed into cultivated landscapes. Practically nowhere in Denmark can we find areas that can be described as original *wild nature*.

To a certain extent, the picture is similar when we consider the tropics. Most of the original tropical rain forest has already been removed and enormous areas are being cleared every single day. If the present rate of clearance is maintained in the tropical forests, it has been estimated that up to 10% of all species in those forests are doomed to extinction within the next 20 to 25 years and that many have already disappeared forever.

It is estimated that 17 million ha of virgin land areas are transformed annually - an area four times the size of Denmark.

The genetic diversity of crops and domestic animals is also being reduced in step with the spreading of improved, high-yield breeds in industrialised agriculture. This is happening at the expense of traditional all-round forms of agriculture, with their more primordial and variegated crops and domestic animals. 80% of global food production is based on 12 types of plant and a few types of animal. It should be added that fish, especially in the developing countries, is the most important source of animal foodstuffs; see Fig. 2.2.

Extensive (deliberate, as well as random) spreading of plants and animals to new habitats - often across continents - can be extremely harmful to the original biodiversity of these new habitats. This is because alien species can often merge into the local ecosystems on an

equal basis with the naturally-occurring species. This can alter the balance so that the original species are wiped out or reduced to only small colonies.

Finally, there may be risks attached to the increasing use of genetically engineered crops and micro-organisms - risks that may correspond to those mentioned above or that may perhaps have still more far-reaching consequences.

Value of biodiversity

Today, when we of the industrialised world protect biodiversity, our motives are primarily moral and aesthetic. According to society's moral code, nature has an intrinsic value and, as the dominant species on Earth, we humans bear responsibility for the preservation of our fellow creatures (even if our acts do not always reflect this moral code). We consider that our lives are enriched by the beauty of nature and we feel that our culture is tightly bound to nature.

But the fundamental reason for protecting biodiversity is more simple: *it is essential to humanity's own survival.* Rich biodiversity is a requisite in maintaining and increasing the productivity of agriculture, for developing new disease-resistant crop strains and for adapting agriculture to changes in the climate or, in other words, for feeding the rapidly increasing number of human beings on Earth.

Biodiversity also supplies us with other vital necessities, such as fuel, timber, clothing and medicine. As far as medicine is concerned, we have only uncovered a tiny fraction of nature's potential. For instance, who could have foreseen that a species of the yew tree would turn out to contain some of the most promising substances in the battle against cancer? (See Box 2.3.)

Most of the activities that are directly or indirectly detrimental to diversity yield short-term economic gains for a - usually small - group of people. But the

Box 2.3

Three epoch-making discoveries

- *The bark of the endangered Pacific yew contains taxol, which has proved to be an active medicament in combatting cancer of the breast and ovaries. The bark of three yew trees is needed to obtain sufficient taxol extract to treat a single patient. Extraction results in the death of the trees. Studies have revealed that small quantities of needles from the closely related European yew can be used in the synthesis of taxol. The process is thus less costly when using the European yew and is harmless to the trees.*

- *The rosy periwinkel grows wild in Madagascar, where it is used in traditional medicine to treat sugar diabetes. Medical investigations have shown that extracts from the plant have proved efficacious in the treatment of leukaemia. Since medicine based on an extract of the rosy periwinkel was launched on the market, the rate of healing leukaemia in children has increased from 10% to 95%.*

- *At the end of the 1970s, a Mexican botanist discovered a small stand of a hitherto unknown perennial wild strain of maize. This stand was so small that it would probably have been destroyed had it not been discovered. This wild maize distinguishes itself in that it is resistant to seven types of virus disease that infect cultivated, annual maize. Since the wild strain crosses easily with the cultivated, it is easy to transfer its resistant properties to crop plants.*

costs of this direct or indirect damage to diversity must be born by all of us - and perhaps they will not become payable until much later.

Nowadays, a concentrated effort is being made on developing methods of measuring the economic value of biodiversity, with a view to gaining more reliable information on which to base political decisions concerning nature management. It is easiest to measure the productive utility value of biodiversity as the value of that which is harvested and marketed. There is however no unambiguous relationship between biodiversity as such and biological production.

It is difficult to fit the value of biodiversity into conventional economic models. In the first place, this is because the value of biodiversity has for many cultures and nations an intrinsic value: the beauty and uniqueness of life that it is the duty of mankind to protect. In the second place, it is impossible to assess the wealth that still lies concealed in Nature's treasure chambers, e.g. in the form of new crops and medicinal plants. In the third place, it is not only impossible to predict the wealth still unrevealed, but also the wealth that will be lost if we do not change the course of development.

This is what makes the *precautionary principle* so vital: the principle according to which a lack of complete clarity over the full extent of a threat to the environment must not be used as an excuse for neglecting to combat that threat. We simply do not know what will be lost to ourselves and our descendants if we impoverish biodiversity.

How can biodiversity be conserved?

The conservation of biodiversity requires the development of methods of long-term management and sustainable utilisation of biological resources, at the levels of the ecosystem, species and gene

pool. This is a significantly broader matter than traditional work on the conservation of endangered species and types of nature.

The following measures are especially necessary at the global level:

- the protection of ecosystems and their natural processes, through the development of sustainable utilisation of biodiversity in the fields of agriculture, forestry and fisheries;
- the conservation or restoration of ecosystems and their natural processes, so that viable populations of the naturally-occurring flora and fauna can be maintained in their natural habitats (*in situ* conservation);
- the promotion of people's understanding of the importance of preserving biodiversity at the national and global levels, through economic subsidies and the transfer of knowledge to third countries, and through ensuring their countries a share of the profits derived from the use of their biodiversity.

Convention on Biological Diversity

It was the recognition of the threats to Earth's biodiversity that impelled the UN environmental organisation, UNEP (United Nations Environmental Programme), to commence work in 1988 on preparing a convention on biological diversity.

That work ended four years later with the UN Conference on the Environment and Development, held in 1992, in Rio de Janeiro, Brazil, where 155 countries signed the Convention. A global action plan for the environment in a broader sense was also adopted at this conference, the so-called *Agenda 21*. Apart from a separate chapter on biodiversity, *Agenda 21* also contains a number of chapters that bear indirectly on this. These chapters concern, for instance, agriculture and forestry.

The Convention came into force on 29 December 1993, i.e. 90 days after it had been formally ratified by 30 countries. On 21 December 1993, Denmark became the 39th country to ratify the Convention. By 1 February 1996, 141 countries, including the EU member states, had ratified the Convention. This is an unusually short time for an international convention to come into force. It emphasises the gravity with which the problems are considered in international circles.

But the adoption and entry into force of the Convention is the beginning rather than the end of a process. The Convention should be broadly considered as a framework on which the Parties must now build at the national level, and in close international cooperation.

The Convention perceives the problems in a holistic manner, since it combines nature conservation with consideration for utilisation and development. Nature conservation conventions have hitherto focused on conservation in a narrow, conventional sense - rather than concerning themselves with the sustainable utilisation of natural resources. The principle of sustainability has great significance, e.g. for agriculture, fisheries, forestry and commerce and, for obvious reasons, its developmental aspects are crucial to developing countries.

The other main aspect of the Convention is the confrontation with the idea that, in common with space and the sea, the Earth's species of flora and fauna should be considered to be humanity's

common inheritance or property, since the Convention recognises each individual country's sovereign rights over its own natural resources.

The principle of national sovereignty is first and foremost of significance to biodiversity at the genetic level. A large proportion of the global biodiversity is to be found in the developing countries, whereas the biotech industry that profits from the resources, e.g. through the development of medicines, is located in the industrialised world.

The biotech industries of the industrialised world have so far had unobstructed and cost-free access for collecting *raw materials* in the developing countries, then patenting their finished products and also letting the suppliers of *the raw materials* pay dearly for those products.

The Convention defines the right of the developing countries to dispose of their own resources and gives opportunities for the more equitable distribution between the developing and industrialised countries of the profits harvested by the biotech industry. The gathering and export of genetic resources now requires the permission of the relevant countries - and these countries can make that permission conditional on their receiving a share of the economic and scientific gains deriving therefrom. Thus, the potential economic value of biodiversity has become an important motive for its protection.

The Convention also acknowledges that the developing countries shall re-

Box 2.4

Article 8d of the Convention on Biological Diversity, 5 June 1992:

**"Each Contracting Party shall as far as possible and as appropriate:
... d) promote the protection of ecosystems, natural habitats and the
maintenance of viable populations of species in natural surroundings;"**



ceive assistance from the industrialised countries so that they can fulfil the obligations of the Convention.

Conservation of biodiversity in Denmark

Danish biodiversity appears quite insignificant in the global perspective. A single hectare of the Malayan rain forest has three times as many species of tree and bush as the whole of Denmark. Denmark is the home of 49 species of mammal - Zaire has 409.

The reason for this *apparent poverty* of species and ecosystems is due in part to the natural conditions of our part of the world, but also to the fact that Denmark is one of the world's most intensively cultivated countries, where man has succeeded in altering the original countryside quite fundamentally over the last 7,000 years. Today, the Danish terrestrial ecosystems consist almost exclusively of semi- or fully cultivated types.

Our biodiversity does not become any the less valuable or worthy of conserva-

tion because of its scarcity. Our meadows and heaths, forests, watercourses and coastal waters are the habitat of flora and fauna that have evolved and adapted to precisely the conditions that prevail there. These species, and the genetic variation they represent, are just as unique in their living patterns and adaptation as are the colourful fish that inhabit a coral reef or the wealth of orchids in a tropical rain forest.

Anyway, Denmark possesses types of countryside that are quite special, seen from the international standpoint, and which we therefore have a special obligation to protect. This is true, for instance, of the tidal flats of the Jutland Wadden Sea, the low-water areas of the Danish waters and the Atlantic dune heath along the west coast of Jutland; see Box 2.4.

And lastly, because of the extent to which our countryside is a product of human intervention, it perhaps represents our most important culture-historical monument. The Danish landscape, with its flora and fauna, is a part

Box 2.5

The cormorant - a native species

The cormorant has nested in Denmark throughout historical times, albeit in dramatically varying numbers as it has often been the object of persecution on the part of man. In periods it has been banished from the country as a breeding bird. The last time this happened was in 1876.

The cormorant returned to Denmark as a breeding bird in 1938. Due to hunting during the early years, it moved around until it finally settled in the Vorskø Nature Reserve, in Horsens Fjord, where there has been a permanent colony ever since. Hunting in the breeding period limited the number to about 200 pairs but this control was stopped in 1972, on the initiative of the Danish Nature Conservation Council. The number of individuals in this colony then increased rapidly, while other colonies were established in other parts of the country. A contributing factor to this was the fact that the cormorant was included in the EC Bird Protection Directive and therefore became totally protected in Denmark in 1980, as well

as in the other EU countries. The increase in the cormorant population has resulted in many complaints from the fishing sector.

For this reason, permission was granted in 1993 for commercial fishermen to shoot cormorants that settle near fishing equipment. Permission has been granted during 1994 and 1995 to chase adult birds away from newly established colonies and, under special circumstances, to control the breeding success of established colonies.

The Ministry of Environment and Energy has also established a cooperation with the Danish Ministry of Agriculture and Fisheries on the development of protective devices and cormorant-proof pound nets. This balanced management contributes to minimising the damage caused by cormorants while it permits Denmark to maintain a viable cormorant population, which contributes to global biodiversity.

(Source: Ministry of the Environment 1992b, Vesselbo, 1994.)

of all Danes' history - a part of our cultural identity.

What is this biodiversity that we wish to preserve?

Precisely because the Danish countryside has been created by man, the question of what biodiversity we want to preserve is as relevant as it is difficult to answer.

We must take our point of departure in the fact that our biodiversity has been, is and will continue to be in a state of constant change as a result of natural processes, as well as our use of

natural resources and our other activities. A Danish biodiversity that is uninfluenced by man is impossible since we are, ourselves, a part of it. The question is rather how much and in what ways our influence shall be exercised; see Box 2.5.

One overall target of the Danish programme must be *the preservation of native species of flora and fauna and their variation and habitats as cornerstones of Danish nature, together with their protection against the further propagation of non-Danish species*. It is only through the preservation of large, viable popula-

tions of our native species that we can safeguard their genetic variation. Correspondingly, we can only preserve our ecosystems when this is done with their original assemblages of species. A particular effort must be made in the case of species and types of nature for which Denmark has special responsibility.

In order to safeguard large, viable populations we must also protect large areas. But, since biodiversity depends on the interaction between ecosystems, species and their variation, the protection of large areas in itself does not always increase biodiversity.

The desire to preserve our authentic biodiversity and to prevent that which is often called *flora and fauna pollution* shows that, as far as certain ecosystems are concerned, an increase in the number of species is not a goal in itself. It is characteristic, for instance, of raised bogs, heaths, poor fen and lobelia lakes, that they are poor in species - i.e. that they are only inhabited by organisms that have adapted to their extreme growth conditions over millenia.

Denmark has a long tradition of nature protection and our efforts to date have reduced the impact on biodiversity of our intensive use of the country's na-

tural resources.

However, it has not been possible to avoid gradual diminishment of the populations of a large number of rare and common species. Our endeavours hitherto can be described as largely defensive, directed primarily at the treatment of symptoms and directed especially at particularly vulnerable species and habitats.

Apart from protecting the aspects of nature that are considered especially valuable, efforts must also be directed towards the more general protection of species and entire ecosystems. At the same time, it is important to affirm that more attention must be devoted to the causes of depletion rather than its effects. In other words, *traditional* nature conservation must be supplemented with preventive measures to ensure *that the depletion of biodiversity is avoided in the future and that, where such depletion has already occurred, restoration be carried out to the greatest possible extent.*

Care must be taken and zero-solutions must be adopted so that Nature is given the benefit of the doubt. When intervention is necessary due consideration must be given to the needs of our species, their variation and their habitats.





Chapter 3

Biodiversity and the landscape

Ice age

Denmark is a young country in the geological sense. Its landscape was mainly formed during and after the last ice age, which started about 120,000 years ago and which ended about 12,000 years ago. For by far the greater part of the period, the glacier was restricted to the Scandinavian peninsula, whereas Denmark consisted primarily of tundra or arctic steppe outside the glacial region.

A colder period started about 25,000 years ago, during the last of many ice ages. It culminated with the maximum extent of the glacier, which covered the Danish islands and half of Jutland, about 7,000 years later. The glacier receded from the Danish area as a result of an increase in temperature and Europe is now in a post-glacial period.

Formation of landscape after ice age

Here follows a brief description of the formation of the landscape after the ice melted.

Water and wind played freely across the open, treeless landscape that was Denmark at the time. The landscape was levelled, rounded and furrowed. Alluvial clay, sand and gravel were deposited on the beds of lakes and in hollows and the wind created dune systems at the coast and inland.

As plants and animals migrated into the country, the formation of the landscape became increasingly affected by biological processes. The formation of stable vegetation, which gradually evolved into forest covering most of the country, dramatically reduced the forces of ero-

sion and sand drift. The vegetation also influenced the formation of soil, the water table and run-off conditions.

After the end of the ice age a large part of the country - perhaps a quarter - was covered by a multitude of large and small shallow lakes and wetlands. For the most part these became partly or wholly filled with alluvial material and later with lime precipitation and deposits of plant and animal remains, including pollen; see Box 3.1. Those that were not filled in can still be seen in the landscape as ponds and lakes.

The land rose as the ice melted. This was because it had been freed from the weight of a glacier that was up to one kilometre thick. As the ice was thickest in the northern areas, the depression and subsequent elevation were also greatest in these areas.

After the ice melted, Denmark formed part of the North European mainland, and plants and animals from the rest of Europe were able to migrate north into Denmark freely, which is the reason why the forest spread during that period and covered the plains. Several of the animals that had adapted to the open countryside, including the Irish elk and reindeer, disappeared as the forest advanced. On the other hand, the aurochs was able to adapt to the forest and its number increased.

Silvian mammals, such as the elk, bear, wolf and lynx, migrated to Denmark as the forest advanced. A temperature increase of a couple of degrees above today's summer temperature made it possible for species that sought warmth, such as the European pond tortoise, to

become common in the marshlands. It disappeared again when the temperature dropped.

The reason why the aurochs, elk, lynx and bear disappeared from Denmark over the following millennia is not known with any certainty, but it was probably due to a combination of many different factors: the formation of an archipelago about 6,000 years ago, man's hunting of the creatures and man's subsequent transition from hunting to agriculture. This transition meant that the forest was cleared for cultivation and man thus removed the habitat of the large "forest animals".

The sea rose later and, at the end of the "hunting" stone age about 6,000 years ago, it washed in over the present coasts and reformed the country into a deeply incised archipelago with a far smaller area than the Denmark we know today. However, a gradual elevation of the land took place over the next 2,000 years, so that the present Denmark took shape about 2,000 years ago.

Although certain natural, dynamic landscape processes still occur, the country now primarily bears the stamp of man and his works.

Biodiversity in Europe

The biodiversity of Europe is less than that of other parts of the world. This is

due in part to a general tendency for the number of species to decrease from the tropics towards the poles and, in part, to Europe's special geographical circumstances during the ice ages.

The climatic zones of the northern hemisphere shifted towards the south during the ice ages. This meant that the species of flora and fauna were compelled to adapt to the new conditions if they were to withstand the advance of the glacier. There was a great risk that species would die out because of their inability to pass the migration barriers. The mountain ranges that run east-west through Europe and the Mediterranean Sea are good examples of such barriers.

A number of animals that live in Africa today, such as the hippopotamus, rhinoceros, lion, hyena and elephant, were also common in Europe during previous interglacial periods.

New species, such as the mammoth and woolly rhinoceros, which were especially adapted to the peculiar living conditions of the steppes/tundra, emerged during the ice ages. On the other hand, during the warm, interglacial periods and the present post-glacial period, these animals had difficulty in finding suitable habitats and therefore became extinct.

Thus, Europe was richer in flora and fauna before the ice ages than it is today. Because of the migration barriers, Eu-

Box 3.1

Pollen reveals history

Apart from the loss of biodiversity, the decline of the marshlands and moist hollows has also been accompanied by the loss of important information pertaining to cultural history and natural history on the last 10,000 years' evolution of the landscape. This material was concealed in the deposits of plant and animal remains in lakes

and marshes.

Vital information can be obtained by analysing the flower material (pollen) contained in layers of peat. The distribution of grains of pollen can tell us how the assemblage of tree species in the Danish forests has changed over time.

Box 3.2

Land use and types of nature

Types of nature are characterised by particular geographical conditions, specific plant and animal life and by physical and chemical factors, regardless of whether they are wholly or partly natural.

Denmark's composite nature can be classified into a number of overall types: forests, uncultivated dry grassland, heath, dunes, bogs, humid permanent grasslands, lakes, watercourses, coastal meadows, salt reed swamps, urban areas and sea.

*The different types of nature are coded in colour on the 4-cm map sheets published by National Survey and Cadastre - Denmark. A type designated **fully cultivated** is also shown on the same maps in white.*

*Depending on the degree and frequency of human intervention, nature types are classified as **virgin, semi-culturally conditioned** or **culturally conditioned**. The percentage area of virgin nature types is less than 1% in Denmark.*

rope lost a number of species during each ice age. This has resulted in a significant overall loss of biodiversity - a loss that it has been impossible to counterbalance through either the immigration or evolution of new species. Moreover, man has been a powerful contributory factor to the extinction of species ever since the last ice age.

Danish biodiversity in the international perspective

Due to its insignificant size and the prevailing climatic conditions, Denmark only has a modest proportion of Europe's already limited biodiversity. However, the country's situation between the tem-

perate coniferous forest region to the north and the temperate deciduous forest region to the south, between the mild winters of the Atlantic region to the west and the more continental region to the east gives it a sprinkling of habitats and species from many different climatic regions.

Thus, the Danish variation in climate, terrain and soil is divided up into a changing mosaic of such nature types as meadows, forests, coastal areas, lakes and watercourses, bogs and heaths; see Box 3.2. This makes it possible for a large number of ecosystems to coexist in a modest area, each with its own peculiar assemblage of flora and fauna.

