NATURE DEVELOPMENT

An exploratory study for the construction of ecological networks

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agriculture,
nature management and fisheries

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Cover: The Oostvaardersplassen: With its 6000 ha. it is one of the largest nature-development areas in the Netherlands.

COLOPHON

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Preface

The Exploratory study Nature Development has been published in 1988 as a background document for the Nature Policy Plan of the Netherlands (1990).
The study can be seen as the basic document for the development of the Ecological Network laid down in the Nature Policy Plan. In the study, nature is discussed with regard to its origin, present state and possibilities for improvement and restoration. It describes the different biogeografical regions of the Netherlands.
The concept of nature development is worked out as a new, offensive strategy for nature conservation in the Netherlands. There is a compelling need for nature development in the Netherlands on account of the considerable loss of area of natural habitats and fragmentation of natural areas with far reaching effects on ecosystem functions and the survival of plant and animal species.
Preservation alone is not likely to result anymore in sustainable conditions for the remaining ecosystems.
This analysis holds for more countries in Europe and other parts of the world.
As both necessity and opportunities for nature development are broadly recognised now, this English edition may contribute to further discussions on the topic of nature development and nature conservation.

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Introduction

Nature development and nature policy

Nature development in the Structure Plan on Nature and Landscape Conservation

The Structure Plan on Nature and Landscape Conservation (Part A, policy plan, 1981) presents nature development as one of the main features of the nature policy. This new element of the policy is described as follows:

'The policy on developing ecological values will concentrate on large-scale situations where there are as yet no established forms of land use, on small-scale situations where there are projects suitable to be accompanied by nature development and on introducing facilities for plant and animal species within the existing land use.'

In the Structure Plan, nature development is understood to mean:

'a complex of human interventions in nature and the landscape and regulation of practical activities aimed at desirable ecological development.'

It is explained that nature development may involve a whole range of activities that may be undertaken on a variety of scales. The scope of these activities is indicated, on the one hand, by 'large-scale conservation projects' aimed at developing large new wildlife areas (see front cover) and, on the other hand, by 'small-scale nature development projects' aimed at introducing small-scale facilities for a few plant and animal species (for example nesting places for swifts).

The importance of nature development in restoring or developing an 'ecological infrastructure' is mentioned several times in the Structure Plan, as is the concept 'ecological infrastructure' itself, but this is only partially developed.
Attention is also given to the important contributions that various other bodies in the public and social sectors can make in the area of nature development. If, right from the outset, nature development is made an integral part of the planning of work conducted by government and individuals on every scale, and if existing situations are also looked at from the point of view of the possibilities they offer for nature development, all kinds of opportunities for nature can be exploited.

Social response

The social response to the introduction of nature development (ND), as one of the main features of policy and the related policy plan, is clearly favourable. Local government, advisory bodies as well as environmental Non Govermental Organisations (NGO's), regard ND as a valuable extension of existing policy of conservation and management of ecological values. Many parties do point out that nature development should not be a substitute for or alternative to the conservation and protection of existing ecological values. There are also warnings that nature development should not be used as a motive for carrying out a variety of projects that have (far-reaching) negative effects on nature and the landscape. A framework is called for that can be used in practice to elaborate the concept of nature development, also in relation to ecological infrastructure.

In natural science circles, and also amongst designers and developers, the concept 'ecological infrastructure' (whether or not in relation to nature development) is greeted enthusiastically, resulting in workshops, symposia and scientific publications with all the attendant discussions. Although the scientific debate concentrates mainly on the (quantitative) practicability of the so-called 'islands theory' in mainland situations (cf. Chapter 4), there is a consensus on the importance of spatial-ecological relationships (and isolation!), and on whether it is desirable to restore and develop these, for the 'sustainable survival' of plant and animal species.

In the meantime 'ecological infrastructure' is becoming a well-known concept and, often in conjunction with 'nature development', is increasingly being translated into concrete and practical guidelines for the benefit of planners, for example within the framework of regional planning and land development. Ideas and concepts have been further developed in practice with close interaction between scientific and design/development circles and policymakers. An interdepartmental project group 'Nature Development and Ecological Infrastructure' has initially played an important part in this. Not only has the theoretical development of concepts and ideas been of importance, but also the tremendous knowledge and experience that have rapidly been acquired in practical situations such as the Delta area, Oostvaardersplassen, Markiezaat and the Veluwe, as well as in management of wayside verges, riverbanks and shorelines and in construction of small-scale facilities.

Nature development in practice

Nature development logically complements nature conservation and environmental protection which mainly concentrate on preserving existing ecological values. Thanks to the experience gained in nature conservation and in the related nature management, the way in which nature development has to be tackled can now be determined better and in more specific terms. The progress made in international ecological research, especially on (relatively) undisturbed ecosystems that are still functioning naturally, makes it possible to predict which ecological values may arise from a particular abiotic situation, such as soil conditions, (ground)water system, physical location.

If conditions are formulated clearly beforehand, it is possible to allow specific ecological values to develop. In this way, knowledge about how ecosystems function, the translation of theory into concrete situations and the creation of conditions all form an important basis for nature development in practice.

Nature development has achieved some good results in the Netherlands so far, as regards both 'small-scale' nature development and the 'large-scale' development of new wildlife areas. Some striking examples on a smaller scale include the flower-filled wayside verges, achieved by adapted development and management; the increase in the number of biotopes of amphibians as a result of digging pools; the boost given to peat formation in some places by adapted water management; the development of waterside vegetation and the creation of places to breed, nest and sleep for birds and bats. (Smaller) wildlife areas have also been developed or are planned in various places on a local or regional scale.

Oostvaardersplassen; system approach

The best known example on an international scale of the development of a large (new) wildlife area is the Oostvaardersplassen lakes area where the developments towards a complete ecosystem demonstrate that mother nature can manage on her own - certainly in large areas - with less human management than was thought possible until recently. This does not mean though that it would

not require any effort to develop an area like this. Quite the opposite. A great deal of effort is concentrated on gaining an understanding of the processes in an ecosystem of this kind by comparison with data about natural systems. On the basis of this, a particular avenue of development has to be chosen and the important limiting conditions for how the system functions can be determined. 'Conventional' methods of field and laboratory research are used as well as 'modern' methods such as computer simulation of how (parts of) the system function(s). The limiting conditions set then have to be translated into (one-off) development measures and management conditions at system level (for example relationships between water dynamics, grazing, cyclical development of vegetation). Once the conditions have been developed and fixed, the intention is that the system can operate internally and (to a large extent) independently.

Free ranging Konik horses have been introduced in the Oostvaardersplassen area, not just as a management tool, but as integral part of the ecosystem. (photo: F.W.M. Vera)

The knowledge and experience that have been and are still being gained from the development of the Oostvaardersplassen, together with the remarkable results achieved, have helped ensure that more attention is focussed on the ecological processes in a system approach when developing other 'new' wildlife areas such as Markiezaat, Krammer-Volkerak and Voordelta in the South-West Delta area.

Experiments are also carried out in existing (larger) wildlife areas in order to achieve a form of management involving a certain degree of so called self-sustainability. The initial results of, for example, so-called development management with the aid of large free-roaming grazing animals, such as oxes and horses, are promising with regard to both nature development and the practical management effort involved as well as the technical cost of this effort. Herbivores such as beavers, roe deer, red deer, wild boar and elk are no longer considered as "just another species" but regarded as ecologically essential elements in systems.
The significance of nature development as the second feature of the policy goes beyond the literal meaning of allowing nature to develop. In the last few decades nature policy has been particularly characterised by the steady loss of wildlife areas, the loss of plant and animal species and a deterioration in the quality of nature and the landscape. The primary aims of the nature policy are to stop this deterioration and to preserve the conditions under which plant and animal species can permanently survive. It must be recognised, however, that to achieve these aims, in the short term at any rate, means facing serious problems, given the very intensive and dynamic land use in the Netherlands. By pursuing the policy angle of nature development, the perspective becomes broader. Not only is the objective of stopping deterioration at the forefront; it is also possible to make improvements. In this way, nature policy can develop both a defensive strategy and a more offensive strategy.
Within this strategy, three main avenues for nature development, that have been developed from the lines of policy outlined in the Structure Plan on Nature and Landscape Conservation, can be distinguished:

- nature development aiming at achieving a starting point for more 'complete' ecosystems, where natural processes play a decisive role, in keeping with the indigenous ecosystems of the Netherlands, such as the sand dunes and the fluvial areas.
- nature development aiming at reinforcing spatial/ecological relationships ('ecological infrastructure') within and between wildlife areas and (within and between) nature areas in the man-made landscape.
- nature development aiming at optimising, in particular, the abiotic starting point for nature, with (or connected with) various kinds of uses of the (agricultural) cultivated land, wet and dry infrastructure, recreation and woodlands.

In this exploratory study the main emphasis is on developing the first two avenues into a framework for nature development, related to indigenous ecosystems of the Netherlands.

Scope of the exploratory study

This study concentrates on nature development as part of the nature policy. Other aspects of the nature policy also come under discussion. However, the intention is not to examine here the problems of landscape conservation and landscape development and the relationships with the nature policy. Neither is it the intention to make judgements about strategic policy choices. The study does contain information and criteria that may help to make such decisions in a responsible manner in due course. Finally, the pronouncements about the advisable and necessary deployment of policy instruments must also be regarded as being of a provisional nature. The analysis performed here, with the aid of reference data, a system approach and the concept ecological infrastructure, in order to find a spatial ecological framework for nature development, may also be an important building block in formulating a vision of the future for nature policy as a whole.

Structure

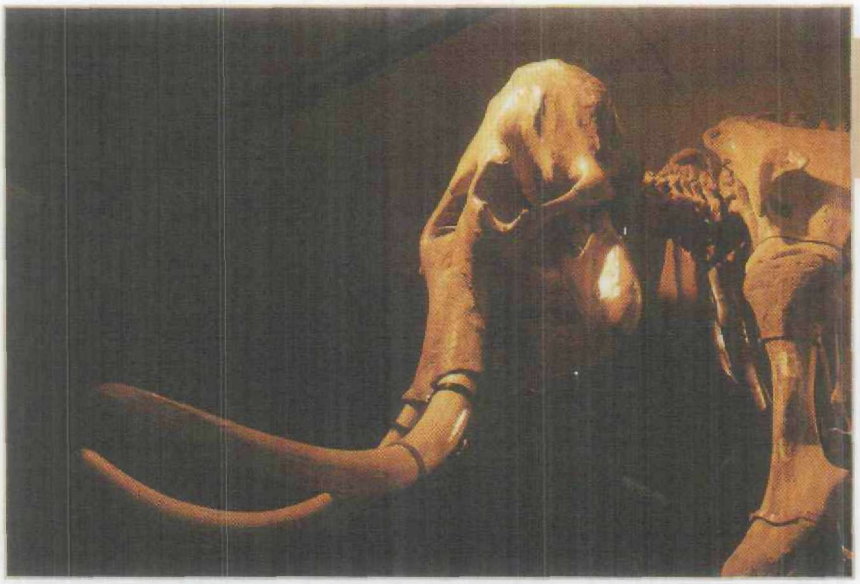
The first chapter examines the place of nature development in the nature policy in more detail by briefly outlining the relationship between 'man and nature'. The second chapter takes a close look at the problems and questions relating to the nature policy in general and to nature development in particular and some possible solutions are explored. An important instrument for nature development is introduced in Chapter 3: working with an ecological reference. It is explained how the reference is built up and the ecological reference formulated is set against the present situation. From this ecological reference, combined with a view in which the ecosystem approach is the central feature (Chapter 4), a concept and possible elaboration of a spatial ecological structure for nature in the Netherlands is derived (Chapter 5). Chapter 6 explores the conditions for nature development on the basis of the proposed structure. In the concluding remarks a few starting points are presented that are important if the points mentioned in this study with regard to nature development in particular and nature in general are to be put into practice.

1 Nature development in a historical context

Man and nature

Dependency

In the period since modern man evolved, man has been directly dependent on nature for the vast majority of the time. To begin with, as a part of nature, as a hunter and gatherer, he had only a limited influence on his environment generally speaking. As a result of the development of hunting methods and the invention of weapons such as the spear and the bow and arrow, man gradually began to exert more influence. This sometimes had significant consequences for some animal species even in prehistoric times, for instance in Australia where the sudden extinction of many large animal species some 20,000 years ago is to a certain extent attributed to the arrival of man. In all probability man also played an important part in the extinction of a variety of large land-based mammals in the period shortly after the last Ice Age.



The Mammoth was the last of the elephant species in Europe. Man at least contributed to its extinction at the end of the last Ice Age.
(photo: F.W.M. Vera)

Agriculture

When agriculture was developed for the first time in the Near East around ten thousand years ago and this 'invention' slowly became more widespread, only then did man increasingly begin to change his environment. People became more permanently settled and their numbers grew.

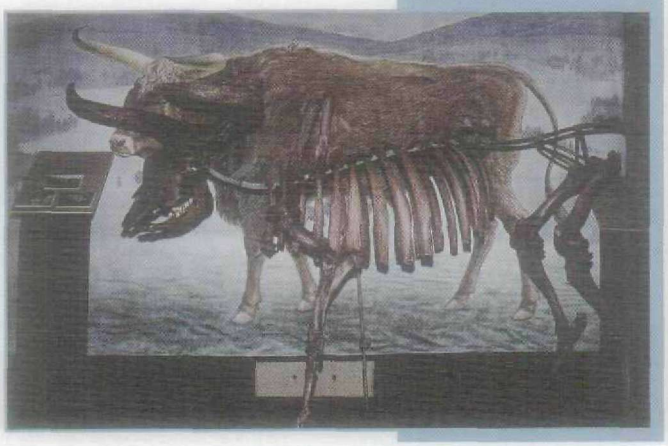
As a result of woodlands being felled, land being brought under cultivation and vegetation being burned, the numbers of some plant and animal species declined, while other species, that were adapted to the conditions created by man through agriculture, were able to multiply.

By domesticating a number of 'wild' species of mammal, it was possible to develop livestock farming. The wild ancestors were regarded as rivals of the domesticated species, partly because they had the same food preferences. This led to the original wild animal species being driven away or, in some cases, made extinct,

along with other rivals such as predators like lion and wolf that preyed on both wild and domesticated species. Examples of domesticated species that died out in the wild in this way include the aurochs, the tarpan (the European wild horse), the wild (Ethiopian) ass and the wild dromedary.
In addition, there are a few species that almost suffered the same fate, for example the yak, the camel and the guanaco (the wild ancestor of the lama and the alpaca). Various species of wild plants, that were the ancestors of the cultivated crops used by man, also declined in numbers and are often only found now on the fringes of their original area of propagation. Examples of these include wild grasses and cereals.

Hunting and the management of game

There are signs that, before the advent of agriculture in Europe, prehistoric man had already developed forms of selective hunting, with the aim of optimising the basic food supply. This is probably the earliest form of what we could call 'animal husbandry'.
Later hunting became a reason to protect animal species, and to safeguard the areas in which they were found, from general use. It was no longer a matter of safeguarding food supplies, but rather a question of the rights of ownership and the privileges of the elite. In the Middle Ages this led in some places, for example, to a ban on tending cattle, clearing land for arable farming and wood felling and even to supplementary feeding of game. The hunting grounds of the Russian tsars in Bialowiecza on the Polish-Russian border even resulted in the preservation of the last remaining population of European bison in the whole world. Protection of this kind was not always so successful. Protective measures and the battle against poaching could not prevent the aurochs, the ancestor of our domestic cattle, disappearing from the earth. The last one died in 1627 in Poland in the Jaktorowska Forest, south of Warsaw. Several large animal species have disappeared from vast areas of Europe as result of human intervention. As a consequence, there are large 'gaps' in the distribution of many large animal species (birds and mammals), that mainly cover the most cultivated part of Europe. Examples of the mammals are elk, European bison, tarpan, wolf and lynx, while the birds include the white-tailed eagle, the golden eagle, the imperial eagle, the black vulture, the black stork and the greylag goose. Some large mammals were favoured for the sake of hunting, for example red deer, wild boar and fallow deer. Hence the fallow deer was re-introduced early in Central and Western Europe from Southern Europe for the purposes of hunting. As a result of being favoured, these large mammals are still fairly widespread nowadays, although in areas often remote from one another where high population densities are maintained, often artificially.



Skeleton of Aurochs found in the Western Jura in France The Aurochs, ancester of our domestic cattle, finally came to extinction in the 17th century.
(photo: F.W.M. Vera)

Nature conservation

For a long time the only reason for protecting nature to a certain extent was to safeguard hunting rights. It was not until the 19th century that other reasons emerged. Romanticism came to the fore partly as a reaction to Rationalism, according to which science tends less and less to regard man as being part of nature, but rather as an individual entity placed above nature. The Romantic Movement appreciated the unspoilt beauty of nature and was characterised by the romantic aspiration to 'get back to nature'. In the United States this was an important reason for establishing

the first National Park in 1872: Yellowstone Park. In Europe the romantic ideal of appreciation also led to the protection of a few areas of land that appealed strongly to the ideal of beauty, for instance the Forest of Fontainebleau south of Paris.

The situation in the Netherlands

In the Netherlands too, the same romantic ideal led to the call for the last areas of 'unspoilt nature' to be protected. Van Eeden, a renowned Dutch naturalist for example, spoke out in favour of the preservation of the Beekbergerbos near Apeldoorn, regarded as the last trace of primeval woodlands in the Netherlands. The remarks of Harting in the periodical 'Album der Natuur' ('Nature Scrapbook'), "A work devoted to spreading knowledge about the natural world amongst educated readers from all walks of life", also contained a hint of romanticism. He observed the destruction of Schollevaers Island near Nieuwekerk on the IJssel, an area where thousands of breeding pairs nested, including species of birds that are characteristic of the Netherlands as a delta area such as cormorants, spoonbills, bearded tits and all kinds of herons and terns. He sighed about it in 1866 thus:

'Schollevaers Island as a model of the original birdlife in this region has largely lost its significance. It is one of the many places where man, driven by self-interest, has abused his own power.'

The increasing interest in nature also led to an appreciation of nature and to the growing realisation by a small group of people that nature and landscape should be recognised as independent entities and therefore need to be protected on ethical grounds. The period during which this appreciation and recognition grew was one of industrialisation when developments in science and technology were responsible for bringing about major and rapid changes that had a drastic effect on nature and the landscape.

Developments up to the 19th century

This does not mean that there had been no changes until then. The construction of dykes and canals since the Middle Ages, the development of the towns and the drainage and use of low-lying land meant more than just scars on the landscape. The increasing population and the poor climatological conditions during the 'Minor Ice Age' from the 15th to the 19th century meant that the land was more and more intensively exploited. Overgrazing and the need for building materials and fuel had led to almost complete deforestation of the Netherlands. Sand drifts consequently occurred on a large scale in the drier sandy areas (dunes, push moraines). Overexploitation and excessive drifting removed the top layer from land suitable for agriculture, especially in the higher-lying sandy areas. The resulting 'wasteland' (dry and wet poor heathland) was only of limited and indirect significance for food production, being mainly used as a common grazing area for cattle. In the western peat areas 'natural' fertility, maintained by oxidation of the drained peat, was lost when the level of these areas became so low (and the peat so wet) that oxidation was considerably decreased. Instead of (intensive) farming, it was only possible to make marginal use of the peat area as grasslands. Because the forests in the country had been overexploited, there was hardly any wood left for fuel purposes. So, the Dutch developed a method of extracting wet peat and drying it for fuel. This wet peat extraction that followed in many places, resulted in lakes. The reclamation of these lakes resulted in large-scale polders. They are further aspects of the processes of change in the west of the country.

Although the changes briefly outlined above took place in general more gradually until the middle of the 19th century, the overall result was a rather bleak picture of overexploitation. A country that was bare, exhausted and dug up over large areas, much of which were barely suitable for food production any more.

Large scale Peat extraction caused considerable change in the Dutch landscape.
(photo: F.W.M. Vera)

Major changes

The advent of artificial fertiliser in the second half of the 19th century heralded some far-reaching changes. Artificial fertiliser freed agriculture from the age-old relationship between cattle farming (manure) and arable farming and market gardening. Until the mid 19th century, arable farming and market gardening were dependent on animal manure (and human manure), for the most part supplied by the domesticated animals used for farming. To fertilise a given area for arable farming, a grazing area many times larger was needed for the cattle. These grazing areas consisted of wasteland such as heath and woodland. The advent of artificial fertiliser considerably reduced dependency on animal manure. Consequently it was possible to restore the productivity of exhausted agricultural land and to make other land more suitable for more intensive agriculture. Hence the peat areas offered new opportunities for use as grassland as a result of deeper drainage (steam-driven pumping stations) and the introduction of artificial fertiliser. Wasteland was no longer required in the agricultural business plan. At the same time artificial fertiliser made it possible to regain the arable land and productivity lost over a few centuries. Moreover, it became an attractive prospect to bring other areas of wasteland into use too. The process of converting wasteland into arable land was started. The area of wasteland decreased from around 900,000 hectares (about 28% of the total surface area of the Netherlands) in 1833 when the land register was introduced, to about 600,000 hectares around 1900. The area has continued to decrease substantially to its present figure of about 136,000 hectares. Part of the wasteland has undergone (re)afforestation. Furthermore, partly as a result of coal increasingly replacing wood and peat as a fuel, the chances of survival of trees planted on a smaller scale were improved. The threat of illegal felling to meet fuel requirements was reduced. Admittedly, this did not make up for deforestation activities but the landscape changed from large open areas to a smaller-scale closed landscape, especially in the higher-lying sandy areas.

Reaction

Alarmed by the drastic and relatively rapid changes in the landscape and the resulting decline and disappearance of plant and animal species, people got organised around the turn of the century in order to fight these developments. Although the government had recognised in legislation in 1880 that nature conservation was of general importance, it was this individual initiative that actually marked the beginning of organised nature protection by NGO's. At that time the only way of preserving areas from the developments was to purchase them. People did try to adopt another course, for example by proposing a legal framework for the protection of ecological values; these attempts failed at first, however. Until 1941 land was purchased exclusively by individuals. As a result of limited financial resources and the spirit of the times, it was usually only possible to protect parts of areas with an abundance of wild plants and animals in this way. People were often forced, therefore, to concentrate on areas that were most under threat and were most highly valued for their ecological value. By purchasing land, it was hoped that the present situation could be maintained as far as possible. For the most part, however, it was not possible to prevent such areas becoming fragmented and only being partially protected.

Images of nature

In this context it is important to mention that right from the start, different images of nature and landscape were pursued with regard to what was then generally referred to as nature conservation. In addition to 'primeval nature', other areas were considered important enough to be protected as 'areas of outstanding natural beauty'.

Throughout the history of nature conservation, there have been a variety of views about the images of nature that should be pursued. Opinions were (and are) also sharply divided about the way in which this should take place. This was partly due to the fact that, for much of the land purchased, the ideal approach of 'let nature alone' initially adopted did not produce the desired results. Since a large part of the land was not 'primeval nature' and had undergone some form of cultivation, and since essential abiotic and biotic processes that had disappeared were not restored, there was often a drastical change when cultivation ceased as a result of the succeeding vegetation. In practice, therefore, people often reverted to the old form of cultivation and management was established on that basis. Although the debate about methods persisted, this did not result in actual experiments being conducted using a form of management aimed more at natural development. One striking aspect is, for example, the debate about the possible contribution of nature development to the pursuit of nature conservation and natural science, as early as in the 1940s and 1950s. On one side there was an optimistic view about the chances for nature development, by creating the right conditions, and on the other side a more pessimistic view which argued that 'the wildlife areas lost can only be retrieved after going through the same centuries-long period of natural development'. The part that man should play in nature and the landscape was often of central importance in these discussions. Opinions differed about the significance of man as an ecological factor in the types of nature and landscape aimed at. At one extreme of the argument, man was situated outside nature in thought and his influence regarded by definition as negative (so-called non-interventionists), while at the other extreme man was seen as an essential part of nature, and hence as an ecological factor, whose influence could be positive, negative or neutral (so-called interventionists).

Man as manager of nature

In the post-war period of reconstruction and major change, nature conservationists had their hands full. Tremendous efforts had to be made to combat the deterioration in nature and the landscape as much as possible. Although during this period proposals were first put forward to carry out actual experiments using a more natural form of management and nature development, in practice the view prevailed that man was an essential factor in the management of nature and landscape. Looking back in 1971, Westhoff a Dutch scientist and naturalist formulated this view as follows:

'Man was placed outside nature in thought. We have now learned to regard this as a romantic view that we no longer share. Since the advent of ecology, or in broader terms, environmental biology, we have grasped that man is one of the factors in the biosphere, and hence in the existing ecosystems, just like the influence of weather and wind, earth, water and animals, and that this influence can be regarded as negative and corrupting. The importance of a wildlife area is not governed by the presence or absence of human influence. Man has not only had a corrupting influence on nature but also an enriching one because he has increased the variety of ecosystems, in the first place by creating scores of what we now call semi-natural landscapes. Many of our valuable wildlife areas containing a wide variety of species are semi-natural landscapes: heathland, arid land, reed land, sedge marshes, quaking bogs, chalk hills grassland, dyke meadows, sand drifts and interior dunes. Their creation and survival are due to a certain human influence, a form of cultivation that for centuries was practised in the same way.'

Reflection and discussion

Under the influence of new scientific understanding, experiences in nature management and large and small-scale examples of nature development, and encouraged by 'critical' social groups, doubts were cast on the 'official' views. The excellent results of small-scale nature development using another form of management for wayside verges and the banks of ditches, showed many people that it could be done differently.

A (new) period of reflection and discussion about the aims and methods of nature conservation had begun. The initial results of the discussions have emerged in the last few years in the form of broader aims, in terms of both individual nature conservation efforts and government action. Alongside the conservation of nature and the landscape, the development of nature and the landscape occupies a valuable place. The discussion about methods and about the relationship between the strategies of 'conservation' and 'development' is now fully underway.

We can see a similar trend in other European countries too. In Britain, for instance, the Nature Conservancy Council has developed the term 'creative conservation' into a strategic policy plan. On the other side of the Atlantic, in the United States and Canada, it is now the custom to implement all kinds of nature development projects partly (or especially) for the benefit of hunting and to compensate for any interference. The methods sometimes employed (use of explosives, large-scale excavation and fertilisation) seem a bit too harsh for the situation in the Netherlands at the moment.

2 Problems and questions

Looking for solutions

Decline

As a result of the pressure of cultivation in most of Europe, the large-scale ecosystems, that had come into being in the moderate climate zone after the last Ice Age, have become highly fragmented and disordered. A variety of large animal species, in particular, have disappeared from vast areas of Europe. The distribution and numbers of many species of plants and animals have declined in the course of time as a result of the increasing pressure of cultivation. For a long time a few species were able to take advantage of the conditions created by man, until this century when land use was rapidly intensified, leaving less and less space for these species. The range of species thereby became increasingly narrower. A situation in which ecological processes provide the driving mechanism of the systems by means of natural components had been replaced by one in which man plays a dominant role as a result of cultivation measures, technical developments and economic and social processes.

The decline in plant and animal species continued at a faster rate in the second half of this century. In the Netherlands, the increasing population growth, industrialisation, urbanisation, land reclamation, standardisation, stone-cladding and canalisation of rivers and streams as well as the construction of dry and wet infrastructure signified just as much of an attack on the remaining ecological values. Environmental pollution, for example through the use of persistent pesticides, resulted in the decline of species. Some waterways were so polluted with all kinds of substances that ecological functioning was severely impeded. In agricultural land use, technological changes and expansion occurred in quicker and quicker succession, so that first plant and animal species that had managed to hold their own in cultivated land and subsequently species that had taken advantage of the cultivated land came under severe threat. The effects of all kinds of practical functions were also found to be appreciable in wildlife areas where hydrological and environmental problems arose as a result of drainage, pollution and acidification; it appeared that ecological values could not be preserved in many wildlife areas.

Present state of affairs

The result of the changes outlined above is that there are virtually no ecosystems in the Netherlands' situation that have not been affected. Vast areas of the systems have been removed through clearance and cultivation.
The great variety of natural landscapes has been brought more and more under cultivation and exploited by man. As a result, all kinds of elements have been lost from the systems and various relationships have been severed.
It is increasingly apparent that for many plant and animal species, the wildlife areas and the remaining natural areas in cultivated land are insufficient and are too loosely interrelated to enable these species to survive in the Netherlands.

It also has to be mentioned that the picture is not unremittingly bleak. The fight against the deterioration of nature has also marked up some successes. For instance, the sharp decline in the numbers of various birds of prey and of a species such as the Sandwich tern has been checked.
Furthermore, nature appears to seize the opportunities offered by man as soon

as they arise. For example, nature development projects such as the Oostvaardersplassen, not only resulting in the reestablishment of species such as the greylag goose and the great white egret in the Netherlands, but also other species well beyond the national borders benefit, such as the marsh harrier and the bearded tit.

Definition of the problem

The problems and activities surrounding nature protection policies have shifted over the course of time. At the beginning of the century the battle against the loss of natural areas was top of the list of priorities. Wasteland was then being cleared. Wildlife areas were given another social function. In the 1930s unemployment relief projects brought about a renewed attack on wasteland. In the post-war reconstruction phase, the effects of industrialisation and the intervention of various hydraulic engineering works and projects affecting the infrastructure played a role. Towards the end of the 1960s, the developments in agriculture , meant that more emphasis was placed on the attempt to hold onto the ecological values in the agricultural man-made landscape.

A decade later increasing environmental pollution led to rising concern about the basic abiotic conditions for nature, while more recently attention has focussed on the processes in nature and on the preservation, restoration and development of spatial and hydrological relations that are important for nature.

The relationship between nature and agriculture, as the largest land user in the Netherlands, has always been marked by tension. Under the influence of rapidly developing technology and market conditions that sometimes vary greatly (due to the Netherlands' open economy), agriculture displays a fickleness that most plant and animal species cannot keep pace with. Nevertheless, agriculture, as an economic activity, will maintain a position within the social field of influence by using new modern technologies and will have to continue to do so with due regard for good basic environmental quality. The basic quality that is required for a sustainable agricultural production environment is, however, very different from the basic quality that is required for the sustainable survival of the indigenous wildlife.

A different and better relationship with agriculture, as the most important economic function in rural areas, is therefore of crucial importance for nature policy. This relationship will have to contribute to solving what in effect could be regarded as the key problem for nature policy:

'How to organize the sustainable survival of ecosystems indigenous to the Netherlands, with the plant and animal species they contain?

In search of solutions

It is evident that it is not possible to leave things as they are or to go back to how they once were; on the one hand, because the changes are (have been) so great that this is not practicable and, on the other hand, because it would result in a constant struggle against developments in other sectors of society which, for purely economic reasons, leave less and less space for nature. This certainly does not mean that the struggle for what still exists now should simply be given up. The strategy just has to be adapted. The solution is definitely not to wait expectantly on the sidelines of the field on which other social functions display their developments and activities. The solution will have to be found by building a relationship between nature and other sectors, such that the 'permanent' survival of species is much less dependent on developments in society. This means that the strategy of creating nature reserves, concentrated on 'independent'

nature, has to be implemented further and that, even in cultivated land, functions need to be segregated to a certain extent. Furthermore, it is vital that clear limiting conditions are developed in order to drastically limit the external influence of other functions on nature. Where intervention is socially necessary, compensation will have to be made. For agriculture, in particular, the strategy of segregation means that agriculture shifts from having a determinative (and in effect increasingly restrictive) role in the survival of ecological values to having a more supportive role. This probably fits in better with a number of developments in agriculture itself that are linked with vital restrictions in production and the preservation of a sustainable production environment. It also has to be considered that there is a certain interaction between the two sectors. Hence production restrictions in agriculture can have a major effect on the management of the existing nature reserves on agricultural cultivated land and on the development and management of land where production may be discontinued and which may then be used for natural purposes.

Possible solutions

There is no simple solution to the questions we are now faced with. A number of possible avenues are explored in the Structure Plan on Nature and Landscape Conservation based on an analysis of the problem. Furthermore it is concluded that the avenues complement one another and must have a synergetic effect. With reference to the structure chosen in this chapter to consider the problems, the solutions broadly outlined here involve a combination of avenues, that are set out in the Structure Plan on Nature and Landscape Conservation. These may be summarised as follows:

- Firstly, to slow down sharply and if possible stop the decline in ecological values by means of a more effective policy on nature conservation and nature restoration. On the one hand, this involves preserving ecological values in cultivated land, which in turn has to do with, in particular, the relationship with and effects of practical functions. On the other hand, it involves preserving ecological values in the wildlife areas themselves; internal and external management, in particular, requires an enormous effort and in some cases further reflection.
- Secondly, another relationship with the practical functions will have to be found. This entails working towards a spatial configuration of functions and fixing limiting conditions, so that the more vulnerable ecological functions that are to be protected are not adversely affected by other functions. In most areas this will result in a large degree of segregation between agriculture and nature. In other cases agriculture may have a supporting function. This entails, among other things, maintenance of the functions for meadow birds and geese in agricultural areas, a form of planning that uses a tenable 'green approach' based on the existing small natural and landscape elements, and more multifunctional management of, for example, the edges of farmland and ditch patterns.
- Thirdly, in the development, planning and management of wildlife areas, attention will have to be focussed on restoring and developing relationships and on establishing more 'complete' ecosystems, in which self-regulating processes play an important part.

Contribution of nature development

Nature development can make a clear contribution to the avenues outlined above. It is important to ask within what framework and with what aims nature development activities have to be undertaken. For this it is necessary to first look at nature itself.

In a dynamic process in which species evolve and become extinct, complex systems existed and exist in nature, in which every opportunity to live is exploited, by means of differentiation and specialisation in all 'corners' (niches) of the systems and optimum utilisation by living species of the energy flows in these systems, given the (abiotic) conditions. Systems like these can be characterised as 'complete ecosystems'.
For the third avenue in particular, information can be derived from a knowledge and understanding of the composition and functioning of ecosystems. This information can provide an insight into which ecosystems could potentially exist under the present (climatological and biogeographical) conditions in the Netherlands. Moreover, it could be deduced for the other avanues how best to join in with the functioning of 'ecosystems'.

Some general rules for nature development can be derived from the processes and patterns of the 'present' and 'potential' nature in the Netherlands, in conjunction with knowledge about complete ecosystems elsewhere in the world. The direction in which (wildlife) areas have to be developed can then be explored in order to achieve a sustainable and stable system of natural areas within the limiting conditions of a multifunctional country. The exploration can be done by constructing a coherent picture of systems, that can be characterised as a so-called ecological reference. This reference is an important means of gaining further insight into how to 'interact' with the ecosystem in order to stimulate and restore natural processes.

3 Ecological reference

In search of a standard

Images of nature

People do not derive images of nature from thin air, but rather from their knowledge and experience, from their environment and also from fairy tales and fables. You only have to think of the image of the wolf who eats little girls dressed in red and the image of the lion, the fearless king of the beasts. The images vary widely, depending on where people live, how dependent they (still) are on their environment and what knowledge they have about nature. The opportunities for becoming acquainted with virtually unspoilt nature also determine the images that people form. Since most of Europe is densely populated and used for agriculture, the image of nature people have there is nearly always of a man-made landscape given over to agriculture or forestry and any images of the future are therefore derived from this.

Unspoilt nature, in the form of 'complete' ecosystems, virtually no longer exists or else is found only in remote corners of Europe. In contrast with many of the inhabitants of other continents, therefore, (West) Europeans living in their continental environment are scarcely able to gain an impression of more 'natural' nature to add to their images of nature and from there develop possible future images of nature.

In the Netherlands, the most densely populated country in Europe, unspoilt nature in the countryside is a thing of the past. Every landscape has been used and because of that modified in some way or other by man. Nearly every existing forest in the Netherlands has been affected due to planting out trees and harvesting wood. Moreover forests are usually laid out on highly degraded soil. Only parts of the coastal area and the Wadden Sea are still considered to be more or less natural.

'Real nature', as seen in TV documentaries, mainly exists elsewhere, while in advertising the term 'nature', with a wide variety of meanings, obviously scores points. Natural ingredients in foodstuffs, environmentally-friendly washing powders, and the 'back to nature' feeling of a long weekend in a bungalow-park in the country all undermine the possibility of being able to form more balanced images of nature.

In search of data: (pre)history

As mentioned in Chapter 1, from the outset there has been discussion amongst Dutch nature conservationists about the images of nature and landscape that are to be pursued. Various reference images were and are employed; a common feature of these is that they are often based on (until recently) demonstrable situations in the Netherlands or available historical accounts of nature and the landscape that provide a more or less detailed picture.

One problem is that these accounts (including detailed maps) do not go back much further than the 19th century and hence describe the situation of an agricultural man-made landscape that still included a relatively high percentage of wasteland. The topical and reliable historical accounts describe patterns, such as were created following a long history of human intervention. It is often much more difficult to determine from the accounts how the patterns came about and which (natural and cultural) processes were and are at work here.

In order to gain an insight into images, or rather into the developments and changes that occurred before the time for which we have a reasonably reliable picture of the patterns, quite different and often fragmentary source material in archives and registers has to be consulted. In this way, historical images of nature and the landscape can be reconstructed with great difficulty, and as we go further back in time these become less detailed and less reliable. If we go even further back to prehistoric times, we have to rely more and more on geological and spatial geographical data, pollen analyses and the results of biological-archeological surveys in order to make a reconstruction. This latter branch of science, in particular, produces relatively limited data about fauna from excavation work; moreover, the location of sites is more or less 'a coincidence', so that extrapolation and some speculation is necessary during the reconstructions.

The result of a search like this far back in time (and into the ground) is not only a collection of images of nature and the landscape that gradually become more vague; it is mainly the experience gained of the enormous and constant changes that have taken place. If we confine ourselves to the (pre)historic period since the last Ice Age, around 10,000 years ago, when climatological conditions changed to the situation, such as the one that exists now more or less, the picture was one of continual change. A constantly changing struggle between the rising sea (which rose rapidly at first and then intermittently, though steadily) and the rivers, between peat formation and sand cover, between land and water. Plant and animal species lived in the midst of this dynamic situation. They were adapted to it and were often dependent on it. Man adapted and began to exert more and more influence, first on animal species that could be hunted and later, with the advent of agriculture, livestock farming and more or less permanent habitation, on the landscape as well. In historical times man gradually left his mark more and more. Natural processes, patterns and species increasingly disappeared.
Gaining more insight into the history of the development and the natural processes and systems of the Netherlands does not mean that we could get back to 'primeval nature'. Quite apart from the question of how far back to go and to what kind of primeval nature. What matters is that (pre)historical analysis reveals what the essential controlling processes in nature are (and have been), what part man played, what plant and animal species are found as a result, what changes have taken place and the causes of these.

Biological sciences

The modern biological sciences, especially ecology and biogeography, form another source of information. In the last few decades these sciences have discovered all kinds of principles and processes in ecosystems that appear to be universal. This was the result of research on still (fairly) undisturbed ecosystems, so-called base-line areas, on the different continents. The research revealed that various species of plants and animals can indeed exist over different continents and climatological zones, but that their form and their function in systems have very many similarities. Furthermore, there appear to be all kinds of similarities in, for instance, interdependence, nutritional physiology and strategies relating to food supply and survival.

These universal principles and processes also apply, in principle, to nature in the Netherlands' situation. It is a matter of considering whether and how these principles and processes can be translated into the present practical circumstances and applied in practice.

Present nature situation

Finally, a great deal of information can be derived from the present situation in the Netherlands, from the wildlife areas and fragments of natural areas that still survive today. The occurrence, distribution and numbers of plant and animal species in the Netherlands (given the biogeographical context of Europe) the 'trends' identified and the possible adaptation of species to the practice of cultivation provide information about sturdiness and vulnerability in relation to a variety of changes. Elements of the natural systems are distributed in pieces, as it were, over a wide area. As a result, in the present situation a study on any scale of natural processes and the patterns that result from them is only possible with a few of the Netherlands' characteristic and more dynamic ecosystems. In the coastal area, the Wadden Sea and in a few large 'open-air laboratories', such as the changing Delta area and the Oostvaardersplassen, a wealth of data is being collected about the larger-scale interactions between processes and patterns. With some creative and detective investigation, situations can still occasionally be found where former large-scale processes are (still or once again) underway on a small scale, for example the formation of flood-plain forests in the fluvial area. Furthermore, an increasing amount of information can be derived from a variety of nature management and development experiments (conducted on a smaller scale) about the interaction between processes and patterns.

Building a reference: *puzzling out and putting in order*

(Pre)historical data, universal principles and processes, the present situation and biogeographical data on species all enable an ecological reference of nature in the Netherlands to be outlined. The reference is not 'precisely' placed in time but gives an indication of how nature in the Netherlands might be under the present climatological and biogeographical conditions, if ecosystems were not affected by all kinds of cultivation measures. Building such a reference helps gain a better understanding of the natural systems characteristic of the Netherlands and of their mutual relationships.

It is a question of discovering the interrelationship between essential processes, elements and patterns. Starting from the principle of simplicity that says: 'how can we explain a given phenomenon as simply as possible, in other words making a minimum of assumptions', in building a reference we can identify the control variables, that can be the pretext for planning and managing nature in general and for nature development in particular.

Building a reference is actually a process of putting things in order, like doing a jigsaw puzzle. The pieces of the jigsaw are the various data and bits of information obtained from the different sources. The leitmotif that runs through the jigsaw is the interaction between processes and patterns.

Significance of the ecological reference

When the jigsaw puzzle of the reference is built up out of the various pieces, we can derive information from the whole that could not be obtained from the individual pieces. Using this, it is also possible to clarify the question of how the existing wildlife areas and natural elements should be seen in terms of their ecological relationship. In other words, what ecological position do the various existing natural components and building blocks hold?

By comparing with the present (spatial/ecological) situation, it can then be deduced from this whether any essential components or processes are missing and if so, what measures should be taken within the framework of nature development or nature conservation.
If the changes that have taken place over the course of time are compared with the reference, the effects of the measures, in terms of their relationship, can be determined. Together with the information on processes and components, a model is created that can be used to work towards a more "sustainable" kind of nature in the future.

The ecological reference is therefore not an objective in itself; rather it is a testing framework, against which the present situation can be compared, as well as a kind of standard that can be used as a basis for setting objectives. Where possible and desirable, the ecological reference should be 'stuck to' as closely as possible to ensure that there is a good chance that plant and animal species survive within the context of an ecosystem. We are concerned here with levels of aspiration and not with an 'all or nothing approach'.

Other references

In addition to the ecological reference outlined below, there are, as stated, other current or historical references in use for the preservation of nature and the landscape, in which elements and processes associated with cultivation, such as mowing, cutting peat and grazing 'controlled' by man, play an important part.
For the reasons already mentioned, these references will not be discussed further in this study. It should also be mentioned that, basically, man is not placed outside the ecological reference; instead he occupies a more modest position in it. On the other hand, man will have to play an essential role in bringing objectives nearer on the basis of (elements of) the ecological reference.

Contructing the Ecological Reference

On the basis of the method described above hereafter a description will be given of the Ecological Reference of the Netherlands, starting with the abiotic base on which subsequently the biotic aspects are projected.

Ecological reference: the abiotic base

Undeniably the Netherlands has the character of a delta to a large extent, judging by the description given by Louwe Kooijmans:

'A delta comes into being at the place where two very different landscape-forming systems meet and interact: the river and the sea. When a river flows into the sea (or into a lake), the rate of flow decreases suddenly, together with its ability to transport sand and clay. The river drops its load and in this way a sedimentation area is formed on the coast, around the mouth of the river. The strength of the sea exerts its influence in the form of waves, tides and currents. Sand brought in by the sea can also contribute, as can be the case on every coastline - even where no river flows into the sea. The end result is a more or less triangular tract of land, built up from recent sedimentary deposits, that we call a 'delta' after the Greek capital letter that has the same shape.'

There are two major European rivers that flow into the sea in the Netherlands and provide sediment: the Rhine and the Meuse (Maas). There are also a few smaller rivers, such as the Scheldt and the Eems. The top of a delta is formed by

Probably the only "unspoiled" nature in the Netherlands, Tidal mud flats in the S.W. Delta-area, give an image of what the major part of the Dutch coast must have looked like.
(photo: F.W.M. Vera)

the river splitting into different courses, along which the water is conveyed to the sea or to a lake. In the Netherlands this top is found where the Rhine splits, in the vicinity of Lobith on the border with Germany. Into this Delta the hypothetical journey to construct the Ecological Reference is started.

The coast

Viewed from the sea, the delta begins with a delta front, built up of sandy features, such as bars, beaches and dunes. The relatively high dunes are very young in geological terms. They were created on a complex of old bars and dunes that originally formed a kind of lagoon coastline. As a result of the steady rise in sea level, the shallow lagoons behind the low dunes became so filled up with sediment that tidal-flat areas were created. As a result of the water in this area becoming fresher, after the sea was closed off by higher dunes (or when the sea level temporarily fell) and fresh water drained away from the land, peat areas were then able to form on an extensive scale behind the coastal front.
The higher parts of the dunes are relatively dry, but in lower-lying valleys and hollowed out depressions there are many small dune lakes. Dune streams flow out of the dunes into the peat areas behind. Some dune streams flow directly into the sea.

In a few places the gradually rising sea has broken through the coastal front and has eroded a path through to the peat areas behind. Where no resistance from rivers is encountered, a landscape of tidal flats and salt marshes with lagoon systems is created once again. Seawater flows in and out via a multi-branched system of creeks. The coarsest sediment, sand, is deposited on the bottom of the creeks and directly along the edges. Where the water from the creeks broadens out and loses speed, silt is deposited. Vast new tidal-flat and salt marsh areas were created in this way behind the delta front.

Peat bogs

A vast peat area lies behind the coastal front, bordering on the sheltered tidal-flat and salt marsh areas. The peat area curves round from Zeeland in the south all the way to Groningen in the north, around the higher-lying sandy areas. The thick

layer of peat behind the coastal front owes its existence to the rise in sea level levelling off about 7000 years ago. Since the beginning of the Holocene, around 10,000 years ago, the sea level had risen too rapidly (about 2 metres per century) to allow peat to form continuously. The thin layers of peat were repeatedly washed over by the sea and covered with sediment. Only once the rate at which the sea level rose decreased, could peat formation keep pace with the rise in groundwater behind the delta front. For that reason peat formation could take place on a large scale in the shallow lakes behind the dunes. Peat is in fact a large sponge that holds a tremendous amount of water. The sponge can become saturated though. In the highest areas bog pools are created that periodically escape. A continuous stream of water from the saturated sponge creates bog streams that flow into the tidal-flat areas or into the rivers.

Rivers

Where the rivers flow into the sea, the interaction of flowing river water and saline seawater, with a twice daily tidal flow, creates a brackish and freshwater tidal area. The tidal flow moves upriver up to 60-70 km to the east.

Inland near the Betuwe, the river water rises in periods when a lot of water is carried down, for instance at the end of winter and in the spring, because of the slight gradient of the land there. Unhindered by main dykes, the rivers (including the IJssel) burst their banks and flood a broad plain many kilometres wide. If the water in this inner delta broadens out, it immediately loses so much speed and power that the coarsest sediment, sand, is deposited first. In this way natural levees are formed which extend in strips on both sides of the summer bed from the top of the delta through the peat areas. The water comes over the natural levees and extends out so far that silt is deposited. In this way basins containing river clay are created. When the water level falls, because the supply is reduced, the water retreats into the summer bed via a few meandering and interwoven channels. Stream ridges, formerly riverbeds and their natural levees, are a relatively high-lying feature on the landscape. They came about as a result of the river continuously depositing sand on its bed so that the level of the bed was gradually raised. Although the course of a river is relatively stable from a geological viewpoint, at a certain stage the difference in height with the surroundings can become so great that the river, as it were, 'abandons' its bed and starts a new lower lying course. The former bed and natural levees then remain behind as a (relatively dry) high-lying feature. In the peat areas, beside the natural levees of rivers, we also find these dry 'outcrops' in the form of old river courses, which date back to the time when the peat bog had not yet extended to there.

Higher ground

The rivers are, as it were, directed through the higher neighbouring land in the direction of the peat areas. Areas of higher ground include the Utrecht Hill Ridge, the push moraines and sandy heath area of the Veluwe, the push moraine of Elten and Montferland, the Nijmegen push moraine and the sandy heaths of North Brabant. Higher ground is reputed to be dry. This is also true of the larger push moraine complexes because the groundwater lies deep. In some places, however, there are impermeable layers in the shallow substratum. Water collects there in the form of pools and marshy land, in which small peat bogs sometimes form. Streams fed by seepage water form on the margins of the push moraines and flow into the rivers or subside into the neighbouring peat bogs.

The higher ground of the sandy heath areas in the north has more or less impermeable layers over a large area that were left behind when the glaciers retreated from the Netherlands after the last but one Ice Age. Marshes form in these areas in hollowed out depressions; these give rise to many streams that cut into the

ground. In places where the flow of water ceases and deeper lakes are created, peat areas are formed on a wide scale. More localised impermeable layers are found in the sandy heath areas in the east and south that give rise to comparable situations of marshes and peat bogs. Certainly the sandy heaths in Brabant, Gelderland and Overijssel are extremely varied with alternately dry sandy plateaus in the form of dry round tops and moist to very wet marshy hollows that often have no drainage system of their own. The overall impression is of a large dimpled surface. The marshy hollows gradually fill up and spill over into many lowland streams and a few small rivers such as the Vecht, the Berkel, the Oude IJssel and the Dommel, which burst their banks during the rainy season and flood a considerable area for a short time.

The southern part of Limburg is much higher and hence dry. This came about as a result of the earth's crust very gradually rising and being covered in places during glacial times by fine material borne by the wind (loess). Limestone rock rose to the surface from the substratum. Deep valleys are cut by the Meuse and the Limburg streams in this marl limestone area, a foothill of the Central European limestone region, and in the old fluvial deposits.

Ecological reference: *the biotic components*

The picture outlined above forms, as it were, the substrate with which plants and animals interact. The species that are found depend on what the environment has to offer. Climate, soil, nutrition, water and the dynamics of these determine what plants can live there and what biological production can take place. This also determines to a large extent what animals can live there and in what numbers, dependent on the plant production. On the other hand, plants and animals can themselves greatly influence their environment, for example vegetation that creates landscapes, such as peat bogs and woodlands, or the grazing and burrowing activities of animals. In this way a dynamic pattern is created in which plant and animal species in different biotic communities reflect the variety of the abiotic environment.

A variety of transitions exist between these biotic communities and many species and individuals interchange. Yet there are clear differences between the biotic communities in the coastal area, the dunes, the (peat) marshland, the rivers and on higher ground.

Flood plains of the major riversystems in the Netherlands must have shown an abundance of life, like this flood-plain in modern Venezuela. (photo: F.W.M. Vera)

The coast

The saline and brackish water in the coastal area and in the estuaries is a rich source of food carried down by the rivers. In the tidal-flat area and lagoons a rich soil life can also survive because of the huge amount of food available in the form of algae and organic material. Many fish, birds and mammals benefit from this in their turn. Many species of fish use the shallow coastal waters as a spawning and breeding ground, so that other fish and many bird species and marine mammals, such as the common seal and the grey seal, the porpoise and the dolphin, benefit once again. Where the influence of salt prevails, it is mainly bird species that prefer open ground that are predominant. They often breed in colonies in remote places where there is little chance of being hunted by predators and look for food far out to sea. They include Sandwich terns, common terns, little terns, Arctic terns and black-headed gulls. Sometimes even an osprey will carry food washed up on the beach back to its high nest. The tidal-flat and salt marsh area also provides food for numerous species of birds during the summer and winter months. Particularly during the autumn, hundreds of thousands of waders from northern regions stop to feed. Geese and swans that are staying for the winter also add to the numbers. Large herbivorous mammals, especially the specialised grass eaters such as wild horse (tarpan) and the wild oxe (aurochs), regularly stay on the salt marshes that are situated on the mainland or that can easily be reached at low tide. As a result of their eating habits, short cropped grasses predominate. Geese spending the winter there take advantage of regrowth of the grasses by consuming it as food. Salt marshes in more remote or isolated locations are usually not used by grazing animals. There we find lush vegetation including sea lavender, sea aster, thrift, sea plantain and sea poa, to which many insects are attracted.

Plants such as sand couch-grass, marram grass, sea rocket and sea thistle are found on the sandy beaches and in the sea dunes, where the salt influence and the sea breeze prevail. Further from the coast, poor vegetation is found in the shelter of the dunes, including sea buckthorn, elder, dewberry, burnet and dune pansy, while heather grows in the more lime-deficient dunes. In places where the groundwater comes above ground level, grass of Parnassus, cicendia, numerous species of orchids and reeds are found growing on the edge of lakes in the dunes. Badgers, foxes, hen harriers, Montagu's harriers and red-backed shrikes hunt for prey here. The rabbit, which originates from more southern regions, can have a tremendous influence in the dune area as a result of its grazing and burrowing activities and can even rival the larger grazing animals. In general, however, their numbers are kept down by occasional occuring diseases and by predators.

Large mammals such as red deer, elk, aurochs and tarpan are found especially on the landside edge of the dune. Here grassy plains are bordered by thickets of roses, hawthorn and privet, that protect growing trees such as oak and elm from being eaten by large herbivorous mammals. The ground is rooted up in some places by wild boar. The light soil rich in humus is also a substrate for a profusion of herbal flora, both in the grassy open woodlands (with species such as wild asparagus, hairy violet, hemp agrimony) and on the edge of the thickets (for example hedge violet, Solomon's seal) as well as in the forests (for example bugle, star of Bethlehem, enchanter's nightshade, spring monkshood). The variety in the structure of the vegetation offers many hiding-places for all kinds of songbirds, small mammals and their attackers, such as the goshawk and the pine marten. The brown bear also roams around these parts. Porpoises, bottle nose dolphins, common seals and grey seals can be seen on the seashore.

The brown bear as part of the European ecosystem. Reintroduction is now under serious consideration in several parts of Europe, following the succes of rehabilitation in e.g. the Abruzzo National Parc in Italy. (photo: F.W.M. Vera)

Peat bogs

The peat area behind the coastal dunes is a large area of open landscape with only low vegetation. In some places there is marshy woodland in the peat area with taller vegetation growing such as alders, for instance near open water and alongside bog streams. The open peat bog itself offers a poor supply of food and few animals are found here. Only a few species of birds such as the golden plover breed here. Animals are found more in the area where the peat bog meets the dunes and the great rivers. A mosaic landscape is stretched out here made up of woodlands and scrub, open grassy vegetation, small lakes and marshy woodland. This landscape is rich in plants such as bog orchid, small valerian and marsh lousewort. In areas where the grazing activities of wild cattle and horses turn reed and sedge marshes into wet grassy, natural pastures in places, a natural 'grassland bird community' is also found, with species such as the black-tailed godwit, the ruff, the shoveler, the wood sandpiper, the black stork and the white stork. The common crane also looks for food there with its young. As a result of grazing, the slope from the river natural levee to the peat bog is a profusion of flowers that attract many insects and here the black grouse can be found. Wherever marshy vegetation, such as reeds, willows or black poplars, is found growing in the vicinity of water teeming with fish, we find large colonies of fish-eating birds, such as night heron, grey heron, purple heron, great white egret, little egret, squacco heron, bittern, spoonbill, glossy ibis, pelican and cormorant. The white-tailed eagle and the osprey breed in isolated places.

Rivers

In the fluvial area the dynamics of the water are an important determining factor in plant growth. Where water only collects occasionally in winter, oak, elm, ash, hawthorn and sloe can survive along with a rich vegetation of grasses and herbs (for example star of Bethlehem, wood hyacinth). Wherever water collects only once every few years until the summer, i.e. until the growing season, only willows and black poplars survive.

The natural levees along the great rivers are indeed dominated by the silhouettes of oaks, elms, ashes, willows and black poplars, but there are also quite a few stretches with grasses and herbs that partly owe their existence to the grazing activities of aurochs and tarpans and to the pruning activities of red deer, elk and roe deer. These large herbivores use the natural levees, sometimes several kilometres in width, as an access route to this paradise, where plenty of lush juicy foliage can still be found during the dry summer season when the plants on higher dryer ground are getting old, tough and difficult to digest. The large herbivores also attract their predators, the wolf and the lynx. Elk venture from the natural levees into the ponds, where they can also feast on submerged water plants. The elk is almost as much at home in the water as the busy beaver. The wild boar roots around in the mud looking for the nutritious tubers of rushes and reeds.

The ponds vary a great deal in appearance due to the river periodically flooding. They form extensive chains of pools, in various stages of drying up, with vast fields of marsh vegetation such as reeds, reed mace and marsh endive. Thick marshy woodland also grows around the edges. This type of terrain is an outstanding breeding ground for fish-eating gregarious birds and a habitat for a variety of waders.
Besides large herbivorous mammals, smaller species also move along the line of groves that can be relatively narrow especially in the peat area. Examples of these species include the fox and the Mustelids, such as the polecat and the pine marten.

Higher ground

On the higher ground of the dry push moraine complexes, vast forests grow. The most important species of trees found here are the common oak, durmast oak, lime, elm, beech and hornbeam. The trees have very different classes of life span. A lot of dead wood is found in the forest at various stages of decomposition. Many plant and animal species take advantage of this wood, for example the larvae of large beetles, such as the stag beetle, that live off dead oak. In places there are large open spaces in the forest that mainly come about as a result of storms and forest fires. On a smaller scale open spaces are also created by the natural death of trees and by the activities of large herbivores such as elk, red deer and European bison, especially around the scarce drinking places on the push moraines. In some places the grazing activities of the large herbivores preserve the grassy open spaces for a long period of time. The burrowing and rooting activities of, particularly, wild boar also contribute. In general, the growth of plants on the poor dry ground is fairly low in comparison with the neighbouring fluvial areas, for example. Heather even grows here and there in the driest places. As a result, the population density of (large) herbivores is also low in general.

More food is to be found in the transition areas between the dry push moraines and the river and peat areas, and also alongside the streams that originate in the seepage areas on the margins. The landscape there has much more of a mosaic character of woodland, scrub and open grassy spaces that are affected by the grazing activities of the large herbivores. Aurochs and horses also feel more at home here than in the more enclosed woodland on the push moraines. As a result there is a varying structure of plants with a lot of border and groundcover vegetation of which many insects and hence insect-eaters take advantage. The trees themselves can withstand any damage caused by the herbivores. They all form new shoots after being grazed on. Consequently they can eventually grow beyond the reach of these herbivores to a large extent. Expansion (and hence the density) of the mosaic woodland is limited by the herbivores as it is virtually only the saplings of trees growing between inedible or prickly bushes that get the chance to grow into trees. Only in the event of intense grazing does this mechanism of 'bush encroachment' fail to work too and the forest cannot be regenerated. But on the other hand, disasters, such as a succession of hard winters or disease among the large grazing animals, can limit the number of grazing animals for years. The trees can then, as it were, escape from the 'grip' of the herbivores so that a more enclosed woodland can develop.

The dryer parts of the sandy heath areas in Gelderland, Brabant, Overijssel and Drenthe attract similar plant and animal species to the push moraines. More enclosed woodland is found on the dry sandy tops and plateaus, while approaching the many moist hollows, streams and small rivers, the mosaic patterns are more predominant. One major difference from the push moraines is the presence of water. The marshes and marshy woodland, that are found in the poorly drai-

ned hollows, offer many more plant and animal species sanctuary. Pools, fringed with dense thickets of brambles and yellow iris are the home of the tree frog. The many streams and small rivers are subject to flooding and also periodically dry up; the dynamics of such a system can be compared with that of the great rivers. Groves of oak, ash, elm and alder line the usually dry edges of the streams. Plants such as oxlip, moschatel, oxalis and multibloomed Salomon's seal grow on the banks of the streams and in the woods lining the streams. Beavers, otters, kingfishers, grey wagtails, brook lamprey and crayfish live in or near the streams. In these areas, in contrast to the low-lying areas in the west and north, beavers, especially, add their own dynamics to the system in that they often have to actively conserve water by building dams. As a result of these activities water collects over large areas (or suddenly drains away if something goes wrong!).
The vast peat areas and small peat bogs that are found in the sandy heath areas are comparable with the peat areas in the west and north in terms of plant and animal life, although they were created in a different way. On the margins, the remains of marshes with reeds and willows can still be seen, where the peat bogs originated.

In the transition area between the dry sandy plateaus and the flood valleys and marshes that are richer in plant nutrients, large numbers of plant species grow in grassy vegetation, such as bistort, marsh cinquefoil, great burnet and meadow saxifrage. The vegetation is also kept open by large herbivores that venture in summer from higher ground and from river valleys into the flood valleys and up to the edges of the marshes when these are somewhat drier. The routes chosen are relatively narrow between areas that are different in character, the so-called gradients. The gradients are not autonomous; instead they are dependent on the two systems that border one other. They form in effect the joints that link the various systems. These situations are vital for many specialised plant and animal species, especially for insect species such as butterflies and for songbirds that are dependent on structures.
Areas with most gradients are located near the edges of higher ground where there is a high density of transition areas within a short distance. Examples are places in Drenthe, Twente and North Brabant where many streams, marshes and higher areas are found on a relatively small scale, the northern edge of the Veluwe and areas east of the Utrecht Hill Ridge, where seepage water emerges, and areas in Northwest Overijssel where the sand comes in contact with great rivers such as the IJssel and the Vecht.

Ecological reference: *biogeography and the international scene*

As a predominantly delta area, the Netherlands is no island or remote corner of Northwest Europe. It is a major crossroads on international bird migration routes, a breeding place, a winter home, a 'filling station' and a place to rest for numerous species of birds. Various parts of the delta fulfil an important function as spawning ground and 'nursery' for many marine species in the North Sea. On land the (major) rivers are the living connection with a large part of Western Europe. Numerous plant and animal species in the Netherlands can be found all over the European lowlands. Large mammals such as elk, red deer, aurochs, tarpan, European bison and wild boar as well as bears and wolves are to be found and sometimes migrate over large distances through this area. Only natural borders and barriers, such as mountains and rivers, limit the spread and distribution of species within the mainly climatologically determined distribution areas.
The Netherlands has a maritime climate. In comparison with the rest of the European mainland, this means relatively mild winters with relatively little snow. For many animal species winter is a 'bottleneck' where food is concerned

and for them the Netherlands is a place of escape. The relatively favourable overwintering conditions benefit the herbivores especially. In the Netherlands plants continue to grow well into the winter. This means that the season is long in terms of the comparatively favourable feeding conditions. As a result, over a long period animals can build up their reserves or use up comparatively little of these reserves. In this sense the Netherlands is a good place for herbivores. This is true for both large mammals and birds. In particular, herbivorous birds such as geese and ducks from northern regions take advantage of it, as do large mammals from the east and south. Birds that seek their food in the water also benefit from the geographical location of the Netherlands. The many waterways contain a lot of food and freeze over comparatively little. Deeper, flowing brackish and saline water remain almost always open and hence offer a good chance of making it through the winter unscathed.

Graylag geese use the river ponds and marshes for breeding and moulding. The adjacing flood plains provide plenty of food almost all year round.
(photo Vincet Wigbels)

Present situation: *an initial confrontation*

The ecological reference broadly outlined above has little in common with the present reality. It can also be said that the picture of the Netherlands 'without cultivation measures' and without adjustments for climatological fluctuations and changes is inaccurate since without man-made protection against the sea, the Netherlands would be about half as small as it is now. The coastline would be located somewhere in the middle, a situation resembling the one that arose around 70,000 years ago between the last two ice ages. During that interglacial era (the Eemien), what was known as the Eem Sea extended as far as the Veluwe in the central part of the Netherlands. However, the precise location of the coastline and whether the growth of the peat bog behind the coastal front would have kept pace with the rise in sea level (without being drained by man!) is not of vital importance for using the reference. The various partial systems with interactions between processes and patterns will always exist; the precise location is of minor significance.

Many plant and animal species that might have been expected on biogeographical grounds, throughout the European lowlands, are now only found in scattered areas or in remote locations. Examples have already been mentioned. The fact that they are found in these remote locations is not due to sudden climatic changes that lead them to withdraw from certain areas. The reason is the large-scale and intensive practice of cultivation and the fragmentation of the ecological structure. Sometimes other factors were also involved: species were wiped out by hunting them down, removing their nests or destroying their habitats. The present scattered distribution should not therefore be treated as a static fact. In principle, animals can still migrate over large distances or, if man-made barriers prevent this, they can be shifted by man. In this way vital living elements can be added to systems again in order to set ecological processes in motion once more. Many plant species also find themselves in relict situations from which they are (virtually) unable to escape. They no longer reach potentially suitable growing places, with the result that in the most favourable case they grow for all of their days only in such a relict situation. It is much more likely, however, that they will come to extinction as a result of isolation in an area that is too small.

This means that an open attitude regarding the (re)introduction of plant and animal species into existing situations or introduction into new situations is advisable, if species cannot be expected to get established spontaneously from the relict population. Special attention will have to be given to species that are of great functional importance in ecosystems since they set or keep processes in motion. As this chapter has revealed, species should not be considered in isolation, but rather they should be seen within the context of the ecosystem of which they are a part; in other words a system approach.

A sattelite photograph of the S.W. part of the Netherlands shows the scattered and fragmented situation of the Dutch landscape.
(photo National Aeronautics and Space Laboratory)

4 System approach

Processes, patterns and species

Coherence

Nature forms a coherent whole comprising all sorts of factors that constantly interact via a complicated network of interrelationships. These factors include both living organisms and dead matter, physical, chemical and biological processes. For example, the soil and the water as a substrate for life and the dynamics of processes in the atmosphere, soil, ground water and surface water, giving opportunities but also setting limits.

The living organisms range from invisible bacteria and moulds that break down dead woodland giants, to large mammals such as the European bison that can push over a small tree to reach the green leaves at the top. The complex of dead and living factors, the relationships and the processes are referred to as an ecosystem.

As stated, knowledge about the ecosystems of the Netherlands, as revealed in the ecological reference, is based on data about (pre)historic development, universal principles and processes, the present nature situation in the country and the biogeographical surroundings. The data about the biogeography (distribution) of species concerns not only the species that are still found in the Netherlands now, but also species that have very recently returned (or are on the way) to places from which they had disappeared over the centuries as a result of human intervention. Examples include the great white egret which, after an absence of over a century, is breeding again in the Netherlands; the osprey, which has colonised Scotland from Sweden and Norway; the golden eagle, which is gradually venturing out from its hiding places in the mountains back to the plain and has settled in the Black Forest in West Germany and in the forests of Poland; the black stork, which is regaining hundreds of kilometers of breeding ground in Western Europe that were lost in Eastern Europe. The elk and the wolf, which are also drifting from east to west, are included too. However, their attempts to expand their habitat westwards still have to be paid for with their lives.

The cause of this kind of expansion is usually a large growth in population as a result of protective measures being implemented in places where these species are still found as relicts. If suitable living conditions are re-established in regions where they were once found, this also contributes to (the success of) expansion. The latter factor lead to the great white egret migrating from the Neusiedler Sea on the border between Austria and Hungary or from breeding grounds even further to the east and settling in the 20-year old wildlife area of the Oostvaardersplassen, some 1500 kilometres away.

The black stork is slowly regaining ground in Western Europe. Development of riverine forests along the major rivers in the Netherlands wil contribute to this ecological restoration. (photo Jesus Gazzou)

Processes and elements

Ecosystems are regarded as the highest level of aggregation of flora, fauna, climate and substrate. They are the framework within which species are traditionally found and in which they have evolved. As already mentioned, ecosystems should be regarded as 'complicated cogwheels'. Every plant and animal species occupies its ecological place in space, in time and in processes, its so-called 'niche'. In complete ecosystems all of the cogs of the machinery are present and the whole system runs on solar energy without any extra energy input from outside.

All sorts of processes manifest themselves in ecosystems. The result is a variety of patterns. The processes vary in intensity, tempo and sometimes also location. As a result, patterns vary in time and space. Ecosystems are complicated but this does not mean that they are incomprehensible. Research has given us a better understanding of how they function.

Feeding strategies of larger herbivors determine their effects on ecosystems, the patterns formed, and the way they facilitate for other species.
(graph from v.d. Veen and v. Wieren)

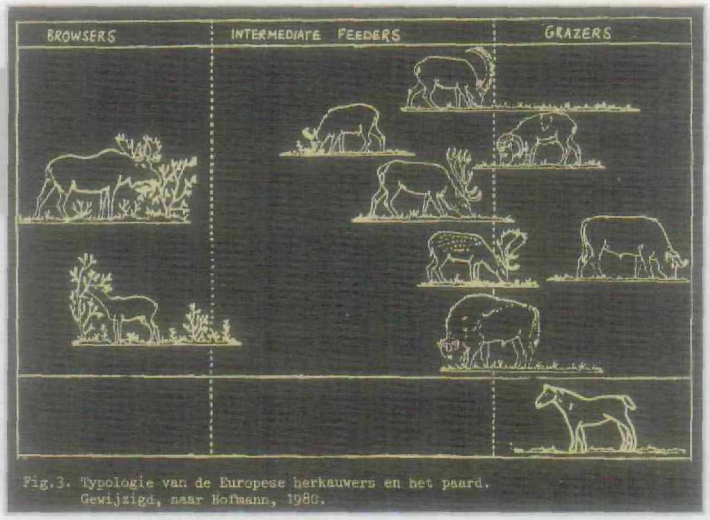


Fig.3. Typologie van de Europese herkauwers en het paard.
Gewijzigd, naar Hofmann, 1980.

Essentials and side-issues

It has emerged that not all elements or processes are equivalent. Some processes, such as the tides, erosion and sedimentation as a result of periodic flooding, appear to be very dominant, as do factors such as trophic level, degree of salinity and acidity and the presence or absence of certain groups of organisms. Bacteria and moulds are a very dominant group in terms of their effect on their environment. They cause dead organic material to decompose and in so doing they close the natural cycle of life and death by bringing it back round to life. They do this by breaking down the dead organic material into particles that can be assimilated again by plants. Insects form a very important link in the land ecosystems. This very diverse group is vital for pollinating many plant species. Furthermore, they are responsible for the decomposition of plant and animal material to a large extent. They also form the staple food for many animal species.

Another conspicuous group that exerts a tremendous influence on their environment in numerous situations are the large herbivorous mammals. As a result of their eating habits, they shape vegetation into particular patterns from open to closed and from low to high. Each species, with its own particular food preference, has a specific effect on the vegetation. Species that co-exist by nature have developed a food preference such that they do not have to compete with one another, especially in times of scarcity when there is scarcely any or no growth,

as in the winter. This certainly applies among the large species. This difference can be traced back to differences in digestive systems. With regard to the relationship between the large and small herbivores, it is usually the case that the large herbivores consume poorer quality food. They eat the fully grown vegetation. The smaller herbivores come along after the larger herbivores have cleared up and take advantage of any young plants that are to be found or any new growth that has appeared.

One group of animals that have an indirect effect on the vegetation are the large predators that live off large herbivores. The predators keep the herbivores on the move within their habitat so that grazing is constantly shifting over a certain range. To a certain extent the predators can also limit the numbers of herbivores. Man also belongs to the ecosystem of course, as a hunter, gatherer and scavenger. Admittedly, from an ecological point of view, man is omnivorous but can be counted as one of the major predators as regards his choice of prey.

Harsh winters, especially when followed by cold springs can have a major impact on the ecosystem, e.g. by killing a vast number of large herbivores. (photo: F.W.M. Vera)

Dynamics of species and systems

Changes not only occur in abiotic conditions, as indicated earlier. Plant and animal life is also subject to change. This has already been examined in discussing the distribution of species in Europe, though these changes, in the form of the decline and disappearance of species, were chiefly caused by human intervention. It is also in the nature of species to move to a different place. The breeding places of birds may be washed away by water so that they have to move elsewhere. Species such as terns need very dynamic conditions, such as shell and sandy beaches. Marsh inhabitants too, such as the spoonbill, the night heron and the cormorant, are renowned for moving about. Species from more stable environments, such as woodlands, tend to stay in one place more but may also be forced to move at a certain point if a wood is blown down or dies.

A succession of cold springs and summers can adversely affect the reproductive cycle for years. With spoonbills, for instance, it can happen that they raise no or very few young for several years. In view of the life span of many species, such as the spoonbill, a few unsuccessful breeding seasons is not fatal to the survival of the species.

Species have adapted to the conditions under which they evolved. This is also true in the case of plant species. The survival of some plant species even depends on disasters, such as floods and fires, that result in the disappearance of entire areas of vegetation. Disasters of this type, as well as hard winters followed by cold springs that result in delayed or minimal plant growth, can be a real blow to

populations of herbivores, including the large species. The drop in numbers can be so great that the remaining animals are unable to keep pace with plant growth in the way the previous population could. The vegetation escapes from the grip of the herbivores and grows sky high. Trees that have been cropped by the constant pruning activities of the herbivores can therefore develop and grow.
The trees are subsequently less susceptible to damage. Even small herbivores such as caterpillars can suddenly increase in numbers to plague proportions as a result of a sequence of certain circumstances and this has an effect that can rival the impact of large herbivores. A plague of this kind can even lead to a temporary drop in the number of large herbivores, as a result of the rivalry.
To a certain extent, major and minor disasters are a normal phenomenon in nature and result in an ecosystem constantly being put back to an earlier development stage. This results in cyclical processes that ensure that a variety of plant and animal species can survive, albeit always in different places viewed over a period of time. Some systems go through the cycle in a very short time, so that very different conditions prevail in a particular place in successive years. Some examples of this are major rivers and a variety of tidal areas. These systems are called 'dynamic'. In other systems a cycle lasts centuries, so that, from year to year, the conditions sometimes change very little. Systems like this are called 'stable'. Examples include woodlands where it takes tens to hundreds of years for trees to build up and then decompose (for example when trees die). If short or long-term cycles no longer occur in systems, they degenerate without there being any build-up from an earlier stage.

Species-area relationship

Islands theory

It is a rule of thumb that if a habitat decreases in area, this leads to the disappearance of plant and animal species. The number of species that disappear or survive not only depends on the area that remains, however, but also on how isolated that area is from other wildlife areas. The link between the size of a wildlife area and the number of plant and animal species that are found there is called the species-area relationship. Briefly, what this means is that the larger an area, the more species are found and vice versa. This rule is universal although there are of course large differences in numbers of species per unit area when different types of ecosystems are compared (compare tropical rain forest and tundra).
In principle, wildlife areas in the Netherlands are no longer cleared. Does this now mean that the plant and animal species now present there will also survive there in the future? Unfortunately this is unlikely to happen.

Besides the loss of acreage and deterioration in environmental conditions, the isolation of the remaining wildlife areas from one another is also important in relation to what can survive in nature reserves. Isolation occurs as a result of the surrounding agricultural land being used more and more intensively and also being developed for this purpose. This means that plant and animal species are losing more and more ground. They are being completely pushed back to increasingly isolated fragments of wildlife areas. These wildlife areas are becoming more and more like islands in a sea of cultivated land. Besides being isolated, the area also decreases in size as a result. This has far-reaching consequences according to the so-called islands theory. It follows from this theory, which is based on research conducted on real islands that can also be applied on land on the

basis of the analogy of 'nature islands' in cultivated land, that even if the size of a wildlife area does not decrease any further, the number of species in this wildlife area will continue to fall. The decrease can be attributed to the fact that these 'nature islands' are still young. The number of species that can still be found there is actually partly based on the situation that prevailed when the wildlife area was much larger. The numbers have not yet reached equilibrium with the much smaller area that is now available. In other words, species are still disappearing.

Settlement theory

The idea that the islands theory puts forward is explained by the differences in dispersal capacity of species. These differences have been studied on birds and beetles. Even the dispersal capacity of many migratory birds is proved to be poor. Admittedly, they migrate over large distances every year between their breeding place and their winter home, but they do appear to have a certain loyalty to a particular place when it comes to choosing a breeding site. For some species, this is often no more than a few kilometres from where they themselves were raised. The so-called settlement theory is based on this difference in dispersal capacity. In particular, species that are part of stable ecosystems, i.e. ecosystems that over time have changed little from their original state, often have poor dispersal capacity. If, as a result of loss of acreage in conjunction with isolation, they find themselves in an island situation, the chances are high that they will become extinct there once and for all if the conditions change. Any local population can die out as a result of all kinds of arbitrary incidents. Hence species can only survive in the long term in a particular place in smaller areas if they are regularly recolonised from other strong and healthy populations. In island situations this can only happen if species are good dispersers. The result is that, through the process of local extinction, species that have a poor dispersal capacity are lost from systems in the long run.

This means that, if stable environments (old woodlands for instance) are reduced to islands within a cultivated area, those species that are adapted to stable conditions will become extinct there once and for all. Only the species that have a good dispersal capacity and that only account for a fraction of the original species found there, will remain. In their turn species that disperse well will eventually find themselves in a situation where few changes occur in the long term and will evolve into species with poor distribution ability. If conditions then change, they too will die out locally. So far this has been established for a few species of ground beetle but may also apply for other organisms. This would mean that all kinds of plant and animal species in isolated situations run the risk of becoming extinct in the long run. For species from stable environments in particular, that have always had poor dispersal capacity, it is therefore essential to reduce the risk of them dying out by expanding wildlife areas and/or linking them to one another. These links can only really be effective if they have a certain stability themselves. Not only species from stable environments are under threat from shrinking habitats; this is also true of a few species that distribute well. Due to the fact that over large areas natural dynamics no longer function, suitable conditions for settlement and reproduction are becoming increasingly scarce.

A few guidelines

In view of the above, a certain degree of internal dynamics within stable situations is needed to keep the species from stable environments 'on the move' and to prevent their limited distribution ability from declining further. Internal dynamics exist under natural conditions in the form of local disasters, such as forest fires and storms, and in the form of biotic dynamics, such as grazing, plagues and predators.

To ensure the survival of species that disperse well, a certain degree of external dynamics is also needed that results in constantly changing conditions. External dynamics are most in evidence in boundary situations, so-called gradients. These gradients function in effect as a kind of capture area for species that disperse well. The boundary areas should, as far as possible, resemble the transition areas between original systems, the gradients, that form the joints that link systems together.

Nature within the context of an ecosystem

To enable nature to function within the context of an ecosystem, it is therefore vital that distribution processes in and between wildlife areas are allowed to proceed as much as possible without being disturbed. This will not be possible in by far the majority of cases but wherever opportunities arise within the limiting conditions of this day and age, an attempt must be made to develop ecosystems based as far as possible on natural processes. The processes involved must be derived from an ecological reference. This reference can indicate which biotic and abiotic components of the systems are responsible for which processes.

Many of these components have been lost from the systems over the course of time. Some can be added again within the scope of nature development. The components relate to surface area, areas that have an essential function in the system, abiotic processes and plant and animal species that are involved in essential processes. Situations that should be regarded as an artefact in that the system has 'gone awry' as a result of the absence of essential elements, will have to be transformed by nature development measures. Conditions will have to be created once more to ensure that the ecosystem concerned develops as naturally and completely as possible.

5 Spatial ecological structure

Core areas, corridors and ecologiocal networks

Present ecological (infra)structure

The spatial structure that encompasses nature in the Netherlands at the moment did not primarily come about on the basis of consciously fixed ecological starting points. To a large extent it is a legacy of what the combination of changes in land use, including clearance and use of wasteland, has left over in terms of space for nature. Ecological considerations initially played very little part in the decision process. What mattered was the systematic (or otherwise) expansion and improvement of the space for functions related to production.

One feature of most of the present wildlife areas and woodlands in the Netherlands is therefore that the land in question was the least important in agricultural terms due to the fact that its potential productivity was too low or that clearance was too difficult due to natural conditions. This has determined the location and size of wildlife areas to a large extent. Another determining factor was the extent to which nature conservation bodies were in a position to acquire areas and establish nature reserves, before they were next in line for clearance.

Seen from the air the seemingly continuous forest area of the Veluwe of some 20.000 ha. in the center of the Netherlands is a fragmented cultural landscape.
(photo: F.W.M. Vera)

All these efforts could not prevent the fact that the spatial structure of nature in the Netherlands is highly fragmented, that all kinds of ecological, hydrological and biogeographical relationships have been severed and that many wildlife areas are (or have become) too small. Many wildlife areas were in recent times a part of much larger units (recent means within a period of tens to hundreds of years) and only very recently have had to proceed as smaller independent units. It may be assumed that, despite a variety of specific countermeasures in nature management, a number of these areas are still experiencing a time-lag effect, in that plant and animal species are being lost without there being any further decrease in surface area. This effect is further intensified due to the fact that the links between similar wildlife areas have been severed, so that distribution and exchange has become very difficult if not impossible for many species.

Required ecological structure

Using the building blocks mentioned in previous chapters, it is possible to outline a framework to develop the required spatial ecological structure. This structure will have to meet a number of requirements:

- Its form will have to be such that the characteristic ecosystems of the Netherlands occupy a clear place within it and such that the associated plant and animal species will have sustainable survival.

- The structure must be spatially 'stable' to a considerable extent in order to give a variety of natural developments the space and time they require. In addition, it is advisable that the structure be as independent as possible of developments in other social sectors (and of fluctuations in the economy as a whole). A certain amount of sturdiness on the 'outside', to be able to withstand external influences, may be important for preserving more vulnerable elements on the 'inside'. On the other hand, a certain amount of flexibility is also required to follow up any opportunities in practice and to be able to respond to any future changes, for example by working with other functions such as water management, forestry, water collection and extensive recreation.
- Finally, the spatial structure will have to link up with nature areas across national borders where possible.

Core areas

In the spatial structure for nature, larger interconnected units are needed in any case as suitable areas (habitats) of a sufficient size for a (large) number of plant and animal species, and preferably for a 'complete' biotic community, in which every food supply strategy (from primary producers to chief predators) can be satisfied. Provided that the right conditions prevail, populations of the majority of the species in the biotic community can 'permanently' hold their own in these large areas and can also 'stock up' smaller areas with species.

These large areas can be regarded as so-called 'ecological core areas' for nature. In a certain sense, the core areas have to be the linchpin for the long-term survival of plant and animal species. If they are to fulfil this function properly, then there should be a perspective for sustainable survival. This means that other functions must not interfere, and certainly not those functions that lead to the disappearance of plant and animal species. If functions are drastically segregated, it becomes possible in a number of core areas to develop ecosystems that are as complete and self-regulating as possible in comparison with the ecological reference for that particular area.

A few of the largest wildlife areas are first considered as starting point for the ecological core areas. Populations there run the least risk of becoming extinct. These core areas, because of their scale, can also be used as reservoirs from which smaller wildlife areas can be supplied with plant and animal species.

In the present situation, by no means all of the large wildlife areas provide the opportunity to allow 'systems that are as complete and self-regulating as possible' to develop. External management of all areas is essential and in some large wildlife areas man will have to continue to play an important role as manager of nature internally as well.

In other areas a compromise form of management will emerge, either because the practical circumstances set limits or because a particular type of management is purposely chosen.

In addition, in many large wildlife areas other social functions take place that play an important role, such as forestry, water collection and recreation. These functions often limit the possibilities of developing these areas as 'ecological core areas'. These areas can, nevertheless, function as a core area, albeit not for a complete biotic community, but for a large number of plant and animal species. The same is true for a few large multifunctional areas, such as large landscape units, and a number of large waterways, that can function, for example, as a core area for specific species. These areas (and others) can be further developed as core areas for a wider range of species, if this option is chosen and if opportunities arise in the future.

Besides core areas there are smaller wildlife areas that can be regarded as derivatives of the ecosystems in the core areas. These smaller areas are not large enough

in themselves to contain complete systems in which every food supply strategy (trophic level) can be satisfied in a sustainable way. These smaller areas can contain important 'subsidiary' populations and can play an important role as larger 'stepping-stones' between core areas. Reciprocal exchange of species between the core areas and these smaller areas broadens the base for the survival of similar species.

Ecological corridors

Similar areas must be linked with one another as far as possible and if desirable. In some cases this can be done by making two areas into one large area with the intervening agricultural land undergoing nature development.

In other cases it can come about by developing ecological corridors, passages or stepping-stones between the (core) areas. Depending on the 'space' that is available, these linking structures can enable the distribution, migration and exchange of species. On the one hand, the aim is for plant and animal species to actually be able to reach suitable areas; on the other hand, it is important that migration patterns (season, day-night) remain intact and that the necessary exchange between (sub-)populations can take place. It is inevitable that the linking structures have a certain 'filtering effect' since all the requirements set by every species in a biotic community can only partly be met. Moreover, the requirements can sometimes conflict with one another.

Furthermore, some combinations of functions may also be advisable and/or necessary with the linking structures. This means that when designing and developing ecological corridors, choices have to be made in advance, based on a reference approach for example, with regard to (what) functions the corridor has to have for what plant and animal species.

Finally, it is important to remember that the corridors must not simply link 'everything with everything', and that isolation (permanent or seasonal) is sometimes an essential factor.

Ecological network

The core areas, the smaller areas and the linking structures together form an ecological network for the Netherlands. The network is built up of (and between) the different ecosystems that emerge from the ecological references. This 'national network' will have to cross national borders to ensure links with the nature and wildlife areas in neighbouring countries. Thus the 'national ecological network' can be one of the starting points for an eventual European Ecological Network', that should preferably be developed from several starting points simultanuously.

Using the national network, links can also be formed with smaller wildlife areas and natural elements. These can function as a kind of 'regional network' so that the man-made landscape can be criss-crossed by a more intricate pattern of links. Spatial stability is also important for these 'regional networks' or links; however, due to the fact that these structures will have to rely more on other (production) functions in rural areas, stability will not be as great as in the national network. Within the fabric of the networks the more dynamic practical functions, such as agriculture, can develop within the limiting conditions governing these functions (environment, space).

Assuming no specific nature requirements are set or any limitations for nature agreed, the ecological values in the (agricultural) cultivated land will be derived from the practical functions. In contrast with nature in the large and small areas of the network, these ecological values will be much less stable and will fluctuate with the development and dynamics of the practical functions. In the case of

species that can fit in with agricultural activities, agriculture can play an important role in preserving populations, for example certain species of grassland birds (meadow-birds) and geese. For these groups of species, it can be considered that cultivated land supports, and complements, the nature in the networks. In addition to, for example, grassland birds, geese and ditch vegetation in the agricultural area, ribbon-shaped elements in the landscape are also included here, such as railway and wayside verges and parts of the wet or 'blue' infrastructure. These elements are not only important for species that can tolerate the practice of cultivation; they can also function as ecological corridors for other species.

A modern form of joint use for nature are the so-called helophyte filters, large marshes that can be created as a purification filter for water treatment. Strips of vegetation planted to act as a noise barrier can also have a joint practical function for nature. In this way activities in other sectors, for example within the framework of the Randstad Green Network, the Green Metropolis in the West and in recreation areas, offer many starting points and possibilities for intensifying the practice of joint use for nature by means of nature development.

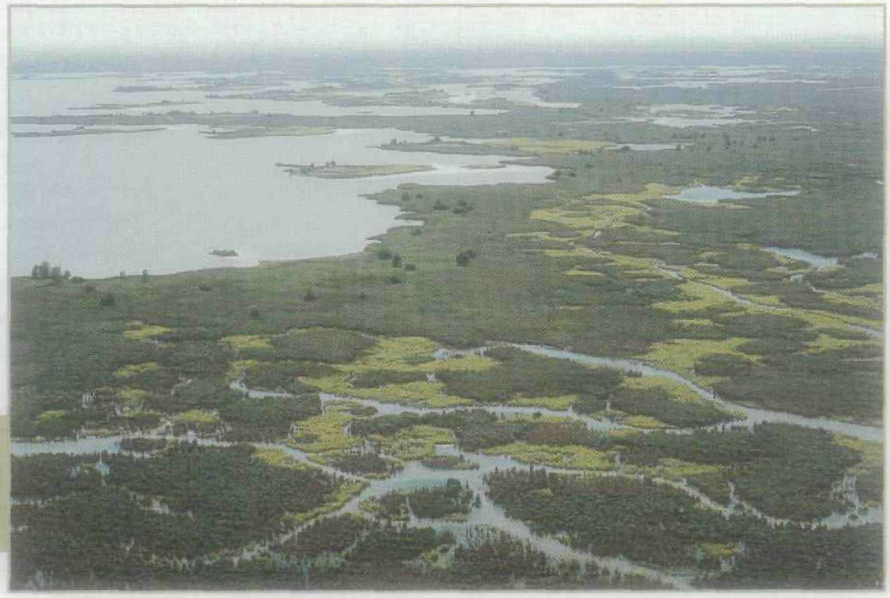
National Ecological Network

Not all of the components of the ecosystems that emerged from the ecological reference described above can be involved in developing and elaborating the network idea. It is a question of making responsible choices in which many factors including necessity, desirability and feasibility will have to be involved.

To help make the choices, a number of building blocks are provided here based on the ecological reference described. Some principles are outlined for a possible method of working and implementation. Using these building blocks the National Ecological Network mentioned above can be constructed.

An important question here will concern in what types of ecosystems/biotic communities, under the present conditions, the functional processes can still be restored and strengthed, in order to be able to develop ecosystems that are as complete and self-regulating as possible. There is also the question of how smaller wildlife areas and elements derived from these systems can be strengthened and developed.

On the basis of this, in setting up the Network, it is particularly important to know which ecosystems are regarded as being representative for the Netherlands and which should be given priority, in view of their international and national importance, in the policy on nature conservation and nature development.



The Oostvaardersplassen nature development area has become a major core-area in the ecological network (under construction) of the Netherlands.
(photo: F.W.M. Vera)

6 Possibilities for nature development in the network

Broad classification

On the basis of the method of working followed here, as developed from the ecological reference, the system approach and the (concept) ecological network, the following (very broad) classification into ecological areas for the Netherlands can be made in order to explore the possibilities for nature development:

- the marine and estuarine area, including the Wadden Sea, the Eems-Dollard estuary, the North Sea coastal area, the Voordelta and parts of the Delta (the East and West Scheldt, Grevelingen);
- the dune area, from the Wadden Islands to the Belgian border, with the associated interior dune woodlands, lakes and marshes;
- the freshwater (marshy) area, from the Lauwersmeer via the Frisian lakes area, Wieden/Weerribben, the IJsselmeer (including Oostvaardersplassen, Randmeren, Naardermeer), the Utrecht/South Holland lakes and peat area together with the connecting North Holland wetlands down to the 'rearside' of the Delta;
- the fluvial area, from the top of the Netherlands' Delta near the eastern and southern border to the IJsselmeer and the Zealand-Delta, respectively, together with the connecting stream drainage basins of the higher-lying parts of the South and East of the Netherlands;
- the sandy area (with drainage valley basins of streams, remnants of high-lying peatland) of the Drenthe Plateau, the province of Overijssel, the Veluwe, the Utrecht Hill Ridge and the Brabant sandy areas.

The area around Winterswijk in the east, the South Limburg hills and other transition areas on the 'margins' of the Netherlands, such as Zeeland Flanders and the Brabant Kempen, have such distinct characteristics that each requires its own regional management. In addition to being linking points with the neighbouring countries of the Netherlands, most of these areas can be regarded as 'off-shoots' of ecosystems, the cores of which are located beyond the national borders of the Netherlands. These areas are ecologically important precisely because many species reach the limits of their distribution in these 'off-shoots'.
The many original gradients potentially offer a variety of local and regional development possibilities. A spatial structure for the biotic communities and species indigenous to an area will have to be found, chiefly through regional reinforcement of the ecological and spatial relationships across national borders.

Elaboration

Further elaboration of the ideas set down here will be required at regional level in order to be able to work with the policy in practice. At that level the heterogeneity within the different ecological areas stands out well and characteristic regional and local conditions can be included in policy formulation.

In the elaboration process, clear relationships in an ecological sense should also be specified between the different ecological areas and the 'marginal areas'. For example, if we consider woodland ecosystems (combined with stream systems), relationships can be strengthened between the plateau woodland and the semi-natural woodland on chalk soils in South Limburg, via the areas along the banks

of streams, down to possible woodland lining riverbanks in the Meuse valley. In this way a more complete relationship is also established between the stream systems and the river system of the Meuse.

Limitation

The nature development possibilities per ecological area can be explored now. Some brief comments should first be made, however. Before we can talk about a real possibility for nature development, three hurdles first have to be overcome:

- the abiotic possibility: the support system must have the conditions (or it must be possible to create the conditions), on the basis of which the desired biotic possibility can be put into practice.
- the biotic possibility: based on the ecological situation and the knowledge and insight gained, there must be a clear chance for the desired nature development.
- the social possibility: the potential chance for nature development must appear to be feasible in the social process of considering the interests involved.

Note: In the original publication in Dutch the development possibilities for the above mentioned ecological areas in the Netherlands are explored in some detail. Because these explorations are very specific for the Dutch situation these have been omitted in this English version.

Starting situation and chances

Starting situation

The development possibilities for the ecological network are largely dependent on the general spatial and physical starting situation. The protection, improvement and further development of the abiotic starting situation and the limitation and control of external influences will therefore continue to be essential objectives of the nature policy, not only to protect existing ecological values, but also with an eye to the development possibilities. How essential, desirable and possible it is to achieve these objectives differs from system to system, as does the level at which this should occur.

The requirements that have to be met to ensure that ecosystems will have sustainable survival, can be derived from the ecological reference and from knowledge and theories about how ecosystems, and the plant and animal species they contain, function. In a more general sense, abiotic requirements are involved here i.e. spatial, such as surface area and links, environmental, such as quality of soil, water and air and the availability (and dynamics) of water and nutrients. In addition to the abiotic requirements, the biotic starting situation is important: degree of completeness, structuring species, self-regulation and dynamics (for example herbivory and predation), as well as reproduction, mortality and ecological relationships.

Space

From a spatial point of view, what is needed, as explained above, is sufficient surface area in the right place to be able to accommodate 'complete' characteristic biotic communities and sufficient opportunities for species to exchange and spread to related situations in order to preserve vigorous populations. Spatially, it is also vital that there are transition areas between the different types of ecosystems. Sometimes spatial isolation (permanent or seasonal) is important to allow partial systems to function or to enable species to survive, for example by excluding rivals or predators.

Environment

With regard to the environmental starting situation to be aimed at, it would be desirable to approximate the 'original' quality and the 'original' flows of matter in soil, water and air as closely as possible. After all, these are the conditions under which species have evolved and survived for a long period of time. The quantity, availability and movement of nutrients and building materials, as well as poisonous substances, determined the basis for the further activities of living organisms and hence for the development of ecosystems.

Man has used, concentrated and shifted natural substances more and more and has produced all kinds of new 'unnatural' substances, while at the same time increasingly diffuse and concentrated waste streams have been created. As a result, great changes have come about in the original processes that take place in the environment and hence in environmental conditions.

The most far-reaching effect on ecological functions is the disruption in processes (flows of substances, cycles) and in the distribution of natural substances such as nutrients. Whereas originally there were all kinds of gradual transitions from high-lying and deficient in plant nutrients to low-lying and high in plant nutrients, the situation now is that there is an excess of nutrients everywhere as a result of the disruption in ecological processes. The results can be seen in an enormous levelling and loss of plant and animal species in virtually every ecosystem, especially in those ecosystems that are more deficient in plant nutrients and are affected by eutrophic groundwater and surface water. Further levelling occurs due to the increasing quantity of nutrients that are deposited through atmospheric transport. (The central themes of 'eutrophication' and 'acidification' in Dutch environmental policy).

Water

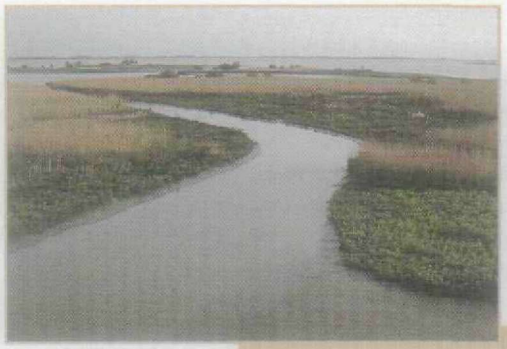
For centuries water has been treated as if it were a tricky adversary in the Netherlands. There was almost always too much of it or else it lay where people would rather have had land. Water quantity was therefore a problem. Water quality did not become a problem until last century when organic pollution became so bad in some places that the water could no longer be used as drinking water.

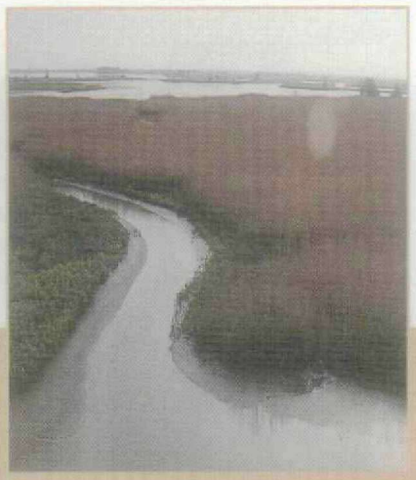
The quantity of water is now a constant problem, not only too much water but also too little. Water quality has also become a constant problem in terms of the inadequate quality for a variety of practical uses. As a result of the increasingly drastic use of surface water and groundwater, particularly in the last few decades, the natural processes at work in water systems have been fundamentally disrupted. Surplus high-quality rainwater is diverted to the North Sea as soon as possible, mainly for agricultural purposes, so that in the summer poor-quality water from the River Rhine has to be supplied to meet the requirements of agriculture. Lowering the groundwater level and collecting seepage water can furthermore have repercussions over a wide area.

Due to the fact that various waterways are connected with one another for the purposes of supply and discharge, there is virtually no water that originates within one particular area any more. It is too often the case that the poorest water quality is predominant.

The effects for ecological functions are twofold:

- There is or there threatens to be a constant shortage of water that originates within a particular area, both quantitatively and qualitatively.
- In addition to the completely disrupted distribution of nutrients, this leads to further loss of original diversity and to levelling at a low-quality level (The central themes of 'dehydration' and 'eutrophication' in Dutch environmental policy).





In the Oostvaardersplassen area, restoration of natural dynamics in water level creates the mud-flat environment for plant species like Senecio congestus which is on the European red list of threatened plant species.
(photos: F.W.M. Vera)

Development of the starting situation

The possibilities for improving and developing the spatial and physical starting situation for ecological functions can best be explored on a regional and area basis. This will have to involve an integrated analysis of the various functions of an area and the search for coherent solutions for the various functions.

In very general terms, working within the ecological network, the aim must be to (possibly partially) restore or develop the quality of the spatial and physical conditions. There is still a likelihood of this within the (potential) core areas. It is less straightforward in the ecological corridors and smaller areas.
The environmental starting situation can be improved in areas of varied relief by taking the domination of 'high' over 'low' more into account, for example by ceasing to use the edges of plateaus and hill ridges for production purposes or by specifying a much lower level of use of manure and fertilizer there.
It is possible, on a local basis, to restore and develop environmental conditions linked with water systems in areas of varied relief by retaining water that originates within a particular area for longer and by, for example, allowing the drainage of agricultural water to take place further downstream. A longer path for the water in polder areas, via a sophisticated watercourse system, also has certain possibilities. In general, surpluses of rainfall local to a particular area should be retained more effectively and for longer, for example in wildlife areas and woodlands that are to be developed, so that high-quality water can be used profitably for much longer. Effluent seepage water rich in lime can also be used to keep the acidification of vegetation in check. Influent and effluent seepage areas must be spared and protected against being overloaded with fertilisers and nutrients. The continual tendency to send Rhine water to every corner of the country must be stopped. This is also necessary to ensure that there is sufficient flushing water for the South West of the Netherlands in the summer to combat the salinization of land by salt groundwater. Furthermore, more use should be made of the purifying ability of a variety of ecosystems, for example by specifically digging marsh systems in the form of helophyte filters and, in general, by letting surface water lie in areas for longer. The latter can come about, for example, by allowing forelands, flood valleys and polder areas with natural drainage, that have become separated over the course of time, to become an integral part of the water systems again.

7 Conclusion and discussion

A vision has emerged in the preceding chapters that can have significant consequences in the longer term for nature and the landscape in the Netherlands. The exploration of the possibilities of achieving a coherent ecological reference, partly by means of nature development, thereby creating a better chance of being able to develop and preserve a more sustainable type of nature in the country, reveals that all kinds of opportunities are available. In order to develop this part of the nature policy further, the vision outlined will have to be elaborated in more detail and further practical experience gained in pilot projects on various scales. This elaboration process will have to specifically consider the matter of social practicability. The form in which social practicability can be analysed should be examined. Studies targeted on particular areas seem to be an appropriate means of doing this.

Restoration and re-development of riparian forest by allowing natural dynamics and ecological processes to happen again, is taking place at several locations along the rivers. These areas are to be future core-areas in the national ecological network. (photo: F.W.M. Vera)

Area-oriented approach: core areas

A foundation can be laid for the sustainable survival of nature in the large wildlife areas and in the areas where nature is the main spatial function. For some of these areas, efforts could be concentrated, as far as possible on the basis of an ecological reference, on developing them into 'ecological core areas' in which the ecosystems have a high degree of completeness and self-regulation. This increases the chances of the biotic communities, populations and species in these ecosystems becoming 'permanent'survivors, not only in the large areas themselves, but also as a result of the 'reservoir effect' on smaller areas. On a national level, it would be worth considering specifying the overall direction of development in the large wildlife areas in connection with the desired links (or isolation) within the framework of the ecological network.

Area-oriented studies could provide a clear idea about what is desirable on the basis of the (main) function nature and what is acceptable in relation to this, on the basis of the other functions in the area and in the surroundings. The current process of formulating 'management and development visions' for large sections of wildlife areas and 'integrated policy plans' for large waterways, can be regarded as an important start for the approach outlined above.

As more knowledge is acquired through studies and experiments about how the larger areas function ecologically, a clearer idea will be gained about the desired reinforcement (or addition) of processes and components and the way in which

this can best take place. Based on this kind of nature development of the large areas themselves, work can begin to systematically establish the main links in the ecological network both between similar areas and in the transition areas between different ecological areas. In this way, further experience can be gained at system level of the distribution aspects of species in relation to surface area and ecological (infra)structure, which are important for developing the ecological network further.

Area-oriented approach: stepping-stones and ecological corridors

It may be expected that the ecological corridors that are needed between large and smaller wildlife areas will for the most part pass through areas that have other main functions usually involving intensive land use. A variety of small wildlife areas and smaller natural elements are often found scattered about in these areas. As far as possible these must form the basis for the development of the ecological corridors, passages and stepping-stones. A variety of watercourses and wayside verges can also play an important part as a framework within which 'wet' and 'dry' linking structures can be situated. The vital ecological corridors as well as the desired nature of such corridors can be broadly specified at national level within the framework of the National Ecological Network.

In order to establish the ecological corridors and improve the spatial structure of nature in areas with other (main) functions, an examination of all the functions in these areas could be used as a starting point. This requires an integrated approach to the functions in rural areas on a regional level. Spatially stable ecological corridors for the ecological functions can only partly be achieved on the basis of the nature policy itself. Collaboration with and the cooperation of other sectors is needed in order to be able to show results within a reasonable timescale. Analysis of the other functions/sectors in a region therefore seems advisable in order to shed light on every aspect and to enable an integrated plan to be developed.

With regard to wishes and requirements based on ecological function, it is a question not only of the (main) ecological corridors in the National Ecological Network, but also of the regional networks and their ecological corridors and of the nature to be found within the fabric of the network. On the basis of the requirements and wishes of the various functions, it seems possible to achieve an integrated study in which an optimisation of functions within a region is specified. The starting point of this kind of study on a regional level is a sustainable fulfilment of function, where functions that are characterised by low dynamics are included within a spatially stable structure, segregated from functions that are characterised by high dynamics, such as agriculture and habitation.

Opportunities

The ecological reference approach outlined in this report can be an important aid in giving form and content to any future nature policy. Regional area-oriented elaboration would seem to be essential in order to gain more insight into details that are sometimes speculative and hence controversial, for example the relationship between woodlands, their formation and grazing by large herbivores. The main emphasis is on gaining an understanding of the essential processes and elements of ecosystems and the relationship with the patterns, to enable operational objectives to be set on the basis of these. During the process of working out objectives, verifiable criteria must preferably be chosen, mainly to be able to adjust situation, as a result of interacting with systems, but also to be able to demonstrate social results. What is involved though is not only large areas (com-

plete/self-regulating) but also management methods, derived from the ecological reference, for smaller wildlife areas, natural elements, watercourses and wayside verges.

As stated several times in this study, the concepts 'completeness' and 'self-regulation' must be seen in relative terms. What matters most is the direction of the policy choices. The extent to which these two concepts can actually be achieved depends largely on segregation of other functions, the available functional surface area for wildlife areas, the abiotic situation, external influences, the relationships with similar areas and, of course, numerous social factors.
On the basis of this vision, great emphasis should be placed on developing an independent ecological network to ensure the sustainable survival of 'complete and self-regulating' ecosystems.
As far as the social opportunities (and costs) of the proposed structure are concerned, this exploratory study ventures no opinion. What is clear is that wherever opportunities arise they must be exploited, while elsewhere opportunities have to be created. The costs per project will vary widely and in some cases may be substantial. Furthermore, it must be considered that to realise the ecological network involves (very) long-term planning and in any case requires projects to be phased. Investments could eventually pay for themselves to a large extent, due to the fact that less internal and external management effort may be expected. The benefits for nature and for society in general will be great, though not always in direct financial terms of course.
On the basis of available knowledge and insight, the policy has already mentioned a few areas that are regarded as favourable for development in this direction. Other areas are added here and a method of working specified to initiate the desired development in phases. A number of projects are already underway, particularly in a few large wildlife areas. A start can also be made in the short term in other places on an experimental basis.

In addition to the area-oriented and more integrated approach, small-scale nature development for specific species (groups) can also play an important part. This may include less far-reaching and relatively inexpensive measures that, with reference to other functions (infrastructure, water management, agriculture, outdoor recreation), can contribute towards nature conservation and nature development.

Spontaneous regeneration of primrose on abandoned arable land along the river Rhine.
(photo: F.W.M. Vera)

Integrated approach

If the possibilities, as specified in this exploratory study, of nature development for the nature policy are compared with the present situation, it appears that in a number of areas, such as the development of the 'ecological core areas' (large sections of wildlife areas, large waterways), policy in the last few years has tended more and more in the direction outlined. The scope for implementing policy is, however, curtailed by available resources, by (spatial) reality and by the diversity of current opinions. Clearly set (sector) objectives and priorities are therefore essential in order to determine a faster and more efficient method of working for the desired development of an ecological structure. All kinds of policy instruments available, are in principle suitable for putting the network ideas into practice. To that end, the instruments should, however, be deployed in a more specific way.

An integrated approach seems essential in which the instruments are deployed in context in order to bring about the desired developments. Precisely because of the characteristics of the ecological functions and in part the other functions with 'low dynamics', these must largely determine the spatial location of the ecological structure. The intensive functions are often spatially more flexible and hence less 'precisely' restricted to a particular area. Within the spatial framework of the network of low dynamics functions, a variety of high-quality intensive (production) functions could exist under certain conditions, such as general environmental quality.

In the case of the large wildlife areas and the important linking structures, spatial stability by means of segregation of functions is required in order to maximise the chances of a sustainable kind of nature. With regard to the regional networks and certainly to the nature within the fabric of the network on the cultivated land itself, more reliance will have to be placed on the other sectors in rural areas. Furthermore, a certain measure of concentration of nature seems to be preferred to a scattered distribution. Patterns of wayside verges and watercourses, for example, offer excellent possibilities for nature development by other sectors. Various suggestions have been made over the past few years for implementing (often small-scale) nature development projects of this kind and activities have been expanded in many places. Further intensification of the involvement of other sectors is vital for the 'joint practical function' that nature has in most of the rural areas. The increased interest from other sectors is of help in formulating a clear planning framework based on the nature policy, in which, among other things, the direction of possible nature development measures is specified. The chance that 'nature' will play a full role even at the planning stage of sectors increases accordingly, so that a variety of measures will form a normal part of the performance and completion of work and of the management and maintenance of property.

This approach has in fact already been set out in the 1984 Structure Scheme on Nature and Landscape Conservation, that also gives various instances of nature development within the scope of land development, water management, raw material production, infrastructure, recreation and living. In the water sector, in particular, developments in many places over the last few years have increasingly concentrated on recognising the importance of ecological functions, not only for mother nature herself, but certainly also for the practical uses of water. The water system approach in the integrated water management policy advocated, fits in well with elements of the reference approach and the regional area-oriented elaboration that have emerged in this exploratory study. Further integration of the planning system outlined in this study into other sectors probably offers the best prospects for nature in most of the rural areas.
The need has revealed itself to limit production in some sectors of agriculture and this will give rise to opportunities to develop a better spatial structure for rural areas that may eventually benefit all relevant functions. Where and at what level the measures will be implemented is vital for nature (and the other low dynamics functions). Unsystematic emissions and/or expansion as a result of either independent market-linked developments or differentiation at industry level do not offer any clear opportunities for improving the spatial structure. The proposed plan for an area-oriented approach, together with the ecological structure outlined, offer a possible framework within which to operate with regard to these developments. The Ministry of Agriculture, Nature Management and Fisheries has in principle a large number of practicable instruments available for this purpose. A coordinated and concentrated deployment of spatial and other

instruments will have a controlling effect to a large extent. The land development instrument, in particular, can play an important part in this deployment. Furthermore, with a project-oriented approach, the relationship with the spacial surroundings of a project needs to be considered. The instruments will have to be deployed more thematically than is possible at the moment.
Physical Planning, the Environmental Policy and the Water Policy will have to be both favourable and embracing as regards the proposed integrated approach. It will be evident that in the picture painted a collaboration model will have to be involved; not only collaboration between the various public sectors and facets, but also between the various (semi-autonomous) public authorities. One very important aspect is therefore the allocation of tasks between the various parties involved in putting regional planning and the concept of the ecological network into practice.

Further elaboration

In elaborating the vision and ideas that have emerged here, many questions will have to be answered before anything can be put into operation and carried out. Some of these questions are raised by this study. Others were asked some time ago and attention drawn to them in this study. Answers are occasionally suggested and in other cases starting points and propositions are put forward. The questions, answers and propositions must be discussed to enable the necessary choices as regards policy to be made in a responsible manner. Choices are seldom or never 'black or white'; it is nearly always a question of the relationship between various strategies, emphasis in approach and nuances in the starting points. A few important points for discussion are touched on below.

In the first place it may be clear that a number of ecological and biogeographical starting points have been directive for the proposals on how to bring about more sustainable survival of plant and animal species. Plants and animals can best survive within the context of an ecosystem.
Moreover, the concept ecosystem is used in a context, related to the large climatological/biogeographical biomes on earth, and does not include the cultivated systems created by man. The starting point is the complete ecosystem with its internal and external relationships, in which, given the natural conditions, every niche is filled, every food supply strategy is satisfied and all corresponding abiotic and biotic processes take place.
The concept ecosystem has not been extended in this study to include cultivated systems. This does not alter the fact that cultivated systems can also be described in ecological terms of processes.
The question concerning to what extent cultivation measures are needed to enable plant and animal species to survive, is in direct relation to the ecosystem view put forward. At the same time it is argued that cultivation measures can favour some species in comparison with natural systems, for example in terms of numbers, but that this will occur at the expense of other species. A clear policy question is raised here: what reasons are there for favouring some species at the expense of others? This involves reflection on objectives of the nature policy in relation to ecological or cultural references. The use of cultural references will involve more than just ecological values. Values associated with the landscape, cultural history and the earth sciences will also be part of this kind of approach. For the sake of clarity in social and policy terms, a choice is made here to draw a distinction between nature policy and landscape policy.

Both areas of policy have their own types of objectives in which the similarities and differences should be identified. Only then can policy choices be made properly, geared to particular areas, and aspects given special emphasis: conservation and restoration of a man-made landscape (preferably with high ecological values) or development towards a natural landscape (preferably with a high degree of completeness and self-regulation).

Ecological reference

The use of an ecological reference also means, among other things, giving priority to letting processes proceed as naturally as possible by completing areas by adding and/or developing essential elements, and (re)introducing plant and animal species, certainly in the case of key species, such as large grazing animals and, in a few cases, predators (for example birds of prey, otters). In many cases the present reticence with regard to (re)introduction has to be overcome. In targeted projects the best possible conditions will have to be created for the species to be introduced. In the short term it is worth considering a broader deployment of red deer, wild boar, wild cattle and horses, beavers, otters and birds of prey such as the white-tailed eagle and the osprey.

Red deer have been introduced in the Oostvaardersplassen area, following the introduction of Heckochsen and Konik horses. With the planned introduction of elk and the already numerous presence of: roe deer, rabits, graylag geese, etc. almost the complete community of herbivores will be re-established. (photo: F.W.M. Vera)

Although according to Beyerinck's Law "everything is everywhere and the environment selects', many species, because they are confined to one place either as a result of the literally 'devastating' selection of cultural barriers (such as roads) or because of barriers (such as monofunctional cultivated land), simply cannot go 'everywhere' in order to find out whether they can live there or that the 'environment' does not 'select' them.

In a few situations similar considerations apply to plant species. In the case of tree species particularly, an enormous cultural selection pressure has been exerted so that exotic species and sterile clones are predominant in many places. The introduction of indigenous fertile species/varieties is advisable in many cases in order to obtain a more natural regeneration and subsequent growth. This problem is illustrated by the search for the last 'natural' black poplars in the fluvial system in connection with the formation of groves of trees, as described in the book about the Plan Stork (a plan for ecological restoration of the flood-plains of the river Rhine).

In a relatively isolated area like the Oostvaardersplassen it is interesting from a scientific viewpoint to examine whether a variety of marsh plants manage to reach the area from their 'old terrain' and if so, how long it takes. Nevertheless, if a complete system is to be developed, it is even more logical to introduce the plant species concerned into the area. Numerous examples can be mentioned where systems can be given a helping hand to achieve self-regulation and completeness without the need for years of study and discussion beforehand.

As already stated, sufficient knowledge and experience seems to have been gained to enable policy choices to be made now. Furthermore, many of the questions posed can best be explored in experiments on a practical scale. For these, the old tried and tested methods of empirical research and trial and error

will have to be reintroduced, supplemented by and incorporated into modern system models. It is not so much a question of conducting explanatory research, but rather of seeking solutions to problems. In other words, how the 'black box' works is less important than the fact that it works.

That there is a need for a better spatial structure for nature in the Netherlands and in Europe as a whole, is beyond question according to almost every expert on the subject. Opinions differ, however, concerning what this structure should look like and how it should function.

In this exploratory study, improving the spatial structure for nature is certainly considered to be just as important as improving environmental conditions while pursuing the objectives of the nature policy.
The network ideas proposed here are largely based on the independence of nature from other functions and on the use of an ecological reference for nature in the Netherlands. A drastic segregation of functions is needed to accomplish the network. A certain amount of interweaving will 'perforce' be required only where there is no alternative. This principle is immediately qualified though by pointing out the positive opportunities for (and often the necessity of) working with other functions characterised by low dynamics, that can be of help in attaining spatial stability and quiet. An additional advantage is that the external effects (environment, water) of a variety of functions are lessened.
On the other hand, there are in fact ideas according to which a high degree of interweaving, even with more dynamic functions such as agriculture, partly determines the structure of the network. This involves not so much embracing intensive high-tech forms of agriculture; rather it is a question of the possibilities in more extensive production or in integrated agriculture. Cultural references play an important part in this approach. The aim is therefore to embrace policy objectives for nature, the landscape and cultural history. The most important consequence of this is that the 'supporting' (economic) functions in rural areas have to meet a good few requirements, which raises the question of whether these requirements are compatible with the 'healthy' economic survival of the supporting functions without the need for substantial subsidies.
Both approaches, one based on an ecological reference (segregation) and the other on cultural references (interweaving), therefore involve a social cost-benefit analysis with regard to nature, the landscape or a combination of the two in relation to the other practical functions in rural areas.
The proposition based on the strategy of segregation is that this results in the best 'ecological values' for the money available. The strategy of interweaving also results in all kinds of other values, though mostly of a less permanent nature. What matters therefore is not the question of whether valuable man-made landscapes (with many ecological values) have to be preserved where possible and whether they can have a support function for the network, since the answer to that is quite simply: yes! What matters is the question concerning the relationship of the emphasis between the various policy objectives of the nature and landscape policy in relation to the social possibilities and the social costs.

Further research

It has been argued that sufficient knowledge has been gained to enable these policy choices to be made. This certainly does not mean that we know everything already and that no further research is needed. A great deal of research is still needed into, for example, the minimum biological surface area required by a variety of species in order to determine how large an area has to be (and how it is made up) so that a population of a species can survive. This also raises the question of to

what extent a 'network' can replace a continuous area and whether habitat diversity can make up for surface area to an extent. Research on regulation mechanisms, both abiotic and biotic (key species), is essential in order to establish the critical conditions for systems as well as possible. This means more emphasis on processes in ecosystems and more acceptance of dynamics in patterns.

We also need to gain a better understanding of actual migration and distribution processes and of how linking structures (and barriers) for plant and animal species function so that we can more effectively determine for what organisms, in what way and in what location the network structures have to be developed. In addition to looking at ecological corridors, research is needed into the importance of permanent, varying and seasonal isolation for a variety of organisms. More attention should also be given to the 'barrier or filtering effect' of cultivated land and to the possibility of lessening this effect for various species.

Concluding remarks

Of course, the above mentioned fields for further research are not at all limitative. The fact however that much more research is necessary into the working of ecosystems and into the possibilities of nature development in the construction of ecological networks should not be used as an argument to postpone or delay the urgently needed action for nature. There is enough knowledge to go ahead and to augment and in part to replace the traditional nature conservation strategies with new approaches like the ones suggested in this study. This study does not pretend to give the answers, but if the questions that are raised by some of the ideas contribute to the discussion on how to improve nature conservation strategies in future, the study will have served it's purpose.

A hurd of Heckochsen grazes the former salt marches of the "Slikken van Flakkee" in the S.W> Delta area, a picture symbolising the possibilities for ecological restoration by means of nature development.
(photo: F.W.M. Vera)

Author's notes

When we finished the final draft of this study by the end of 1987, it was not just the product of working and writing together for several months that was presented. In fact it was the result of some ten years of struggle and experience -exiting and disappointing- in nature conservation policy. It was also the result of the astonishing nature developments in the Oostvaardersplassen, of continuous constructive and challenging discussion with colleagues and friends but also of fierce fights with all sorts of opponents.
So we were not really surprised that on the one hand there was a very positive response for the ideas and concepts presented in the study, while on the other hand we experienced very negative critisism and openly hostile reactions. Especially our ideas on the need for segregation of nature and agriculture were not welcomed, not just by a majority of the agricultural community, but especially by a substantial number of nature conservationists!
Thus, even before the study was first published in a stencilled version in 1988, and later in 1989 as a printed and illustrated document, we found ourselves heavily involved in a vigorous debate among Dutch conservationists.
Yet, in spite of this debate, official nature policy in the Netherlands recognized most of the ideas and concepts put forward in this study in the Nature Policy Plan that was presented in 1989.
The main frame of this policy plan is made up of the National Ecological Network as proposed by us and the strategy of nature development is adopted as an important complementary strategy in nature conservation policy in the Netherlands.

The ideas and concepts presented in our study and adopted in the Nature Policy Plan as well as the discussions going on in the Netherlands also drew international attention. The concept for an European Ecological Network that was presented at the EECONET conference in Maastricht in October 1993, has to a large extent been derived from our concept for ecological networks as laid down in this study. So, many people had become interested in a translation in English. It has taken a while, but we are very pleased that this English version is now available. Though in a way the study is dated, we have decided to keep the editing to a minimum, since we think that the original message is still clear enough.
The fact that the Netherlands according to this study may be considered as an 'ecological disaster area' has forced us to come up with some unusual and unorthodox ideas to restore and develop nature, so as to ensure that our indigenous plant- and animal species can have sustainable survival. As always: necessity is the mother of invention. So the message is simply: don't make the same mistakes as we made in the Netherlands. We hope you can learn from our experience and maybe make use of some of the tools we had to develop.

For this study we made use of a great variety of references. A lot of them are written in Dutch and therefore not easy accessible. They are listed in the Dutch version and not repeated here. We restrict ourselves to some references in English and German listed below.

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Put briefly, nature development is all about creating new wildlife areas. These areas may range in size from very large, such as the Oostvaarders-plassen lakes area, to small, such as a pool for amphibians. Nature developement fulfils an important role in the realisation of the National Ecological Network, one of the crucial points in the Nature Policy Plan of the Netherlands.

This book explores the possibilities for nature development in the Netherlands.

About the authors

Fred Baerselman (1948) and Frans Vera (1949) were yearmate's in biology at Amsterdam Free University. They graduated as ecologists in 1978 and joined Government Service on Nature Conservation Policy. Together with colleagues they developed the concept of ecological networks and of nature development, which form an integral part of nature policy in the Netherlands since 1989.

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