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Development of Rural Areas in Europe: The Claim for Nature

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N.T. Bischoff
R.H.G. Jongman

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Drs. R.H.G. Jongman

Contents

Preface

For its report on 'Ground for choices' the Netherlands Scientific Council for Government Policy needed information on possible future developments in nature conservation in the EC. The Physical Planning Department of the Wageningen Agricultural University was willing to accept this challenge. The present study was supported by a grant of the Ministry of Housing, Physical Planning and Environment – the National Physical Planning Agency.

In 'Ground for Choices' four scenarios for the future of land use in the EC have been developed based on information on technical possibilities as well as on policy options concerning the future of rural areas. To assess the possibilities, the Council needed ideas of the claims that would result from developments in nature conservation. Nicole Bisschoff and Rob Jongman, the authors of this study, have contributed to the report 'Ground for Choices' by devising a Tentative Ecological Main Structure for the EC. This structure is build around existing areas and consists of nature expansion and nature development areas. These areas have been chosen to comply with a set of criteria that have been elaborated in this study.
Even before its publication the study has drawn a lot of attention. In the Netherlands the ideas have been expanded into an initiative by the Ministry of Agriculture and Fisheries to arrive at a supra-national consensus on EECONET, an ecological network for the EC.

The Council is very pleased with the spin-off of the study and hopes that this publication will contribute to further debate on nature conservation within the EC.

J.P.H. Donner
Chairman

Dr. R. Rabbinge
Member of the Council

Introduction

1.1 The context of the project

This report describes the construction of a series of maps concerning present and future nature conservation at the level of the European Community. These maps were needed by the Netherlands Scientific Council for Government Policy for one of its research activities, which resulted in the report *Ground for choices*.

In the report *Ground for choices*, the Council investigates the possible change in land use in the European Community. The report elucidates the conceivable land use developments in the EC and the policy options to attain these developments. For this purpose, scenarios have been worked out for agriculture and forestry. These scenarios are based on four ideas about the main development in agriculture in the EC. The main driving force of this development is the ongoing increase in productivity in agriculture. This will have an effect on agricultural land use, the most prevailing form of land use in the rural areas of the EC. Two factors determine the sustained growth in productivity. First there is an ever increasing agrotechnical know-how. Second the use of assets per unit of output will decrease with increasing levels of production. The basis for these calculations is formed by technical, physical and biological constraints such as soil and climate characteristics and properties of the crop. The agricultural production is realised using different systems, e.g. cereal farming, general arable farming and dairy farming. In most farm systems, production goals dominate and there is little interest in other goals. Using a linear programming model, the feasible future allocation of land use activities has been calculated from socio-economic, spatial, environmental and production preferences. When the model was being constructed, it turned out that not all goals could be transformed into a strict quantitative equation on account of their regional properties. An analysis of agricultural development cannot be realistic without including other land uses such as nature conservation and outdoor recreation. Data on ecological processes and spatial information on nature and nature conservation in Europe are needed not only with regard to the present situation, but also with regard to future developments.

This report presents the methodology and the results of the assessment of a possible development in nature conservation that requires more space for nature in Europe.

1.2 The claim for nature

The wide diversity of natural and semi-natural ecosystems in the European Community needs protection because their vulnerability and actual decline threatens their importance with respect to biodiversity and migratory species. Changing land use and economic development have a great impact on nature. Natural rivers are declining in number and quality as a result of canalisation and pollution; coastal areas are under pressure due to tourist development; and natural forests are transformed into tree plantations. Because of habitat deterioration by land reclamation and pollution, there is a decline in wetland bird species. The seals in the Mediterranean and the North Sea are declining because of habitat loss and diminishing habitat quality. Even those forms of land use are under pressure that until now had been thought to be stable, e.g. parts of the British highland farming area and its semi-natural landscape.

A great effort is needed to actually conserve the most important nature in Europe. Sustainable regional development can only take place if nature

conservation is integrated in development plans. One of the recent recognitions is that exchange processes between ecosystems are essential for their well-functioning. Conservation of habitats and species in relation to each other means the protection of important areas and of the processes within and between them. However, among the major problems faced now in nature conservation are external influences like pollution and land use changes. These external influences affect both the life conditions in ecosystems and the exchange processes between them.

A strategy must be developed of coordination for nature conservation within the EC. Nature does not regard national boundaries and although national conservation strategies might solve many problems they need international coordination to face pollution and land use changes, both of which affect biotopes in all member states. The physical result of European coordination of national priorities and conservation strategies can be a design of an ecological network of priority areas for nature conservation in Europe as proposed in the Habitat Directive as NATURA 2000. The objective of an ecological network can be defined as (1) effective protection of the most important habitats and species in Europe, (2) the development of a coherent structure of important habitats within Europe, (3) facilitation of migration and dispersal of species where desired and (4) prevention of further decline of habitats and species. Such a network must contain areas where natural physical processes and related biological processes can take place without human influence.

The objective of this study is to construct maps of the existing protection status of nature in the European Community (EC) and of a potential optimal situation. In this study nature is considered as a land use category such as agriculture and forestry. Natural and semi-natural ecosystems have a spatial claim. All species need a site to live, to breed, to feed and to take shelter. Nature is partly conserved in designated areas. Extensive areas, however, have no protection at all. In this context the two main questions of this project are:

- Where in Europe is nature protected in designated areas?
- Given the possibility to designate land within the EC, what would be the location of potential areas of nature conservation interest?

Nature strictly related to agricultural landscapes and urban fringes is not included. Neither are marine ecosystems. However, agricultural management for nature conservation objectives will be included. The study has been based on existing data the most important of which are stored in the CORINE (**CO**o**R**dination of **IN**formation on the **E**nvironment) database. This study is the first to make general use of the CORINE Biotope data set as a whole. Other data have been collected and used as far as needed and possible. Important in this respect are the data from ICBP (International Council for Bird Preservation), regional data and information from experts. Without these components the realisation of the maps would have been impossible.

The ecological structure of Europe

2

2.1 Introduction

In this chapter the main elements of the ecological structure of Europe are discussed. Biogeographical differences are important to be able to understand differences in species composition and biodiversity. Within each biogeographical zone many types of ecosystems can be discerned some of which may be specific for a biogeographical zone while other ecosystems may be found everywhere in Europe. All these differences have been included in this study, but here they can be discussed only shortly. Beside the presence of species and ecosystems their spatial relations are important. Dispersal, the movement of organisms through the landscape, is important for the genetic diversity and thus for the survival of populations. For dispersal it is important that biotopes are accessible. In the European landscape most natural areas are remnants of former large nature zones. The principles of dispersal and migration are treated in this chapter. They have been applied within the framework of the Tentative Ecological Main Structure (TEMS).

2.2 Biogeography

In ecological aspect the territory of the European Community is complex. It consists of habitats of many different sizes and a great variety of routes for dispersal of the European fauna and flora. Its wide range of environmental conditions gives rise to a great diversity of nature. Between the semi-arid areas of Greece and the cool, humid mountain regions of Ireland and between the wide lowland plains of northern Germany and Denmark and the high mountains of the Alps, there is a large variety of ecosystems: maquis and garrigue, saltmarsh and dune, mixed oak woodland and boreal forest, peat moorland and calcareous grasslands. Each supports a variety of wildlife species.

Europe can be specified into several biogeographical units. In this report plant geography is used as a basis to indicate biogeographical zones. In plant geography three floristic regions are defined for the territory of the European community, (1) a Central European, (2) a Mediterranean and (3) a Macaronesian (Figure 2.1). The Central European region, that extends from Ireland onto the Ural can be subdivided in (a) an Atlantic and (b) a Central European province. Within these regions and provinces an Alpine zone can be found in mountain areas. Boundaries between them are gradual.

The Mediterranean region reaches from Portugal and Morocco in the west onto the Caspian Sea and the Sinai in the east. Comparable but smaller regions in the world can be found on west coasts of continents between 32° and 40° latitude on the southern or the northern hemisphere of the earth: California, Chile, Cape province and the southern part of Australia (Aschmann 1973)[1]. Its flora is rich. The number of plant species in Spain and Portugal is between 6000 and 8000 (Polunin and Smythies 1973 [2]. Pineda 1991) [3]. The importance of the Iberian Peninsula – but also of the Balkan, including Greece – is great. Well known are the olive (*Olea sylvestris*), the cork oak (*Quercus suber*, Figure 2.2) and the holm oak (*Quercus ilex*). The Mediterranean region is also important

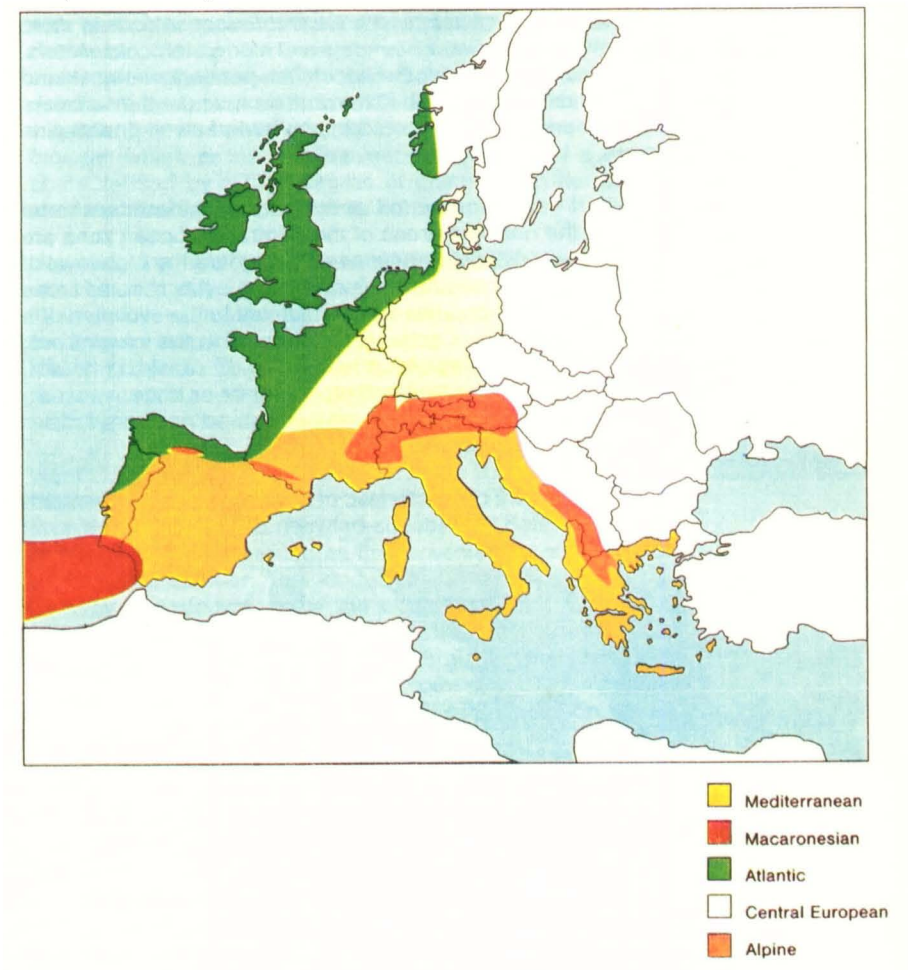
[1] H. Aschmann, 'Distribution and Peculiarity of Mediterranean Ecosystems'; in: *Mediterranean Type Ecosystems, Origin and structure*; F. di Castri and H.A. Mooney (eds), Ecologicalstudies 7, Berlin, Springer Verlag, 1973, pp. 11-19.

[2] O. Polunin, B.E. Smythies, *Flowers of South-West Europe; A field guide*; London, Oxford University Press, 1973.

[3] F.D. Pineda, M. Ruiz, J.M. de Miguel, R. Colmenares, *EECONET; an European Ecological Network; Case Study Spain; Working Document*; Madrid, University of Madrid, Department of Ecology, 1991.

for the fauna. Large areas are classified as important bird areas (Grimmett and Jones 1989) [4]. It is also the main area in the EC where mammals like the brown bear (*Ursus arctos*), the wolf (*Canis lupus*) and the pardel lynx (*Lynx pardina*) can be found (Mallinson 1978) [5].
The Canary islands, Madeira and the Azores are part of the Macaronesian region. They are characterised by a special flora and fauna that partly occurs just in this region.

Figure 2.1 **Plant geographical zones in Europe. The zones are: Atlantic, Mediterranean, Macaronesian, Central European and Alpine**



Source: Agricultural University, Wageningen

The Macaronesian islands count between 2000 and 3200 species (Pineda 1991 [6], Humphries, 1979) [7]. Because of its relative richness in Macaronesian species also the south west part of the Iberian peninsula has been included. Of the Macaronesian flora 20 per cent is endemic. Some species show a disjunct distribution throughout the world, being remnants of the Tertiary flora.

[4] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.
[5] J. Mallinson, *The shadow of extinction. Europe's Threatened Wild Mammals*; London, Macmillan, 1978.
[6] F.D. Pineda, op.cit., 1991.
[7] C.J. Humphries, *Endemism and Evolution in Macaronesia*; in: Bramwell (ed.), *Plants and Islands*, London, Academic Press, 1979, pp. 171-199.

The Atlantic province reaches from Central Portugal to South Norway (Roisin 1969) [8] The climate is highly influenced by the Atlantic ocean. There is a relatively high net precipitation during all months of the year. Wetlands, bogs and heathlands are characteristic habitats. Its geographic position and its climate make this region important for migration of Fennoscandian and Siberian bird species. The largest wetlands in the EC are situated here.
The Central European province is characterised by a moderate warm summer and a moderate cold winter that can last several months. The most characteristic tree species of this climate are the beech (*Fagus sylvatica*, Figure 2.3), pedunculate oak (*Quercus robur*) and durmast oak (*Quercus petraea*). More to the north-east the winter gets colder, the summer drier and the vegetation period shorter. This favours conifer forests of fir (*Picea abies*) and pine (*Pinus sylvestris*).
The same zonation as in Central Europe to the north can be found in mountains from low to high. Here however, precipitation increases enormously compared to lowland areas. Yearly precipitation in the Cantabrian mountains and in the Alps can reach far over 1500 mm (Walter and Lieth 1964) [9]. However, the short vegetation period and the long cold winter favour conifer forests in the higher altitudes. This is the characteristic environment of the Alpine zone.

From a survey conducted for the EC by the Nature Conservancy Council of Great Britain it can be concluded, that many bird species in Europe are declining. In Germany the number of extinct and threatened bird species increased from less than 100 in 1971 to 110 in 1986 and a large part of the plant species are endangered like species of bogs (56.5%), marshes (64.1%) and oligotrophic water (81.3%) besides 195 out of 477 species of dry grasslands (Umweltbundesamt 1990) [10]. This trend can be confirmed for the Netherlands. Already in the fifties the decline of species was a serious problem; in that period 434 species, i.e. 33 per cent of the Dutch flora, were threatened or extinct, while 173 (13%) were expected to belong to this category in the near future (Westhoff 1956) [11]. Especially species of forests, oligotrophic environments and dry and humid grasslands were under threat. In spite of increasing protection no improvement occurred in the status of the species of oligotrophic environments, wet and dry grasslands. Only forest species seem to remain stable because of sufficient protection in nature reserves (Westhoff and Weeda 1984) [12]. In general there is an all over decline of grassland species in Europe, although in France, the United Kingdom and Ireland still large areas exist of species-rich grasslands (Van Dijk 1991) [13]. In spite of financial support the decline of hedgerows still continues in Great Britain (Barr et al. 1991) [14].

[8] P. Roisin, *La domaine phytogeographique atlantique d'Europe*; Glembloux, Presses agronomique de Gembloux, J. Duculot (ed.), 1969.

[9] H. Walter and H. Lieth, *Klimadiagramm Weltatlas*; Jena, VEB Gustaf Fischer Verlag, 1960-1964.

[10] Umweltbundesamt, *Daten zur Umwelt 1988/89*; Berlin, Erich Schmidt Verlag, 1990.

[11] V. Westhoff, 'De verarming van flora en vegetatie'; in: *Gedenkboek Vijftig jaar Natuurbescherming in Nederland*; 's Gravenland, Vereniging tot Behoud van Natuurmonumenten in Nederland, 1956, pp. 151-186.

[12] V. Westhoff, E. Weeda, 'De achteruitgang van de Nederlandse flora sinds het begin van deze eeuw'; *Natuur en Milieu*, 1984, 8(7-8):8-17.

[13] G. van Dijk, 'Half-natuurlijke graslanden in Europa verdwijnen'; *Natuur en Milieu*, 1991, (9):8-13.

[14] C. Barr, D. Howard, B. Bunce, M. Gillespie, C. Hallam, *Changes in hedgerows in Britain between 1984 and 1990*; Merlewood Research Station, Grange over Sands, Institute of Terrestrial Ecology, 1991.

Figure 2.2 **Distribution of the cork oak** (*Quercus suber*) in the Mediterranean region (after Rikli 1942) [15]

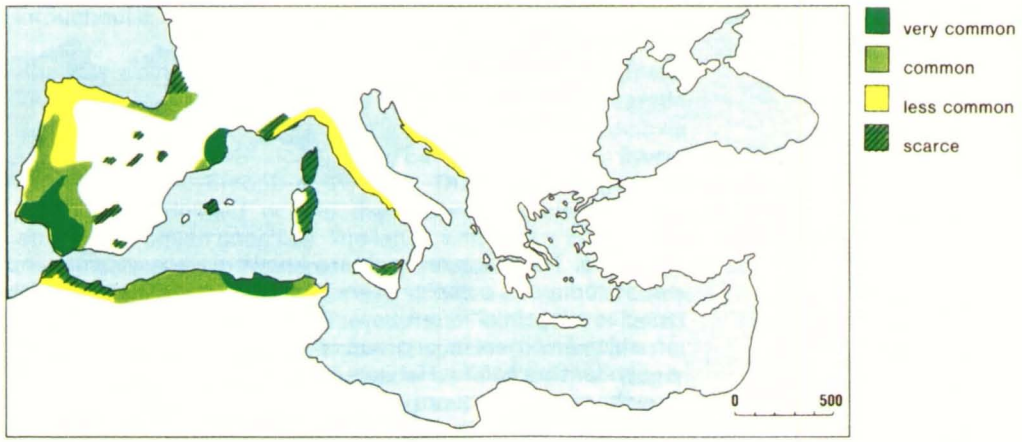
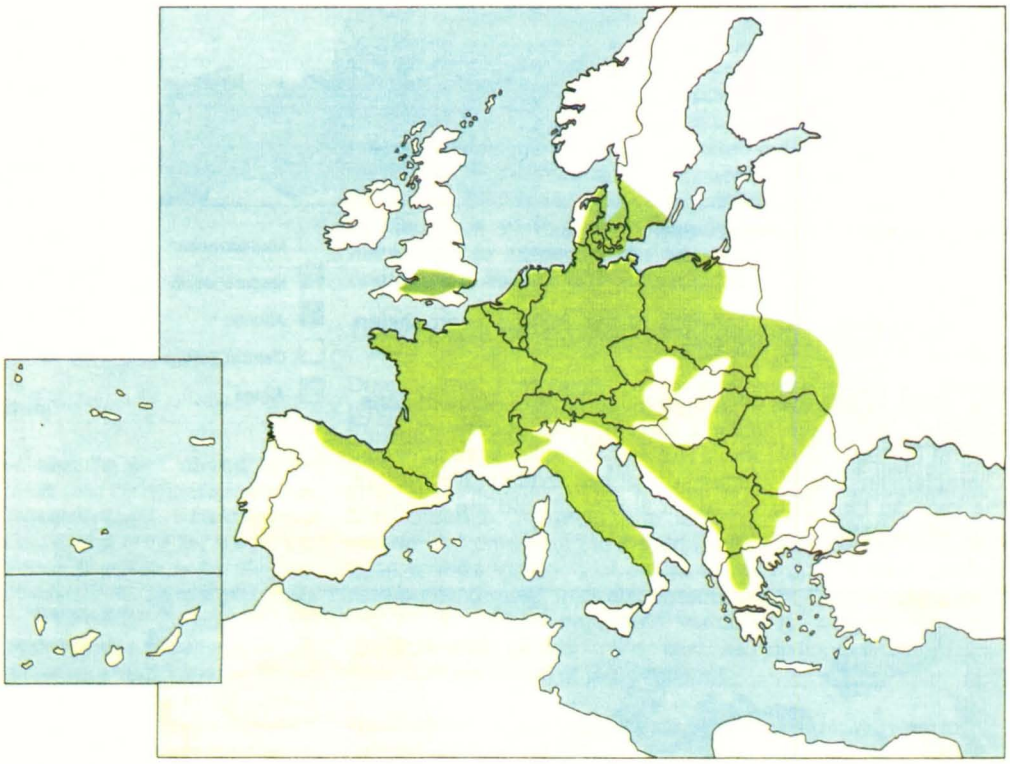


Figure 2.3 **Distribution of the beech** (*Fagus sylvatica*) in Europe (after Hultén and Fries 1986) [16]



For fish the situation is even worse. Of the 72 fish-species that are known from Germany 55 are red list species and 20 have become extinct (Umweltbundesamt 1990) [17]. In the Netherlands fish like the salmon (*Salmo salar*), the

[15] M. Rikli, *Das Planzenkleid der Mittelmerländer, Part. I, II, III*; Bern, Haus Hübner Verlag, 1942-1946.

[16] E. Hultén and M. Fries, *Atlas of North European vascular plants, north of the Tropic of Cancer*; Königstein, Koeltz, 1986.

[17] Umweltbundesamt, op.cit., 1990.

sturgeon (*Acipenser sturio*), the shad (*Alosa alosa*) and the twaite shad (*Alosa fallax*) have become extinct. In the North Sea the common seal (*Phoca vitulina*) suffers by a strong decline (Ministry of Agriculture, Nature Management and Fisheries 1990) and the otter (*Lutra lutra*) has just been declared to be extinct in the Netherlands [18].

In the Mediterranean the decline of species can be exemplified by the status of the larger mammals, like the monk seal (*Monachus monachus*), the wolve (*Canis lupus*), the lynx (*Lynx lynx* and *Lynx pardina*) and the brown bear (*Ursus arctos*). They still are present, but their numbers are declining. Data on decline are lacking, but the general pattern is clear. There is a preponderance of threatened species in the Mediterranean area. In Italy the wolve populations are strongly declining (IUCN 1989) [19] and in Spain the brown bear (*Ursus arctos*), the wolve (*Canis lupus*) and the pardel lynx (*Lynx pardina*) are threatened (Perez and Vela 1991) [20].

Differences between northern and southern Europe are undoubtedly influenced by the natural distribution of species across the Community. Species diversity is lower in northern areas due to the relatively adverse climate at present and the effects of glaciation and climatic deterioration during the Quaternary period; it is higher in southern areas that escaped the most severe impacts of Quaternary glaciation and have a great variation in climatic and physical conditions.

2.3 Ecosystems and biotopes

Within the biogeographic regions all kind of ecosystems can be found. For the CORINE programme a hierarchic system of European ecosystems, defined as biotopes, has been developed (Moss et al 1991) [21]. This list has been used as a basis for Annex IV of the Habitat Directive and has also been used here in a simplified way. The presence of each group of ecosystems in the biogeographic regions is presented in Table 2.1. Some biotopes appear to be widespread, others to be more restricted.

An ecosystem can be defined as the populations in a given area and their abiotic environment functioning in relation to each other. A biotope of a species is characterised by a certain homogeneity in environment for an organism. By analogy to human society it is the organism's address (Andrewartha and Birch 1984) [22]. Besides, species live in interaction with each other. Plants, insects, grazing animals need each other for feeding and reproduction and predators depend on their prey and in this way on their habitat. Because of these complex interactions it is sometimes difficult to indicate a biotope for a species. A biotope is a species-related concept. However, in the context of the CORINE inventory it has been defined as an area of land or a body of water which forms an ecological unit of community significance for nature conservation (Moss et al 1991) [23].

Many species are migratory as is the case for fish species like the eel (*Anguilla anguilla*), the salmon (*Salmo salar*) and birds like geese, swans and cranes. The different parts of their biotope can therefore be far apart. The biotope of species

[18] Ministry of Agriculture, Nature Management and Fisheries, *Nature Policy Plan of the Netherlands*, The Hague, 1990.

[19] IUCN, *From strategy to action. The IUCN Response to the Report of the World Commission on Environment and Development*; Gland, 1989.

[20] M.R. Perez, V.G. Vela, *Inventario de zonas de interes potencial para la red 'Natura 2000' en el estado Español*; Madrid, ADENA/WWF, 1991.

[21] D. Moss, B. Wyatt, M.H. Cornaert, M. Roekaerts, *CORINE Biotopes - The design, Compilation and Use of an Inventory of Sites of major Importance for Nature Conservation in The European Community*; Luxembourg, Office for official Publications of the European Community, 1991.

[22] H.G. Andrewartha, L.C. Birch, *The ecological Web. More on the distribution and abundance of animals*; Chicago and London, The University of Chicago Press, 1984.

[23] D. Moss et al, op.cit., 1991.

like the Pyrenean desman (*Galemys pyrenaicus*) with restricted dispersal activities can easily be defined, while it is much more difficult to locate the biotope of the Otter (*Lutra lutra*), living in a comparable aquatic biotope. However, this animal moves along rivers and lakes, from headwaters to downstream. Its biotope is therefore complexly large and can easily be disturbed by land use and regulation of brooks and rivers.

Table 2.1 **Important ecosystems (biotope types based on the CORINE inventory) differentiated for the biogeographic regions in Europe. Mediterr.: Mediterranean, Macaron.: Macaronesian, Centr-Eur.: Central European**

		Mediterr.	Macaron.	Atlantic	Centr-Eur.	Alpine
1	Open sea	*	*	*	*	-
2	Coastal habitats					
2a	coastal wetlands	*	*	*	*	-
2b	cliffs and rocks (sea)	*	*	*	*	-
2c	coastal dunes	*	*	*	*	-
3	Inland wetlands, lakes	*	*	*	*	*
4	Brooks and rivers	*	*	*	*	*
5	Forests					
5a	broadleaved evergreen	*	*	-	-	-
5b	broadleaved deciduous	-	-	*	*	*
5c	coniferous	*	-	-	*	*
5d	alluvial	*	*	*	*	*
6	Scrubs and heaths					
6a	heaths	-	-	*	*	*
6b	scrubs	*	*	-	*	*
7	Grasslands					
7a	dry grasslands	*	-	-	*	-
7b	humid grasslands	*	*	*	*	*
7c	alpine grasslands	-	-	-	-	*
8	Bogs	-	-	*	*	*
9	Bare land					
9a	inland dunes	-	-	*	-	-
9b	cliffs and rocks	*	*	*	*	*
9c	(semi-)desert	*	*	-	-	-

Habitat has a meaning that is more or less the same as biotope. However, it also is defined according to the Habitat Directive of the EC as a land of water-site distinguished by special geographical, abiotic and biotic features and that can be natural as well as semi-natural. In this study both notions of biotope and of habitat will be avoided as much as possible and be used mostly in their scientific sense unless mentioned other wise to prevent interpretation problems.
The seas, the Atlantic ocean and their coastal wetlands have not been included in this study because they are not important as potential agricultural land and the lack of sufficient data for marine ecosystems. Still, open sea and coastal wetlands are important threatened ecosystems. They are important for fish, birds and mammals. Many species here are declining, because of overexploitation, pollution and habitat loss. Along all coasts of Europe important coastal habitats can be found although the largest area is concentrated in north-west

Europe. The coastal wetland is very important for fauna, especially for bird species. Most mammals like the monk seal (*Monachus monachus*) and the common seal (*Phoca vitulina*) are declining because of loss of habitat quality (Bennett 1991) [24].

Inland wetlands can be very diverse. There can be floating vegetation types, reeds, wet and humid grasslands and sedge vegetations, marsh and fen woodlands and floodplain forests. Because of its diversity in vegetation and its partially mesotrophic and eutrophic conditions it is a natural feeding habitat for many fauna species. Inland wetlands are vulnerable and threatened. So are their bird species and their mammals.

The biotope of wetland birds does not only consist of the breeding and wintering sites, but also of the wetlands in their migration route and these routes as well. This means that the European habitat of wetland birds can be defined as a network of breeding sites, wintering sites and stepping stones over the whole continent. Many wetlands can be part of this network and site quality, area and distance between the sites are the most important variables that determine the functioning of the network. Inland wetlands and rivers vary from fresh standing waters to rivers and brooks and marshlands. In general, the inland wetlands in the EC are smaller in size than the coastal wetlands, although their total area is about the same. Their status is less protected; less than 20 percent of the Ramsar Sites in the EC and the neighbouring countries are inland wetlands of which nearly 50 per cent is situated in Austria and Germany.

Forests are a common natural vegetation type in all Europe. Unique forests exist in the Macaronesian region and especially Madeira, characterised by Canarian oak (*Quercus canariensis*) and A'ores Laurel (*Laurus azorica*). There is a gradient in vegetation types from the Mediterranean broadleaved evergreen forests of cork oak (*Quercus suber*), holm oak (*Quercus ilex*), evergreen oak (*Quercus rotundifolia*) and Lusitanean oak (*Quercus faginea*) via south Atlantic deciduous forests of Pyrenean oak (*Quercus pyrenaica*) to the wide variety of central European forests of beech (*Fagus sylvatica*). On the Pleistocene soils of the Atlantic climate these gradually turn into forests of birch (*Betula pendula*) and pedunculate oak (*Quercus robur*). To the north and east and in the higher mountains conifer forests dominate consisting of Norway spruce (*Picea abies*), European larch (*Larix decidua*) and Scotch pine (*Pinus sylvestris*).

Maquis and garigue (tomillares, carrascal, phrygana) are typical Mediterranean and Macaronesian habitats. The typical maquis reaches about two to three meters in height and is dense and impenetrable; there is a restricted herb layer and the vegetation often exists of just a few species. Garigue or carrascal and phrygana are much richer in herb species and scrub species. Maquis, garigue and phrygana can be considered as degradation phases of the Mediterranean broadleaved evergreen forests. From the Canarian islands in the west to Greece in the east several plant species are replaced by other vicariant species and also the fauna changes from west to east. Garigue and maquis are not only degradation stages of Holm Oak (*Quercus ilex*) and Evergreen Oak (*Quercus rotundifolia*) forests in the Mediterranean region, they also can be the climax vegetation in the gradient to the semi-desert.

In the wood pasture forests of northern Germany, scrubs dominated by Blackthorn (*Prunus spinosa*) are both the degradation stage of hornbeam forests (*Carpinion*) and of ash-elm forests (*Ulmion*) as the stage from which the forests regenerate under grazing pressure (Pott and Hüppe 1991) [25]. In oak-birch forests (*Quercetalia*) their function can be taken over by juniper (*Juniperus communis*) and holly (*Ilex aquifolium*). That means, that in time habitats can change into other habitat types.

On the north west part of the Iberian peninsula the Mediterranean scrubs

[24] G. Bennett (ed.), *Towards a European Ecological Network*; Arnhem, Institute for European Environmental Policy, 1991.

[25] R. Pott and J. Hüppe, *Die Hudelandschaften Nordwestdeutschlands*; Münster, Westfälisches Museum für Naturkunde, 1991.

gradually change into heathlands. Heathlands are characteristic for the Atlantic region. It is a vegetation type of acid soils and is the degradation phase of the birch-oak (*Quercion roboris-petraeae*) forests. The Iberian heath vegetation can reach two to three meters in height and is rich in species. The Atlantic heathlands habitats change gradually from Portugal to Ireland (Oudhof and Barendregt 1987) [26].

Grasslands can be found all over Europe. Where in natural situations grazing pressure is high or climate conditions are extreme, as in the high Alps and the semi-desert, forests and scrubs disappear and grasslands appear. Man changed the landscape of large parts of Europe into grasslands by agricultural exploitation. Many fauna and flora species in Europe depend on this habitat, not only on the natural grasslands but also on the managed grassland areas. That caused a wide range of grassland vegetations from dry to wet, from siliceous to calcareous soils and from north to south. Different types of agricultural land use can be important for the conservation of this enormous diversity in vegetation and its related fauna. Scrubs and grasslands are successional phases in a cycle of degeneration and regeneration of forests after management measures such as grazing or burning.

Bogs are rain-fed vegetations with a dead layer of organic matter that can reach several meters; they depend on precipitation and still are an important source of fuel. Where net precipitation and air humidity are too low, bogs cannot survive. Therefore bogs are found in western and northern Europe. In the EC the most extensive bogs are situated in the Atlantic region. In Ireland and Scotland large areas are covered by blanket bogs. Raised bogs occur in depressions or on slopes in the less atlantic regions of Ireland, Great Britain, and in The Netherlands Belgium and Germany (Glastra 1990) [27]. Bogs are stable vegetations that build their own extreme environment. They are poor in vascular plants and fauna, but rich in mosses and lichens. Black grouse (*Tetrao tetrix*) and Scotch ptarmigan (*Lagopus lagopus*) can be considered as representatives for bogs. Also several reptile species, migratory birds and butterflies depend on or even are restricted to bogs.

Inland bare land can be found in two forms: inland sand dunes in the Atlantic region and rocks, stones and cliffs in mountain areas. Rocks and cliff habitats are mainly nesting sites for large birds and a habitat for Ibexes. The habitat always functions in relation to other habitats: grasslands, scrubs and forests where the species go for grazing and hunting. The Atlantic inland sand dunes were rather common in the Pleistocene parts of Europe from the Middle Ages on. They originated from overgrazing of heathlands; now they are more or less restricted to some areas in the Netherlands. They function as a habitat for reptiles and tawny pipit (*Anthus campestris*) and are rich of lichens.

Superimposed upon this basic pattern, however, are the effects of human activities. In the northern areas the combination of forest clearance, intensive agricultural development and widespread industrial development have caused the extinction of large numbers of species over the last 200 years. And although man's impact on nature in the southern regions have been great since ancient times, as has already been stated by Plato and Posidonius (Glacken 1967) [28], it did not yet appear to influence strongly its species richness. Recently, however, decline of species has become evident. This is mainly caused by land use changes and pollution.

Man's impact on wildlife and natural ecosystems is undoubtedly increasing due to land use changes. Agriculture is becoming more intensive in some parts

[26] J.A.F. Oudhof, A. Barendregt, 'Processing of vegetation relevés to obtain a classification of South-West European Heathland Vegetation'; in: Jongman, Ter Braak, Van Tongeren (eds.), *Data Analysis in Community and Landscape Ecology*, Wageningen, PUDOC, 1987.

[27] M.J. Glastra, *Hoogveen in noorwest Europa: een kwestie van krimp en groei*; Wageningen, Scriptie Landbouwuniversiteit, 1990.

[28] C.J. Glacken, *Traces on the Rhodian shore. Nature and culture in western thought from ancient times to the end of the nineteenth century*; Berkely, University of California Press, 1967.

of the EC but is declining in other parts. Even land use forms that are thought to be stable on the long run, like highland farming in Great Britain, is partly declining (Watson 1989) [29]. Baldios in Portugal are forested and the systems of the dehesas in Spain are under pressure. Towns, tourism and transport systems are expanding and, as a result, these many changes are affecting natural and semi-natural ecosystems. A major effect is the loss of (semi-)natural ecosystems – especially wetlands, lowland meadows, heathlands, dry grasslands and old growth forest. If these disappear, the populations of many species will progressively reduce, and the risk of extinction will increase.

2.4 Dispersal and migration

Dispersal can be defined as all directed and undirected movements of species from one site to another. Plants and animals are both dispersed by wind, water, with help of other species or by own movements. Migration is a specification, while it is directed to a certain site. Dispersal is essential in population survival and the functioning of biotopes.

However, dispersal can only function if there are sites to disperse from and to. Dispersal is important for survival of populations. On the one hand, animal species will leave a population if living conditions cannot support all individuals. On the other hand, species will fill in gaps in populations or sites that became empty. Fluctuations in populations can cause changes in species abundance and and species composition of a site. Birth, death, immigration and emigration are the main processes to regulate fluctuations at the population level. Plants, but also several other groups of species, depend on other species for their dispersal. Restriction of species dispersal increases the chance of species extinction (Den Boer 1990) [30].

The main elements in the landscape that are of importance for dispersal are the area of biotopes sites, the distance between them, the presence of corridors and the barrier effect of landscape and land use between. (Opdam 1991) [31]. Area reduction will cause a reduction of the populations that can survive and, in this way, cause an increased risk of extinction. Because of the increasing perimeter/area ratio, the influence of the surrounding land use will increase, thus causing a change in habitat quality that can again affect the populations. If the dispersal between habitats decreases, isolation will cause less exchange of genetic information and reduce the colonisation of empty habitats. On the long run isolation of habitats can also cause differentiation by genetic diversification, as the Macaronesian flora and fauna show (Humphries 1979) [32].

Routes for species migration consist of zones that are accessible for the species to move from one site to another and back. For flying animals this means that this route lacks barriers and that stepping stones are available for feeding, rest and shelter. What is a stepping stone for one species, a temporary habitat for feeding and shelter, can be a permanent habitat for another. Migration routes can be manyfold, from single wooded banks to small scale landscapes and from river shores to rivers and coastlines. Migration is a prerequisite for many species from northern Europe to survive the winter period.

Isolation is an important feature in agricultural landscapes of northwestern Europe, but even in production forests management can cause isolation of the

[29] A. Watson, *Land use reduction of heather and natural tree regeneation on open upland*; Merlewood Research Station, Grange over Sands, Institute of Terrestrial Ecology, Annual Report, 1988/1989, pp. 25-27.

[30] P. Den Boer, 'Isolatie en uitsterfkans. Gevolgen van isolatie voor overleving van populaties van arthropoden geïllustreerd aan loopkevers'; *Landschap*, 7e jaargang, pp. 101-120.

[31] P. Opdam, 'Metapopulation theory and habitat fragmentation: a review of holarctic breeding bird studies'; *Landscape Ecology*, 1991, 5(2):93-106.

[32] C.J. Humphries, op.cit., 1979.

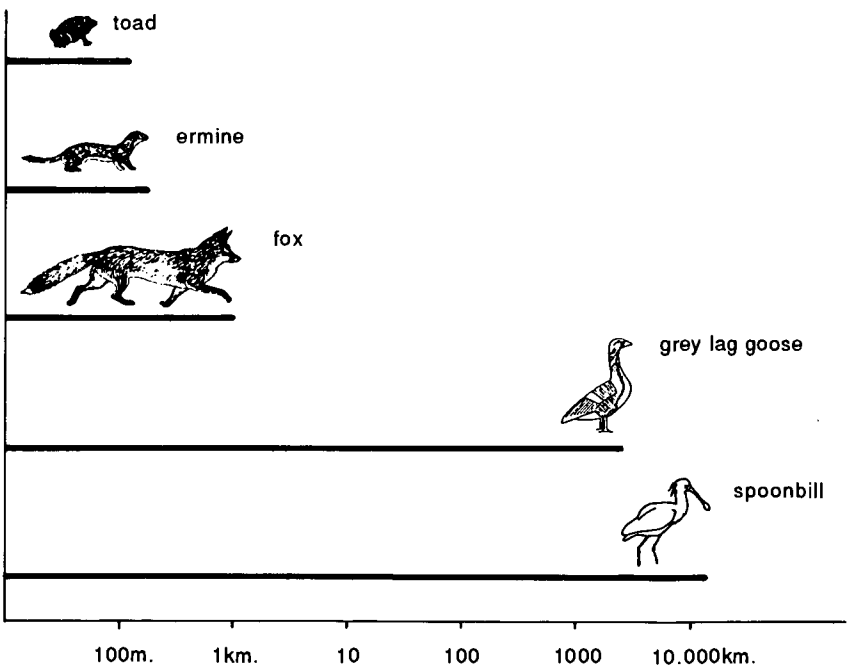
remnants of natural old growth forests within it (Harris 1984) [33]. Most natural and semi-natural habitat sites are remnants of former natural areas. In the time that the territory of the EC was merely covered by natural and semi-natural vegetation, species within these forests and scrubs – in general the less dynamic habitats – had no problems of dispersal or migration. Their biotopes were large and well accessible. Dynamic, though relatively small, ecosystems were present as well and the species were adapted to fast dispersal and colonisation.

Now dynamic biotopes dominate the landscape and populations of wild species of former large stable biotopes are dispersed over several subpopulations in relatively small sites. The single sites are mostly too small to let the population survive on the long run. If one gets extinct it must be recolonised. The species is in danger if the area in between becomes impossible to cross (Opdam 1991) [34]. Species of dynamic habitats are better adapted to present land use and survive easily or even increase in numbers.

To prevent nature decline by isolation of biotope sites it is important not only to preserve or develop areas that are large enough for persistence of populations, but also to maintain the possibilities for exchange of species. That means that important aspects are (1) the size of the sites, (2) the distance between them and (3) the absence of barriers.

Modelling, field research and also nature conservation practice show that without species exchange vital populations can apparently get extinct in the long run. Although this is not the case for all species, it is for many vulnerable species. Ecological corridors and stepping stones can be essential for long term persistence of species. Ecological relations are found to be of all kind, through air, in the water and on the ground.

Figure 2.4 **Distance between biotope sites that can be bridged by species differ largely from some meters to several thousands of kilometers**



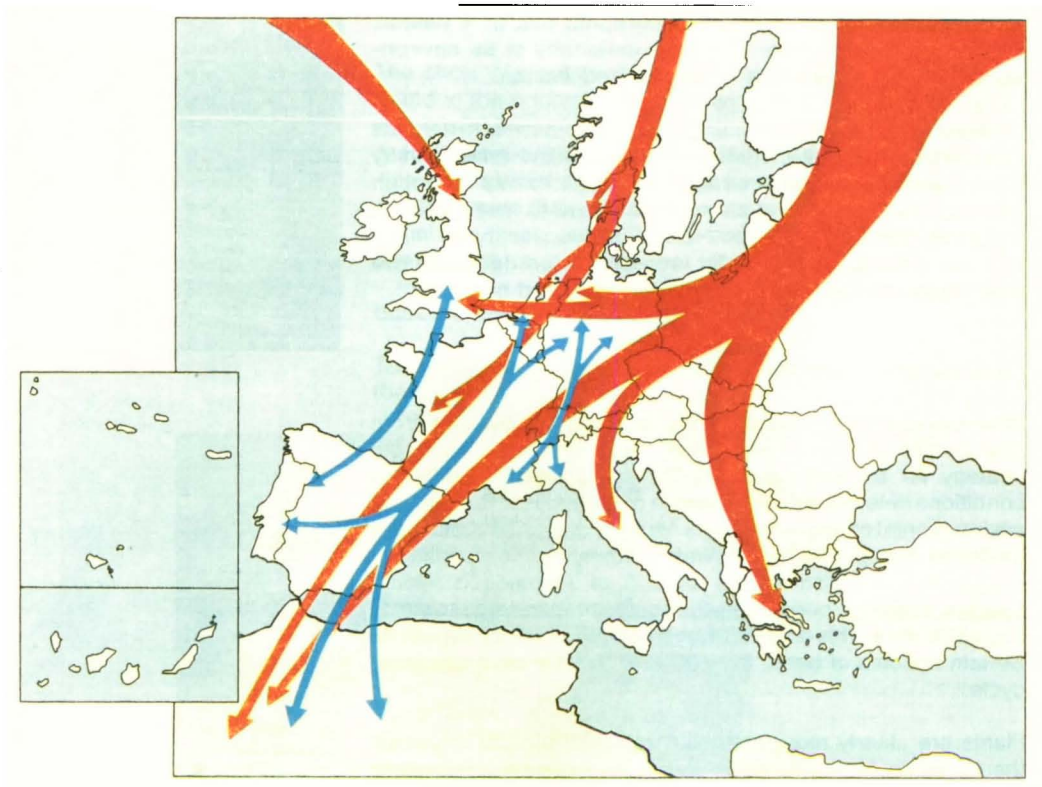
Source: Agricultural University, Wageningen

[33] L.D. Harris, *The fragmented forest. Island biogeography Theory and the preservation of Biotic diversity*; Chicago-London, University of Chicago Press, 1984.

[34] P. Opdam, op.cit., pp. 93-106.

Their spatial scale can differ from local to continental and global. As the distance between suitable biotope sites increases, the number of species that can bridge this distance decreases (Figure 2.4). Ecological corridors can be of all kind as well, which makes it difficult to define them and to realise them in practice. However, research is carried out and for several groups criteria can be set.

Figure 2.5 **Main bird migration routes in Europe. Indicated are migration routes from the Arctic zone into Europe and routes within Europe**

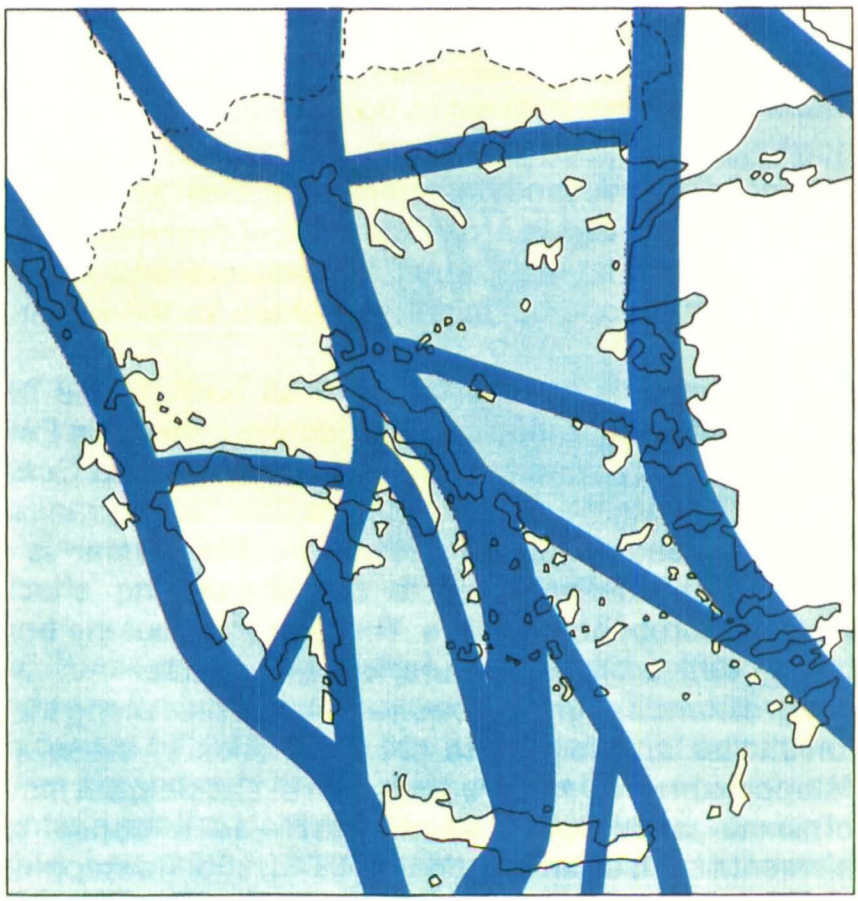


Source: Agricultural University, Wageningen

Amphibians and mammals are able to disperse over distances from several meters to hundreds of kilometres. For small mammals ecological corridors can be hedgerows, brooks and all kind of other natural features that offer shelter. Migration is important for grazing animals like deer (*Cervus elapus*) and roe deer (*Capreolus capreolus*), for predators like the golden eagle (*Aquilla chrysaetos*), the pardel lynx (*Lynx pardina*) and the wolf (*Canis lupus*) but also for most birds of northern Europe. For forest birds small scale landscapes characterised by a certain density in wooded banks can function as corridors from one forest to another. Birds, such as geese, use northern Europe for breeding and southern Europe for wintering. Other birds, swallows and storks use the European continent as part of their migration route to Africa. These species are not only depending on their breeding habitats but also on the presence of temporary habitats within their migration route. These stepping stones are sites used for feeding and resting during migration. The Waddenzee, for example, is such a temporary habitat for many Fennoscandian species.
Migration routes for fauna species are found everywhere in Europe. The large-scale corridors for birds can be classified into two groups, (1) the migration routes from and to Fennoscandia and Siberia and (2) the migration routes

between central Europe and the Mediterranean and Africa (Figure 2.5). There is a hierarchy in the ecological relations within Europe. At a lower scale migration routes can be more specified as for instance for raptors in Greece (Figure 2.6). This means that the sites that are used by the fauna can change with the seasons or with the organism's life cycle.
Not only fauna, but also flora can move from one site to another with help of wind, water or animals. Some need that in their strategy for survival, others use dispersal capacity to adapt to changing environmental conditions.

Figure 2.6 **Migration routes of raptors in Greece (after Handrinos 1987)** [35]



Source: Agricultural University, Wageningen

[35] G.I. Handrinos, 'The significance of Greece for migrating and wintering raptors'; in: Bacetti and Spagnesi (eds.), *Rapici Mediterranei*, Supplemento alle Ricerche di Biologia della Selvaggina, Vol XII, pp. 99-113.

Development of nature conservation

3

3.1 Introduction

Nature conservation policy is common in all the member states of the European Community. However, differences exist between the policies of the member states. Their strategies do not only depend on administrative structures, legislative procedures, but are also based on ideas about nature conservation.
The history of nature conservation can be divided into several periods. Henke (Henke 1990) [1] divides the German history of nature conservation into six stages. The Dutch history can be described in three (Van der Valk, 1982) [2], six (Gorter 1986) [3], or even seven stages (Van Amstel et al 1987) [4]. Curry-Lindahl (1979) [5] and Boardman (1981) [6] distinguish three phases in the international development of nature conservation. This simple division is the most general one and makes it possible to describe the history of nature conservation in all member states shortly. These can be named as:

1. The origin of nature conservation;
2. The consolidation of nature conservation;
3. Landscape ecology based nature conservation.

Nature conservation passed these three phases in all member states in different periods of time. Recently it became part of the EC-policy.

3.2 The origin of nature conservation

At the end of the 19th century the recognition of the importance of nature conservation emerged in most EC member states. The technological and economic development lead to an increasing loss of nature. At the same time the valuation of the beauty of nature, the love for nature and the recognition of its importance for outdoor recreation increased, as expressed in literature, art and architecture. The controversy between valuation of nature and the loss of nature created a basis for the beginning of the nature conservation.
In the first period nature conservation was based on private initiatives and organized through the foundation of voluntary organizations. In many parts of Europe this moment can be located at the turn of the 19th to the 20th century (Table 3.1).
The organization of nature conservation started at the national level, but soon internationalized. Already in the last decennium of the 19th century organizations for bird protection recognized the importance of international cooperation. The first International Conference on bird protection was held in Paris in 1895. In 1902 the first international agreement on the protection of useful birds was signed by the European countries.

[1] H. Henke, 'Grundzüge der geschichtlichen Entwicklung des internationalen Naturschutzes'; *Natur und Landschaft*, 1990, 65(3):106-113.

[2] ÉA. van der Valk, *Planologie en Natuurbescherming in Historisch Perspectief*; 's-Gravenhage, NIROV, 1982.

[3] H.P. Gorter, *Ruimte voor natuur, 80 jaar bezig voor de natuur van de toekomst*; 's-Graveland, Vereniging tot Behoud van Natuurmonumenten in Nederland, 1986.

[4] A.R. van Amstel, G.F.W. Hengreen, C.S. Meijer, E.F. Schoorl-Loen, H.E. van der Veen, *Vijf visies op natuurbehoud en notuurontwikkeling*; Amsterdam, Instituut voor milieuvraagstukken UVA, 1987.

[5] K. Curry-Lindahl, 'Achtergronden en ontwikkelingen van de internationale natuurbeschermingsorganisaties en hun betekenis voor de toekomst'; in: Bongers (ed.), *Natuurbeheer vandaag*, Wageningen, PUDOC, 1979, pp. 139-155.

[6] R. Boardman, *International Organization and the Conservation of Nature*; London, MacMillan, 1981.

The importance of nature conservation on the international level was recognised more and more during the conferences for ornithologists and other ecologists. The first general international conference on nature conservation was organized in Bern in 1913 after a period of activities in separate fields. This conference lead to the foundation of the 'Consulting Commission for International Protection of Nature' in 1914. The first World War, however, made an end to its activities.

After the first World War international coordination of nature conservation restarted with the foundation of the International Committee for Bird Protection (ICBP) in 1922.

Table 3.1 The voluntary organizations in the European countries and the resulting legislation in the beginning of nature conservation

Countries	Voluntary organizations	Foundation date	Legislation
Denmark	Natuurfredningsforening	1911	1917 Laws on the protection of nature
France	Societe pour la Protection de Paysage de France Ligue Francaise pour la Protection des Oiseaux Societe National d'Acclimation de France	1901	1906 Law on the protection of sites and nature monuments of artistic character
Ireland	Taisce (The National Trust of Ireland)		
Italy	Gruppo per la Tutela del Patrimonio Scientifico Nazionale Liga Nazionale per la Protezione dei Monumenti Naturali in Italia Italia Nostra		1922 Law on the protection of natural beauty
Luxembourg	La ligue Luxembourgoise pour la Protection de la Nature et de L'Environment La ligue Luxembourgoise pour la Protection des Oiseaux utiles	 1920	1927 Law on the protection of sites and monuments
The Netherlands	Vereniging tot Behoud van Natuurmonumenten Nederlandse Vereniging tot Bescherming van Vogels	1905 1898	1927 Law on the protections of natural beauty 1912 Law on the protection of birds
Spain	Liga per a la Defensa de Patrimoni Naturel (DEPENA) Individual Alpinists		1917 Law on national parks
UK	National Trust The Royal Society for the Protection of Birds	1895 1895	
Belgium	Vereniging tot Behoud van Natuur- en Stadsschoon Ligue Belge pour la Protection de la Nature Belgische Natuur- en Vogelreservaten (BNVR)	1905 1912 1951	
Germany	Deutscher Verein zum Schutz der Vogelwelt	1875	1888 Law on bird protection
Greece	Greek Alpinists (individual) Hellenic Society for the Protection of Nature Hellenic Ornithological Society	 1951 1982	1937 Law on national parks
Portugal	-	-	1976 Law on protected areas

In the twenties a development similar to that before the war occurred: a congress for the protection of nature leading to the foundation of the 'Office International de la Protection de la Nature' in 1928. An important difference was the great number of non-governmental organizations for the protection of mammals that joined the organization. The period was characterized by the work of pioneers and although there were many good initiatives, coherence was a weak point. In this period three types of organizations based on different visions on nature conservation can be distinguished:

1. organizations influenced by the foundation of the national parks in the USA (Yellowstone, 1872);
2. organizations influenced by the values of nature described by scientists and artists like Alexander von Humboldt (Germany and Jean Lahor (France);
3. organizations emphasizing the importance of bird protection for human utilities.

The first group focused on the foundation of national or nature parks in accordance with the examples in the USA. Conservation and, if necessary, restoration of natural and semi-natural values in large areas were central. In the countries where these organizations had influence, national parks and nature parks were developed which cover rather large areas. Examples are Verein Naturpark (Germany), Individual Alpinists (Greece, Spain).

The main activities of the second group were the protection of areas with high natural values in combination with historical landscapes, often in relatively small nature reserves or as extensive managed historical landscapes. Some of these organizations used the strategy to buy the most threatened areas and to manage them. This was practised by organizations as the Vereniging tot Behoud van Natuurmonumenten (The Netherlands), National Trust (United Kingdom), Natuurfredningsforening (Denmark), La Ligue Luxembourgoise pour la Protection de la Nature et de l'Environment (Luxembourg), Ligue Belge pour la Protection de la Nature (Belgium).

The third group focused on bird protection. They also acquired reserves and reached a high degree of acceptance by the people and the governments. In all cases the legislation for bird protection followed shortly after the foundation of these organizations (Table 3.1). Examples are Ligue Francaise pour la Protection des Oiseaux (France), Deutscher Verein zum Schutz der Vogelwelt (Germany), Nederlandse Vereniging tot Bescherming van Vogels (The Netherlands), The Royal Society for the Protection of Birds (United Kingdom), Ligue Luxembourgoise pour la Protection des Oiseaux (Luxembourg). In countries like Greece and Portugal the developments of nature conservation started only recently.

The public debate on nature conservation in the beginning of the twentieth century was focused on the confrontation between supporters of economic and social development and those who emphasised respect for life and nature. Within the new nature conservation movement the discussion was not strong. The main activities were focused on the preservation of the fast declining nature and the strengthening of the nature conservation movement. In Germany, The Netherlands and Hungary some discussions started on the restrictions of perspectives of nature conservation when it only protects small areas, but they did not get much attention.

3.3 Consolidation of nature conservation

After the Second World War nature conservation was focused on the preservation of values within semi-natural landscapes. This was especially important in the northern states of Europe, where the decline of nature was alarming. In the seventies many changes took place in nature conservation; nature conservation acts were revisited in all member states. Some countries amended the existing legislation, others formulated a wider nature conservation policy and included relations with other policy issues (recreation, urbanisation, regional planning, agriculture). This period can be characterised as the

time of acceptation of responsibility of nature conservation by national governments (Table 3.2).

Immediately after the Second World War nature conservation restarted its activities at an international level. The foundation of the International Union of the Protection of Nature (IUPN since 1956 IUCN) in 1948 was the starting-point for a scientifically based international organization. In 1958 the IUCN founded the International Commission of National Parks to create an international support for national parks.

Table 3.2 **Nature Conservation legislation in the member states of the EC between 1960 and 1980 as far as data are available on legislation. NCA: Nature Conservation Act**

Country	Name	Date	Content
Belgium	NCA	1973	An outline law, the provisions of which are only effective after an executive order comes into force
Denmark	NCA	1972	This act provides general and specific regulations for the planning and protection of nature. This is the principal act concerning the set-aside of areas for protection
France	National Parks Act	1960	
	NCA	1976	
Germany	NCA	1976	A 'frame law' without imposing any obligations on the individual and without providing detailed regulations.
Greece			
Ireland	Wildlife Act	1976	This act includes provisions to give full protection to all species of wild fauna and flora as required
Italy	Presidential Decree	1976	A decree to give responsibility to the regions for the protection of nature, nature reserves and national parks, with the exception of national parks and nature reserves of national importance.
Luxembourg	NCA	1982	The act provides for the designation of protected nature areas monuments. The law requires the Minister to devise a 'Control Plan' for each protected area.
The Netherlands **Netherlands**	NCA	1967	The law provides possibilities to designate several types of protected areas.
Portugal	NCA	1976	
Spain	Natural Areas Protection Act +	1975	
	Regulations	1977	The law together with the regulations does provide for the protection of four categories of open spaces
United Kingdom	NCA	1973	

The UN supported the IUCN to realise an inventory of national parks and equivalent nature reserves. In 1961 the first UN-list of national parks and equivalent nature reserves was published. This was an important basis for the first World Conference of National Parks in Seattle (USA), because the list was not

only considered as an inventory but also as an important list to be present on. An important problem of these UN-lists was the lack of a general definition of National Parks. In 1969 a definition was formulated on the 10th General Conference of the IUCN in New Delhi. In 1971 the second UN-list was published, in which this definition was not yet applied.
Financial problems lead to the foundation of the World Wide Fund for Nature (WWF) in 1961 (Gorter 1986) [7]. This support organization, build up around prominent personalities from the economic and political world, had the task to promote the international nature conservation. IUPN/IUCN participated in other international organizations such as WWF, ICBP and IWRB. In this period, an attempt was made to develop a worldwide consciousness for nature conservation. International nature conservation was still mainly established by non-governmental organizations.
National legislation in Europe is focused on the protection of areas with high natural and semi-natural values which are threatened or are likely to be threatened in the future. Different types of protected areas are defined in the European countries and these show great differences. The strategies, however, are more or less similar: the protection of areas of high natural values in designated areas.
Differences between the member states emerged in the objectives of nature conservation. Some countries designated areas, where other functions can exist beside nature, such as agriculture and forestry. In this period the national nature conservation strategies diversified. Mainly in the northern states of Europe a public debate developed on the question what should be referred to as nature. What had to be protected, undisturbed nature or semi-natural nature of high biodiversity? These objectives require different strategies and can more or less be divided in a strategy of strict separation of nature and other functions and a strategy of integration of nature and other land uses such as agriculture and agricultural management.

3.4 Landscape ecology based nature conservation

In the last decennia of the 20th century nature conservation strategy changes strongly. This change takes shape in new strategies formulated in policy documents on nature conservation and nature rehabilitation of former or potential natural areas (Table 3.3). This stage in the development of the international nature conservation can be seen as a period of cooperation, both world-wide and within the European Community. Development of nature conservation is accellerating at least as far as it concerns organization and legislation (Table 3.4).

Table 3.3 Member states and regions renewing their nature conservation strategies

Country	Terminology in use	Policy notes
Netherlands	Ecologische Hoofdstructuur	Natuurbeleidsplan 1990
Belgium (Vlaanderen)	Groene Hoofdstructuur	Richtnota 1990
Germany	Biotopverbundsysteem	Notes of the Federal States for example Nordrhein-Westfalen (Natur 2000, 1988)
Denmark	Pkologiske Forbindelser	different regional plans 1985
Spain	Potential Natural Areas	in preparation

[7] H.P. Gorter, op.cit., 1986.

On the Second World Conference on National Parks (1971) an international basis was given to the concept of protected areas. In the following decennium the IUCN defined 10 categories of protected areas. In 1970 Unesco restarted its activities on environmental protection and research under influence of the increasing need for protection of nature and natural resources in the end of the sixties. The scientific programme 'Man and Biosphere' lead to a network of Biosphere reserves across the whole world. This programme is started with the objective to develop a scientific basis for the exploitation and the conservation of natural resources as well as to improve the relation between man and his environment. The protection of natural resources gets its first world wide inter-governmental organization in 1972 by the foundation of the 'United Nations Environment Programme' (UNEP). Its task is to coordinate all activities on the environment on UN-level and to work out objectives and standards for international nature protection and the development of the natural conditions of life in conjunction with socio-economic development.

The 'Ecosystem Conservation Group', a conjunction of UNEP, UNESCO, FAO and IUCN, tried to bring this objective by developing a 'World Conservation Strategy' and by promoting this strategy all over the world through the nature conservation movement. This strategy integrates national parks and protected areas in the concept of 'Conservation and Development'. The main objective is to integrate protection of natural resources with socio-economic development. Despite its incompleteness the UN-list of national parks and protected areas has been accepted by most countries and has been an important background document for the World Conservation Strategy. The World Conservation Strategy itself was a basic document for the report of the World Commission on Environment and Development (IUCN 1989) [8].

The importance of international cooperation on governmental level and on the base of conventions in the terms of international organizations is generally recognized. In 1971, the Wetland convention was signed in Ramsar (Iran). In 1973, the European Community started a policy towards wildlife conservation in the First Action Programme on the Environment. One of the aims of this policy was to develop an integrated approach to the conservation of endangered species of flora and fauna and the protection of natural habitats. The European Community adopted a number of legislative instruments. The first was a Recommendation to the member states to adhere to the Wetland Convention and the Paris Convention on the Protection of Birds in 1975.

In 1979 the Bern convention, initiated by the Council of Europe, on the protection of wild fauna and flora was signed and agreed on by the EC in 1982. The UN convention of Bonn on the protection of migrating wild fauna was also signed in 1979. In the same year the EC agreed on the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Furthermore, in 1979 the EC Bird Directive came into force. In 1984 the EC agreed on the fourth protocol of the Barcelona convention. This treaty aims at the protection of the Mediterranean and the prevention of its pollution. The fourth protocol concerns the conservation of endangered Mediterranean species and the areas they inhabit.

The Directive for the Conservation of Wild Birds, agreed on in 1979, emphasised the need for international action on bird protection and set out provisions for the protection, management and control of all species of naturally occurring birds in their wild state in the Community territory. The acceptation of the Bern Convention calls upon the contracting parties to take action to maintain wildlife populations, to develop national policies on wildlife conservation and to control pollution and other threats to wild flora and fauna. This lists endangered migratory species of mammals, birds, reptiles, fish and insects and obliges member states to take steps to protect listed species and control pressures upon them.

In 1984 the EC adopted a Regulation on Action by the Community relating to

[8] IUCN, *From strategy to action. The IUCN Response to the Report of the World Commission on Environment and Development*; Gland, 1989.

the Environment (ACE). Amongst other things, this provides the possibilities of financial support of the European Community to environmental projects relating to important biotopes. The European Community prepared a directive for the protection of natural and semi-natural habitats. Finally in 1988 the first EC proposal was made on a directive on the conservation/protection of natural and semi-natural habitats and their wild flora and fauna. It was agreed on in 1991 and planned to come into force in 1992.

Table 3.4 Historical overview of international and European nature conservation activities

1884	First International Congress of Ornithology in Wenen
1885	International agreement about the salmfishing in the Rhine between the Netherlands, Germany and Switzerland
1895	International Congress of the Protection of Birds in Paris
1887	Foundation of the 'Boone and Crockett Club' (New York) – association of hunters – protection of wild fauna
1902	Convention of Paris – protection birds useful for agricultural purposes
1902	Foundation of the 'International Association of Game, Fish and Conservation Commisioners' in USA and Canada
1903	Foundation of 'The Society for the Preservation of the (wild) Fauna of the Empire (London) – protection of mammals and other threatened fauna in the colonies
1909	Congres International pour la Protection des Paysages in Paris
1909	International Congres on 'World ressources their inventory, conservation and wise utilization' in Den Hague
1911	Foundation of the 'American Game Protective Association' (New York) – protection of wildlife in Northern America
1911	Agreement about the survival of the seal *Artocephalus ursinus* L. between USA, United Kingdom, Canada, Russia and Japan
1912	Internationaler Kongress fuer Heimatschutz in Stuttgart
1913	Conference International pour la Protection de la Nature in Bern
1913	Foundation of 'The Permanent Wild Life Protection Fund' (New York) – financial support for the protection of wildlife
1916	Migration Bird Treaty Act between United Kingdom (Canada) and the USA
1922	Foundation of the International Committee for Bird Protection (London) – protection of birds
1923	Foundation of the 'Gesellschaft zur Erhaltung des Wisents' (Berlin) – protection of the wisent (*Bos bonasus* L).
1923	Premier Congres International pour la Protection de la Nature in Paris
1925	Congres International pour l'Etude et la Protection des Oiseaux in Luxembourg
1926	Foundation of the 'Comite Belge pour la Protection Internationale de la Nature' – protection of mammals
1924	Foundation of the 'British Correlating Committee for the Protection of Nature' – protection of mammals – cooperation with Society for the Preservation of the Fauna of the Empire
1925	Foundation of the 'Commission Permanente pour la Protection de la Faune Coloniale' (France) – protection of mammals, especialy is the colonies
1925	Foundation of the 'Nederlandsche Commissie voor Internationale Natuurbescherming' – protection of mammals
1927	International congress for the protection of waterfowls in London
1928	Foundation of the 'Office International de Documentation et de Correlation pour la Protection de la Nature' (Brussels) – collection of documents on nature conservation
1928	Agreement about Migration Birds between Denmark and Sweden
1929	Migration Bird Conservation Act between United Kingdom (Canada) and USA
1933	First International Congress for the Protection of the Flora and Fauna of Africa in London Convention of London for the protection of flora and fauna in their natural habitats – foundation of national parks in African countries

Historical overview (continues)

1942 Panamerican Convention about the protection of nature and the wild fauna in the western hemisphere (Convention of Washington)
– foundation of national parks and the definition of three categories of protection

1946 International Agreement about the Whales

1947 Foundation of the 'International Waterfowl Research Bureau' in London

1948 Foundation of the 'International Union for the Protection of Nature (in 1956 IUCN)

1958 Foundation of the 'International Commission of National Parks' (ICNP) and later Commission of National Parks and Protected Areas (CNPPA)

1966 First Red Data Book in Luzern/Switzerland

1961 First UN-list of national parks and nature reserves

1961 Foundation of the 'World Wildlife Funds'

1967 First International Symposium about landscape protection areas in UK

1962 First World Conference about national parks in Seattle

1965 First list of wetlands of international importance in Europe and North-Africa (published by IWRB, ICBP and IUCN)

1969 Resolution nr. 1 of the General Conferences is a worldwide definition for the category National Park

1970 Start of the program 'Man and Biosphere' UNESCO

1971 Convention of Ramsar about the protection of wetlands

1972 International agreements about the protection of cultural and natural

1972 UN-Environmental Conference in Stockholm

1972 Foundation of the 'United Nations Environmental Program' (UNEP)

1974 Foundation of the European Environmental Bureau

1975 Convention of Washington

1975 Recommendation of the EC to adhere to the Wetland Convention and the convention of Paris on the protection of birds

1979 Convention of Bern on the protection of wild flora and fauna

1979 EC-Bird Directive in force

1980 Categories of protected areas are defined by the IUCN

1980 World Conservation Strategy
– integrates national parks and protected areas in the conception 'Conservation and Development'

1982 EC agrees on the Convention of Bern

1982 EC agrees on the Bonn Convention on the conservation of migratory species

1983 EC agrees on CITES (Convention on International Trade of Endangered Species)

1984 Foundation of 'Wild Flower Preservation Society Inc(corporated)', (Washington)

1984 Foundation of the 'Verein zum Schutze der Alpenpflanzen'

1984 Adoption of ACE by the EC (Action by the Community relating to the Environment)

1985 EC-agreement on agriculture in evironmentally sensitive areas

1990 EC-regulation on free exchange of information on the environment

1991 EC agrees on the Habitat Directive

Methodology 4

4.1 Introduction

Nature protection in Europe has been analyzed on several occasions and has been defined in different ways. In this study the legal protection status of nature according to international standards has been used as the basis for analysis. The development of the Tentative Ecological Main Structure depends on two aspects:

- the availability of data,
- the criteria for the design of the Tentative Ecological Main Structure.

The first aspect determines the possibilities. Only existing data can be used in the study; it is impossible to gather new data within the framework of this study. Thus, the first aspect depends on the existance of reliable data. These data can differ in many aspects. The aspect of criteria is determined by the definition of the Tentative Ecological Main Structure and two important elements within that structure: core areas and connection zones. The requirements for these functions determine the criteria for the design of the Tentative Ecological Main Structure.

The data are processed with the GIS software ARC/INFO. Two phases have been distinguished according to the objectives of the project:

1. the phase of inventory of protected areas;
2. the phase of inventory of the nature expansion areas and the nature development areas to design a tentative ecological main structure.

4.2 Data

4.2.1 Introduction

Data have been used that have been collected for the whole of Europe in more or less the same way. However, national and regional differences in censuses cannot be completely avoided. Thus, there are inconsistencies in the data.

Data have been collected from various sources. The most important source is the CORINE (COoRdination of INformation on the Environment) database on Biotopes. Furthermore, use was made of the CORINE databases Soils, Designated areas, Administrative regions and Natural vegetation. The most important other data source was the ICBP database on important Bird areas (Grimmett and Jones 1989 [1], Langeveld and Grimmett 1990) [2]. However, these data sources do not cover the whole EC or cover a restricted number of species only. Experts in the member states and national and regional reports have been consulted and, as far as possible, regional data have been used to check the information from the databases.

4.2.2 The CORINE database

The most important source for European environmental data is the CORINE database. The CORINE-programme was adopted in 1985 with the objective of collection, coordination, and improvement of the consistency of information on the state of the environment in the EC. This objective was pursued through two main approaches:

- the development of procedures for data collection and standardization and exchange of data in the EC;

[1] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

[2] M.J. Langeveld, R.F.A. Grimmett, *Important Bird Areas in Europe; Wetlands for the shadow list of Ramsar Sites*, Cambridge, ICBP and IWRB, 1990.

- the establishment of a geographic information system (GIS) capable of providing policy-related information on the EC environment.

The content of the database was defined by the Council Division setting up the CORINE-programme. They specified a number of themes on which information was required, namely:

- Biotopes (i.e. sites of major importance for nature conservation);
- Acid deposition (including atmospheric emissions and damage to soils and biotopes);
- Problems of the Mediterranean region (including land cover, land quality, soil erosion, coastal problems, water resources and seismic risks).

In order to supply results on these various themes a wide variety of data had to be collected and analyzed. Some of these (such as topographic data and administrative boundary data) were fundamental to the geographic framework on which the database could be built. The following data sets have been used:

- Administrative regions (NUTS);
- Soils;
- Potential natural vegetation;
- Designated areas;
- Biotopes.

Administrative regions

The area of the EC is subdivided into NUTS (Nomenclature des Unites Territoriales Statistiques) regions. These are the standard administrative areas used in the EC, primarily for statistical purposes. They are arranged on a hierarchical basis: starting from country code on level 0 followed by regions on level I, provinces on level II and counties or departments on level III. The data on these administrative boundaries have been incorporated into the CORINE database. Not all these levels are represented in every member state and the size of the NUTS regions varies considerably.

In order to ensure comparability in the regions used, a combination of NUTS level II and III has been selected as the lowest levels for incorporation into the CORINE database. Sea and marine coastal wetlands are not part of the administrative area. This can cause inconsistencies in the analysis and statistics of geographical data especially in countries with large marine protected areas.

Soils

The soil map of the European community at a scale of 1:1.000.000 (EC, 1985) was digitized within the CORINE programme. The digitized map was provided by CORINE as an ARC/INFO coverage. The soil map shows some 350 soil classes, according to the FAO soil classification system. It has been used to define nature development areas and corridor zones.

Natural vegetation

The map of the natural vegetation of the EC (Noirfalise 1987) [3] at a scale of 1:3.000.000 was digitized for inclusion in the CORINE database. 'Like its predecessor (Ozenda 1979) [4], it depicts only climax vegetation zones (as opposed to the actual vegetation which currently exists). Still it is it is a very

[3] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

[4] P. Ozenda, A. Noirfalise, R. Tomaselli, *Vegetation map (scale 1:3.000.000) of the Council of Europe Member States*; Strassbourg, European Committee for Conservation of Nature and Natural resources, Nature and Environment Series no 16.

useful map because it recognises over 100 vegetation classes, and takes account of regional variation in vegetation. It has been used to define nature development areas and corridor zones.

Designated areas

In the database of designated areas sites are included that are recognised by national legislation as being under formal protection for the purpose of nature conservation (including biological, landscape, geological, geomorphological and archaeological sites). Many sites that do not have a legal status yet, such as private reserves, are also part of the data set. Reliability of these data is low, since the status of protection in the member states varies considerably, and is not always clear. The data set refers to almost 12.000 point locations which are characterized for their name, administrative region, national and international designation, total area, terrestrial and aquatic area, length, date of establishment and designation, motivation, ownership and a cross reference to the biotope data set. This data set was not yet complete in the period that it was used. Attribute data are not included for all member states and not for all sites. It has been used for the analysis of protected areas.

Biotopes

The purpose of the biotopes inventory is to compile a data set of sites of Community importance for nature conservation. In this inventory a biotope is referred to as a site defined as 'An area of land or a body of water which forms an ecological unit of Community significance for nature conservation, regardless of whether this area is formally protected by legislation' (Moss et al 1991) [5]. These biotope sites are described by administrative attributes (name, designation, administrative region, area), land use attributes (human activities), and habitat attributes (altitude, habitat type, presence of important species and site descriptive information). Collection of these attributes has not yet been completed for all biotope sites.

The geographic units to be recorded in the Biotopes Inventory are sites that may be:

- a geographic unit which has been designated for protection through nature conservation legislation, by notification to international agencies or by voluntary agreements with owners or users;
- a geographic unit of Community importance for nature conservation which is owned or administered by a single agency;
- any area of land or water body which, although without formal protection, nevertheless forms an ecological unit which has Community significance for nature conservation.

A site may contain several biotopes (eg a lake and surrounding marshlands) and may bè important from different points of view (eg a wetland which is important both botanically and ornithologically). The sites are selected for inclusion in the CORINE Biotopes Inventory if they satisfy criteria designed to determine their importance for nature conservation at the Community level. These criteria are based on:

- the presence of vulnerable species of plants or animals;
- the presence of vulnerable habitats (phytosociological units);
- the richness of the site for a taxonomic group (eg bird, mammals, dragonflies, orchids);
- the richness of the site for a syntaxon or phytosociological units.

Although the inventory includes many sites of biological interest which have

[5] D. Moss, B. Wyatt, M.H. Cornaert, M. Roekaerts, *CORINE Biotopes - The design, Compilation and Use of an Inventory of Sites of major Importance for Nature Conservation in The European Community*; Luxembourg, Office for official Publications of the European Community, 1991.

already been designated by national and regional authorities and confirmed in international treaties, it also includes sites of demonstrable ecological importance which are not yet designated.

All sites should be included which

- contain 1 per cent or more of the Community population of a vulnerable species, or;
- are among the 100 most important sites for such species in the Community, or;
- are among the 5 most important sites for a specie in a region of the Community (NUTS).

In addition sites should also be included if they are exceptionally rich in rare species of a particular taxonomic group. The relative importance of this group for nature conservation must first have been independently assessed.

In 1990 this data set contained 5672 registered sites, which are referenced by the x,y coordinates of the biotope's centroid point. For several countries data collection and revision is still going on. After initial site selection and its reporting various checks and revisions of data take place. The overall sequence is as follows:

1. Preliminary site selection and data collection,
2. Collation and preliminary data set construction,
3. Checking and verification,
4. Collection of supplementary data, additional site selection and updating,
5. Revision and updating of data set,
6. Rechecking,
7. Validation,
8. Finalization of data set,

Steps 1, 3 and 7 are carried out in the member states; all other steps are carried out by the Biotopes co-ordinating team at ITE, Monkswood. Updates are regularly communicated to CORINE Headquarters, Brussels.

4.3 Protected areas

4.3.1 Inventory

An inventory of protected areas reflects more or less the actual situation of nature conservation within the EC. All member states have a Nature Conservation strategy and have defined and enacted the protection of natural and semi-natural areas. The definition of protected areas however, differs much between the member states; that means that an inventory of the state of protected areas on European level meets several difficulties. In the past various attempts have been made to inventory protected areas by using a classification of protected areas. The best known classification is the IUCN-classification (IUCN, CNPPA 1982) [6] of protected areas. On European level the classification used by the EC (De Meester-Manger Cats 1979) [7] is the most detailed one.

The classification of the EC has been adapted here for the objective of the inventory of the actual protection of nature in Europe. It has been simplified in such a way, that the objective of protection is consistent between all member states. The objective of the actual protection status is the main criterion for selection. The protected areas can be divided into three groups concerning their general objectives:

- protected areas for nature conservation,
- protected areas for landscape conservation and
- international protected areas.

The protected areas for nature conservation consist of strict nature reserves,

[6] IUCN, CNPPA, *United Nations list of National Parks and Protected areas*, Gland, 1982.

[7] V. de Meester-Manger Cats, *Protected Areas in the European Community. An Approach to a Common Classification (working document)*; Brussel, CEC/ENV/311/80, 1979.

managed nature reserves and national parks (IUCN, CNPPA 1982) [8]. The protection of these areas is enacted. Agriculture, forestry and recreation are not allowed. Traditional land use, especially extensive exploitation of grassland, can be a method of management of semi-natural areas. The objective of protection is the conservation or restoration of natural and semi-natural landscapes which are characterized by a special flora, fauna, vegetation and/or biotic communities. There is restricted access for the public.

The protected areas for landscape conservation consist of characteristic landscapes, nature parks, areas of outstanding natural beauty, etc. The protection of these areas has been enacted. The objective of the protection is the conservation of characteristic landscapes mostly for outdoor recreation purposes. These areas often include protected areas for nature conservation. Agriculture, forestry and recreation are more or less limited by rules concerning land use, buildings and environmental protection. The areas are open to the public.

The international protected areas are composed of different kinds of areas that are designated by international agreements or conventions. These areas have in common that their natural values are of international importance and have therefore been protected by the national governments. They have been brought under one of the international conventions on nature protection or have been placed under the Bird directive.

4.3.2 Coverage maps

Three maps have been produced by an identical procedure. Use has been made of the CORINE data sets Biotopes and Administrative Boundaries. Other sources have been used for those member states that are still in an early state of processing of the CORINE Biotope Inventory (Great Britain and Germany) and for checking the data of the Biotope Inventory.

The data set biotopes is a point coverage with 5672 points and different attribute information files which describe the *biotope point sites*. Each site has its own code, called BPSICD (Biotope Point SIte CoDe). The attribute information is stored in different information files. One attribute information file contains general information such as region codes and the area of a site. Another attribute information file contains the code of protection matched by all biotope point sites according to the classification of the EC. This file contains 7543 records because many point sites are protected by more than one legal status. The percentage coverage of the site by protected areas is given in the same information file. These two attribute information files are used to select the three categories of protected areas, protected areas for nature conservation, protected areas for landscape conservation and internationally protected areas.

The selected biotope point sites are related to the data set of the administrative regions (NUTS). This data set is a polygon coverage. The region code is stored in the coverage data set. The smallest units in this data set divide the EC in a maximum of 829 administrative regions. In this project the division of level I is chosen, which restricts the division into 64 regions. This level has also been used in the report 'Ground for choices' by the Netherlands Scientific Council for Government Policy. For these regions the area covered by the three categories of protected areas has been calculated in total coverage as well as in percentage data. These are presented in maps.

There are also biotope point sites without information on the percentage of protection or the area of the biotope point site. This is a consequence of the inventory not having been completed yet. In 1926 cases the information appeared to be incomplete or incorrect. Because of this all biotopes point sites have been checked and the information on protection has been added or corrected if possible. Other sources have been used to complete the information

[8] IUCN, CNPPA, op.cit., 1982.

on the data of percentage coverage of the three types of protected areas. National inventories have been used to compare with the CORINE data. Thus, it was possible to determine missing data in the CORINE inventory.

4.4 Design of the Tentative Ecological Main Structure

4.4.1 Introduction

In general an ecological network consists of

- core areas,
- corridor zones,
- buffer zones.

Core areas are complexes of natural and semi-natural vegetation that function as an optimal habitat for many species and that are characteristic for a biogeographical zone or important European environment. Buffer zones are areas where excesses of nutrients can be eliminated, changes in water quality can be absorbed and recreation impacts can be directed towards less sensitive areas. Not the nature value of an area is the main reason for its function as a buffer zone, but rather its possible environmental impact on the core areas.

Ecological corridors are zones, landscape structures or man-made passways that contribute to the dispersal and migration of species between core areas. The main objective of ecological corridors is to facilitate movements of species through a more or less hostile environment. They facilitate species to use the landscape to move to other core areas and even remain for a while in the corridor zone.

To design these different zones within the Tentative Ecological Main Structure information is needed on the importance of areas as core areas or as corridor zones. This information is not available. However, information is available on protected areas and on potentially important areas for nature conservation. Most protected areas will be part of the structure, because they have been considered valuable by national or regional governments. All protected areas for nature conservation have been included into the ecological structure. No differentiation has been made for management practices and management objectives. All areas have been included that are protected as strict nature reserve, managed nature reserve or national park (in accordance with the definition of the EC-classification of protected areas). Protected areas for landscape conservation and not-protected areas form a part of the Tentative Ecological Main Structure if they can function as core areas, ecological corridors, stepping stones or buffer zones. Many areas designated as landscape protection areas contain nature conservation areas, which makes them important in the structure.

The international protected areas are of international importance and so all of these areas have been included in the Tentative Ecological Main Structure. The criterion is based on the fact that they are protected as Ramsar sites, EEC Bird Directive sites, European Biogenetic Reserves, Unesco Biosphere Reserves and European Diploma sites.

The procedure to develop the Tentative Ecological Main Structure consists of two steps (Figure 4.1):

- assignment of 'nature expansion areas' that are based on CORINE data or national information, and;
- design of nature development areas and corridor zones based on extra information from regional sources, expert information, the map of the natural vegetation of Europe (Noirfalise 1987) [9] and soil data.

[9] A. Noirfalise, op.cit., 1987.

4.4.2 Nature expansion areas

The actual extent of protected areas is not in accordance with the potential extent of areas of nature conservation interest. Many areas with high nature values are not protected and often the protected areas are too small to function without support from other – unprotected – areas. The expansion of protected natural areas is an essential part of designing an ecological main structure.
Nature expansion areas can be integrated into the Tentative Ecological Main Structure in the same way as protected areas for nature conservation. They can function as core areas, parts of ecological corridors or as buffer zones. Small scattered areas can be part of the corridors or stepping stones. Stepping stones function as isolated parts of ecological corridors and are secondary habitats that can be used by species to survive temporarily in a hostile environment. Their presence is especially important for migratory species that make use of scattered island habitats. At the level of the EC, the design of nature expansion areas is possible, but it is not possible to specify functions within the ecological structure. Structure, functioning and size of the habitats are influenced by many different circumstances that can differ from site to site and, except for the influence of climate and global and continental pollution, cannot be determined on the EC-level. This means that a hierarchical bottom-up approach will be required to work out the ecological structure in detail. This has partly been done by using experts and regional information to check the design of the Tentative Ecological Main Structure.
The inventory on nature expansion areas requires different criteria than the inventory on protected areas. The criteria are not based on the status quo, but require a concept on the strategy for nature conservation based on expansion and renewal. Expansion areas can be natural and semi-natural ecosystems that are characteristic for the biogeographic zones in Europe or function as part of an ecological structure for species migration. This means that fully man-made landscapes that do not function as semi-natural areas but are restricted to parts of Europe (e.g. Eucalyptus plantations) are left out of consideration.
The inventory of not-protected, important natural areas requires a generally applicable definition and must be based on consistent data all over Europe. Systematically collected consistent land cover data that are related to information on important ecosystems are not yet available. The most complete database is the CORINE Biotope Inventory that contains areas:

- with a known actual situation of a high nature value;
- with a high nature value that is described in the European Biotopes Inventory (CORINE);
- not yet protected as protected areas for nature conservation, and;
- with an actual natural situation that requires protection by law and means for management to guarantee the conservation of the actual natural value.

In this study, these CORINE criteria have been used for the first selection of areas with high nature values in the biotope inventory of the EC (Laboratory of Land Management 1990) [10]. In this way all potential areas with high natural values as considered in national inventories can be selected.
For further selection of nature expansion areas the criteria diversity, rarity and location have been used within the selected CORINE data set of Biotopes. The three criteria complement each other. The criterion diversity meets the objective that the European diversity in habitats will fully be expressed in the Tentative Ecological Main Structure; rarity meets the requirement that rare and threatened habitats will be included and location is meant to prevent fragmentation of nature as far as possible. These criteria have been applied as far as possible. Application however, has strongly been restricted by the incompleteness of the data set.

[10] Laboratory of Land Management Katholieke Universiteit Leuven (ed.), *CORINE Data Base Manual; Version* 2.2; Brussels, Directorate General for the Environment, Nuclear Safety and Civil Protection, CEC, 1989.

Diversity

This criterion was focused on the preservation of the diversity of ecosystems within the European Community as well as in the biogeographic regions. This criterion means that for the Mediterranean biogeographical region habitats are selected that might be widespread in all Europe, but that emphasis is laid on the Mediterranean habitats including regional differences and diversity. The same has been done for other regions. Only Macaronesia has been included nearly totally, because of its richness in endemic species and its vulnerable small area. Widespread habitats are, amongst others, coastal wetlands, cliffs and rocks, coastal dunes, inland wetlands, lakes, brooks, rivers, alluvial forests and coniferous forests. Some of these are more or less comparable through all of Europe, e.g. alluvial forests, but others vary considerably in species composition in the different parts of Europe, e.g. natural coniferous forests.
Typical Mediterranean – and Macaronesian – habitats are broadleaved evergreen forests, varying from forests of the Açores laurel (*Laurus azorica*) on the Macaronesian islands and Lusitanian oak (*Quercus faginea*) and cork oak (*Quercus suber*) forests on the west part of the Iberian peninsula to forests of *Quercus macrolepis* in Greece and Pyrenean oak (*Quercus pyrenaica*) in the mountains of the western mediterranean region. Maquis, phrygana and garigue are typical mediterranean vegetation types that show a comparable variation from west to east. Species and vegetation type replace each other. The same can be said about dry grasslands and (semi-)deserts. Moreover, a member state can have its own diversity of characteristic habitats.

Rarity

Habitats can be rare because their abiotic environment is rare. These habitats will be included into the Tentative Ecological Main Structure because of their mostly irreplaceable abiotic environment. Often these habitats are also threatened by human activities. Serpentine rocks are an example of this kind of rare habitats, that can be found in several areas in Europe, but always in small outcrops and can be characterised by endemic species. All Macaronesian habitats are rare, because of small extent of the area of the islands that make this biogeographical region. The Atlantic coastal bogs and fens are very characteristic for parts of Ireland because of the climate and the easy access of the influence of the ocean and do not occur in other parts of Europe.
Habitats can also be rare because the majority has been destroyed in the past, usually by human exploitation. This is the case for alluvial forests in northern Europe that have been changed into grasslands, bogs in great parts of the continent that have been used for fuel production, natural broadleaved deciduous forests that have been changed into conifer plantations, north atlantic heathlands that have been changed into agricultural land and forests of Açores Laurel (*Laurus azorica*) that have been burned and exploited.
Habitats can be threatened because of human impact. These habitats are not yet rare, but their exploitation by man is so intensive that the possibility of extinction of these habitats is possible. The habitats can be selected according to the threatened species that depend on these habitats. These species are listed in the red data books of national governments, in international conventions and in the annexes of the EC bird directive and habitat directive. To these habitats belong inland wetlands, the remaining alluvial forests, native coniferous forests, humid grasslands, alpine grasslands, dry natural (semi-) grasslands and bogs.
All these habitats are included in the Tentative Ecological Main Structure using a basic assumption of nature conservation strategy at present: conservation of rare and threatened habitats in designated areas. Due to this criterion it is possible that natural areas are selected that are isolated and do not seem to have a physical connection with the ecological structure. Partly they can function independently of the network or to complete the ecological structure

as stepping stones, partly they need further extension and connection with the ecological structure.

Location

This criterion originates from the concept of an ecological network. A network has to prevent the isolation of habitats. Large areas and ecological corridors are means to prevent species loss through isolation. Existing or proposed core areas are connected by habitats that are located in close relation to or in the surrounding of core areas.

Analysis and design

The criteria diversity and rarity have been used to select data from the CORINE Biotope Inventory. The selection in this project lays emphasis on important habitats related to a biogeographical zone or a migration route. Besides other sources have been added where data were lacking and or appeared to be incomplete. Consequently many not-protected habitats, that are part of the CORINE Biotope Inventory, have also been included in the nature expansion areas. The area of the not-protected habitats has been calculated as well as the area of the protected areas in the EC.
The delineation of most of the biotope point sites is not yet included in the CORINE database Biotopes. The location of a habitat known as x,y-coordinate of the centroid is not enough to assign a nature expansion area. The delineation had to be derived from combined geomorphological and topographical maps and habitat information in the later phase using information from various other sources as well. This means that delineation has to be carried out by hand.
The biotope point sites have been selected by their ecosystem types for all available regions at NUTS I level (64 regions). Selection had to be made at a rather high hierarchical level and interpreted with help of natural vegetation map (Noirfalise 1987) [11] the European soil map and regional data (Figure 4.1).

4.4.3 Corridor zones and nature development areas

Development of large self-regulating natural areas requires an approach of development of (semi-)natural areas: natural deciduous forests, alluvial forests, bogs etc. The possibilities for development depend directly on the abiotic situation (soil, climate) and on the minimal area that is needed for the ecosystem and its species. Nature development areas are defined as areas in which nature will be an important land use form but that can include other forms of land use as well depending on the objective of development. The ecological values that are present are not known and detailed objectives for nature development in an area cannot be defined within the scope of this project.
Development of (semi-)natural areas to connect core areas as corridor zones can only be realised with knowledge on the ecological requirements of the natural areas that have to be connected. Because this project focuses on the European level most attention is given to migration and species dispersal on larger distances like bird migration and migration of large mammals. Local or regional corridors can be included in a later phase. Nature development areas and corridor zones complete the Tentative Ecological Main Structure. In this context the only important criterion is the possibility to enlarge or connect protected areas and nature expansion areas by nature development areas, where it seems needed and a possibility is present for the development of self-regulated ecosystems.
The criteria are:

- the presence of natural vegetation or soil types comparable and in close relation to the habitats selected as protected areas or expansion areas;

[11] A. Noirfalise, op.cit., 1987.

- the presence of areas from the shadow list of important bird areas in relation protected or nature expansion areas (Grimmett and Jones 1989) [12].

Analysis and design

The possibility to develop new nature areas for the connection of existing natural areas depends on the location of selected areas. The selection of these areas has been carried out by hand for each NUTS region, because of the delineation problems of the selected areas of importance. Most corridor zones and nature development areas have been selected by using the vegetation map of Europe and the data on important bird areas. The soil map has only been used when its information was clear to interpret. In many cases the soil map provided too much detailed information for interpretation at this level.
In all the regions the above information has been evaluated with the following criteria:

- if a habitat selected as a nature expansion site matches the vegetation unit of the Natural Vegetation map and is concentrated on one or a few soil units, the area of the soil unit and the vegetation unit around the site will be selected as nature development area or ecological corridor;
- if several selected habitats match a degradation type of the Natural Vegetation map, the zone between different sites has been selected as nature development area or ecological corridor;
- if soil units in combination with vegetation units appear to be a recognizable structure that correspond with protected areas and nature expansion areas the soil unit or vegetation unit will be part of the map as a nature development area or ecological corridor;
- bird areas important according to ICBP data (Grimmett and Jones 1989) [13] have been added except for coastal wetlands, because these are not involved in agricultural development.

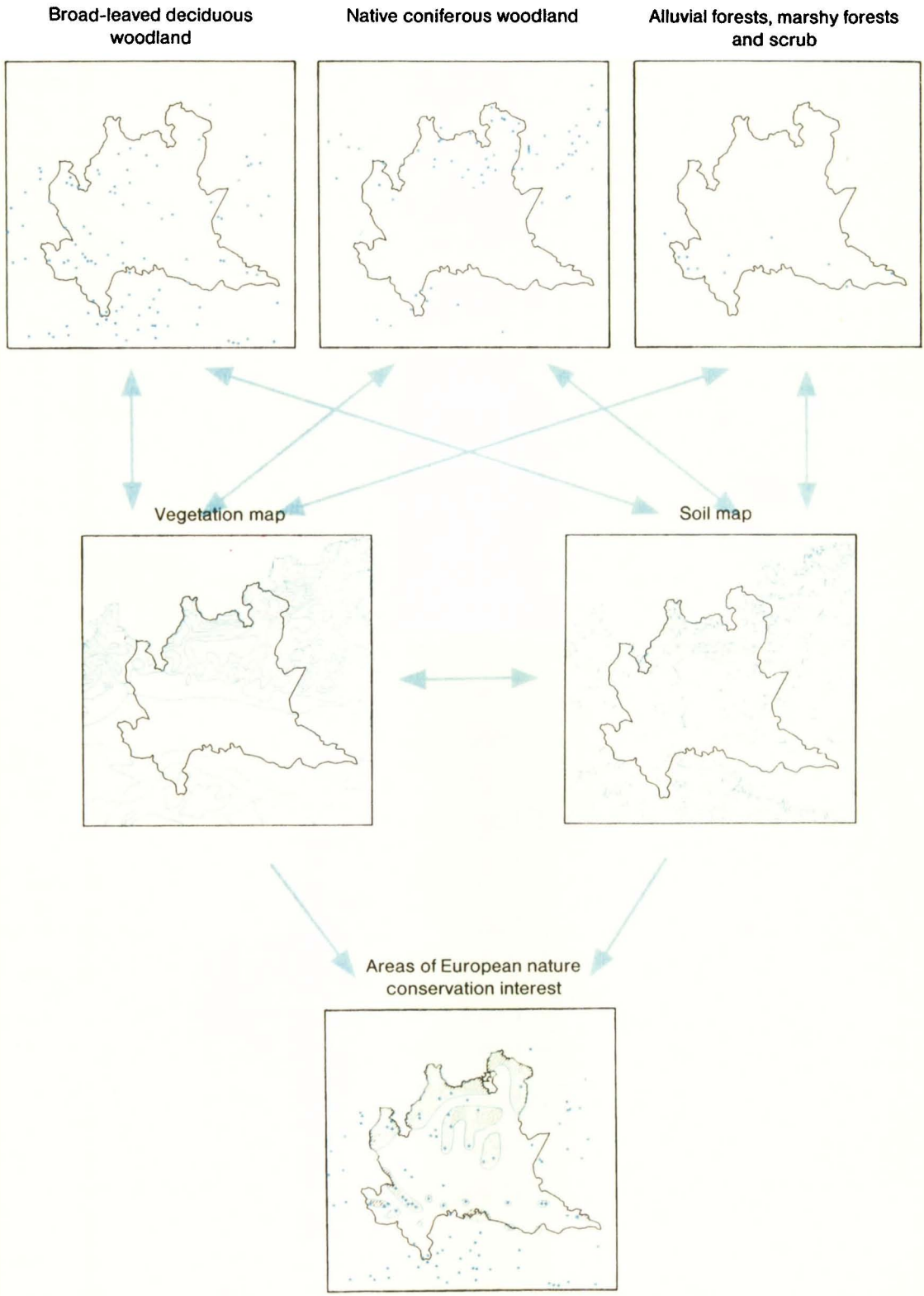
Based on these steps a map has been constructed of potential areas of nature conservation interest. In this map only the potential delineation of the combined categories is given. After consulting experts in the member states the map has been corrected. This map is considered to be a Tentative Ecological Main Structure of the EC. The coverage has been calculated for all regions as follows:

- the total area of a region is the area of the polygon derived from the NUTS-coverage;
- the total coverage of the structure in a region is the sum of the protected area, the expansion area and the nature development area;
- the coverage of the protected area is based on protected areas for nature conservation;
- the nature expansion area is the sum of the protected landscapes and the not-protected area's;
- the nature development area is the coverage of the structure for a NUTS region minus the protected areas and nature expansion areas.

The total area selected as potential area of nature conservation interest and as Tentative Ecological Main Structure is about twice as large the area of which data are available.

[12] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[13] ibid

Figure 4.1 **Procedure of the design of the Tentative Ecological Main Structure exemplified for NUTS-region Ireland**



Source: Agricultural University, Wageningen

RESULTS 5

5.1 Introduction

The results are presented as a overview of protected areas and a tentative ecological main structure for the territory of the EC, consisting of areas of nature conservation interest within the EC excluding sea and coastal wetlands. The results are presented in percentage cover maps and a map of the Tentative Ecological Main Structure. A summarised description of each member state is given in Annex II including maps and tables.
Categories of protected areas have been simplified and fused if needed because of the confusion in terminology between countries to designate protected areas. Three types of protected areas have been defined:

- protected areas for nature conservation,
- protected areas for landscape conservation,
- international protected areas.

These three types are considered to play a role in national and international nature conservation. They also can play an important role in the ecological structure as developed in this project. The maps are percentage maps of NUTS regions, because of the lack of delineation data in the CORINE Biotope data set.
The maps of protected areas can be used in relation with the map of the ecological structure. They give insight in what at this moment is considered to be important according to the member states. The total area covered in each NUTS-region shows the effort that has been made in nature conservation. It does not give insight in the reasons why parts are not protected or even not included into the Tentative Ecological Main Structure. These might vary from lack of data to other land use priorities.
The tentative European Ecological Main Structure is based on national data and is the top of a hierarchy of ecological structures. It is constructed by a bottom-up approach: regional data have been used to make a general ecological structure of the EC. The nature expansion areas consist of two types: not-protected habitats and protected areas for landscape conservation. They are based on data from CORINE and other sources. No delineation data are available here.

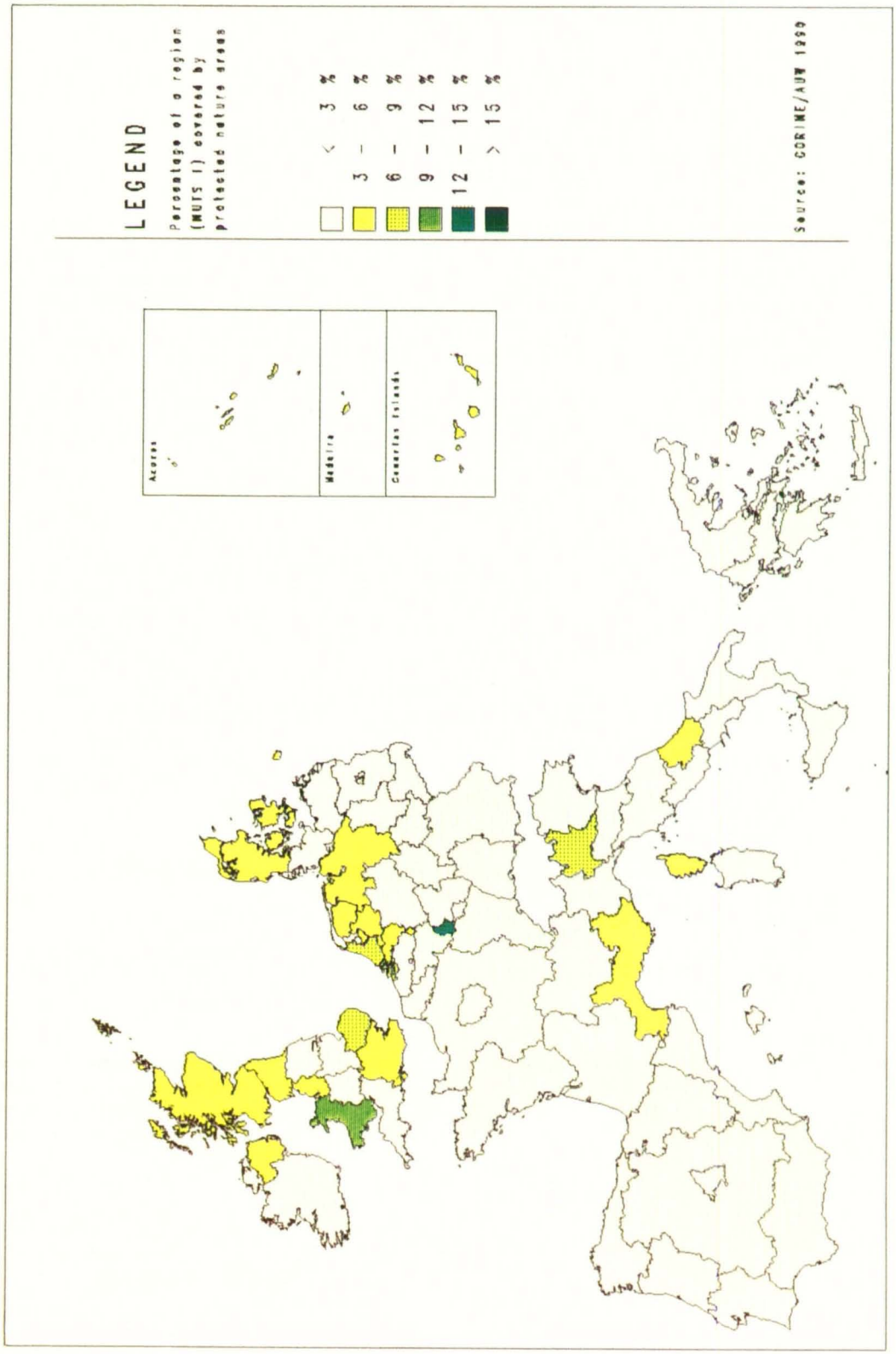
The habitat connection areas are supposed to be part of the ecological structure. The delineation of the Tentative Ecological Main Structure has been made by hand.

5.2 Protected areas

Protected areas for nature conservation

The protected areas for nature conservation consist of strict nature reserves, managed nature reserves and national parks according to the IUCN-definition. Figure 5.1 shows that many NUTS regions have less than 3 per cent of the area designated as protected areas for nature conservation. Classes over 12 per cent are not presented at all.
Most differentiation is between 3 per cent and 12 per cent coverage for areas for nature conservation. In France differences may be caused by the location of the National Parks. Outside these parks protected areas for nature conservation are rare. The same explains the high coverage in Lombardia and Abbruzi-Molise in Italia. In Germany, the Netherlands, Denmark and Great Britain some large reserves and a large number of relatively small protected areas caused a higher percentage of protected areas. In the Netherlands for example over 500 protected areas are listed in the CORINE database.
In many regions the coverage is less than 3 per cent of protected areas for

Figure 5.1 Protected areas for nature conservation in the EC



Source: CORINE/ Agricultural University, Wageningen, 1990

nature conservation. In the southern regions the number of protected areas is small, but the areas covered are large when compared to the northern countries. Protection of nature conservation becomes more important. It may even be an issue of national policy as can for instance be shown by the Portuguese nature conservation policy after 1976. Moreover, in many regions of Spain, Greece and Portugal human impact has been relatively low and the need for nature protection policy seemed not urgent until now. However, there is a quick change to land abandonment on the one hand and agricultural intensification on the other.
In the regions in Germany, France, Great Britain and Belgium, the impact of human activities is high, but still the relative cover of protected areas is less than 3 per cent. In these regions many natural areas have already been destroyed and will disappear in the near future due to intensive land use.

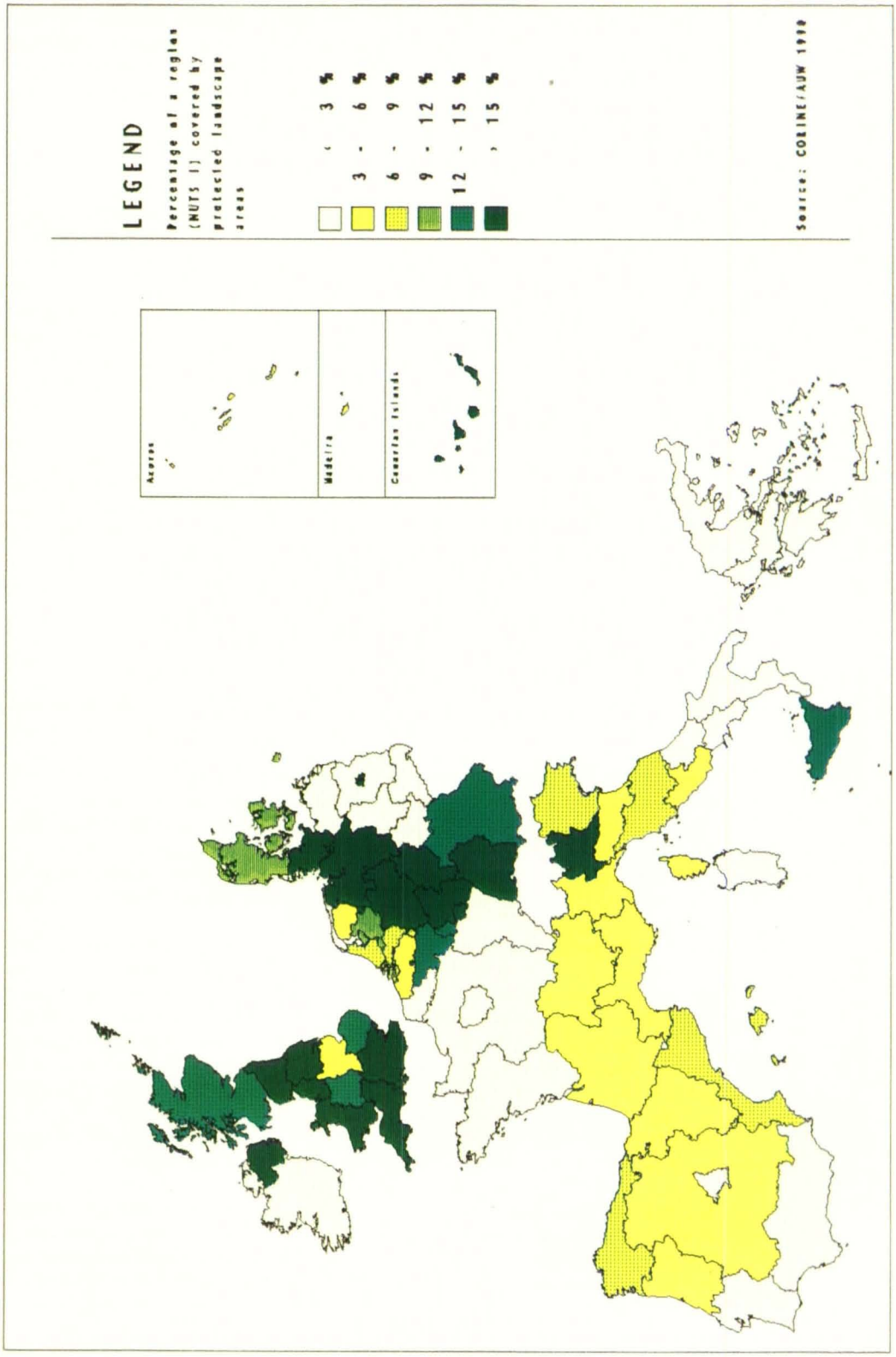
Protected areas for nature conservation are too small in coverage to be a firm basis for an ecological structure for the EC. However, in nearly all NUTS-regions they are present, so they still can be the starting point for a strategy for development of an ecological structure.

Protected areas for landscape conservation

The protected areas for landscape conservation consist of nature parks, national landscape parks, areas of outstanding natural beauty or bufferzones according to the definition of the EC-classification of protected areas. The objective of these areas is the conservation of landscape values. In practice the protection is not strict. Other functions as agriculture, forestry and recreation can still be maintained and developed in a more or less adapted way.
The coverage of protected areas for landscape conservation has been shown in Figure 5.2. In some regions protected areas for landscape conservation cover less than 3 per cent. In Greece and Ireland the coverage of protected areas for both nature and landscape conservation is low. There is however a great potential for the conservation of nature and landscape also in relation with tourism development. The underrepresented regions of France are characterized by large-scale agricultural landscapes.
The regions characterized by 3 per cent to 12 per cent protected areas for landscape conservation are concentrated in the southern part of the EC, in the south of France, in Italy, Spain and Portugal. For these member states habitat information indicates that landscape conservation areas often have the potentials to develop towards national parks. The protection status is less because of the regional importance of these areas for agriculture, outdoor recreation and tourism. Some of these areas are overloaded by tourism, which threatens its sustainability.
The regions where more than 12 per cent of the area is covered by protected areas for landscape conservation are characterized partly by a high population density: Germany, parts of Belgium and Great-Britain. In these member states landscape protection has a long history. In Germany the protection of nature parks was started in the beginning of this century. The nature parks are often well developed for outdoor recreation (camping sites, nature trails etc). Land use in these areas often includes traditional forestry, agriculture, fisheries and hunting.

In Great Britain a strong public demand for the preservation and conservation of wildlife and landscape started in the last century. This resulted in a great number of national parks. However, the protection of these parks is not in accordance with the definition of the IUCN. They are therefore classified as landscape parks. The high percentage of protected areas for landscape conservation can be explained in this way. In Scotland the high cover percentage originates from the 40 national landscape areas.
Areas in this category differ very much, depending on the national or regional

Figure 5.2 Protected areas for landscape conservation in the EC



Source: CORINE/Agricultural University, Wageningen, 1990

nature conservation policy. Areas protected for landscape conservation mostly contain important nature as well. This is partly due to the definition of nature conservation areas by the IUCN. The coverage is higher than the coverage of areas for nature protection. The low coverage of landscape protection areas and nature protection areas in Ireland and Greece might partly be due to the late development of nature conservation. The landscape protection areas can be an important part of the Tentative Ecological Main Structure.

Internationally protected areas

The internationally protected areas consist of a variety of designated areas based on international agreements and conventions. Figure 5.3 shows that in most of the regions the percentage covered by international protected areas is less than 3 per cent. In some regions the cover percentage is higher, but only three regions exceed 15 per cent coverage. Mostly the protection status is comparable to the protection of the national nature conservation policy. International protected areas in the southern member states are often recently protected areas outside the existing national reserves and protected landscapes. Recent jurisprudence of the European court has enforced the strength of international protection by designation as EC bird directive areas.
In coastal regions the area of international protected areas includes coastal wetlands which are excluded from the Tentative Ecological Main Structure. The total coverage of international protected areas is not according to the data of these regions shown in Figure 5.3, because coastal wetlands are located outside the administrative boundaries of the EC.

5.3 The Tentative Ecological Main Structure

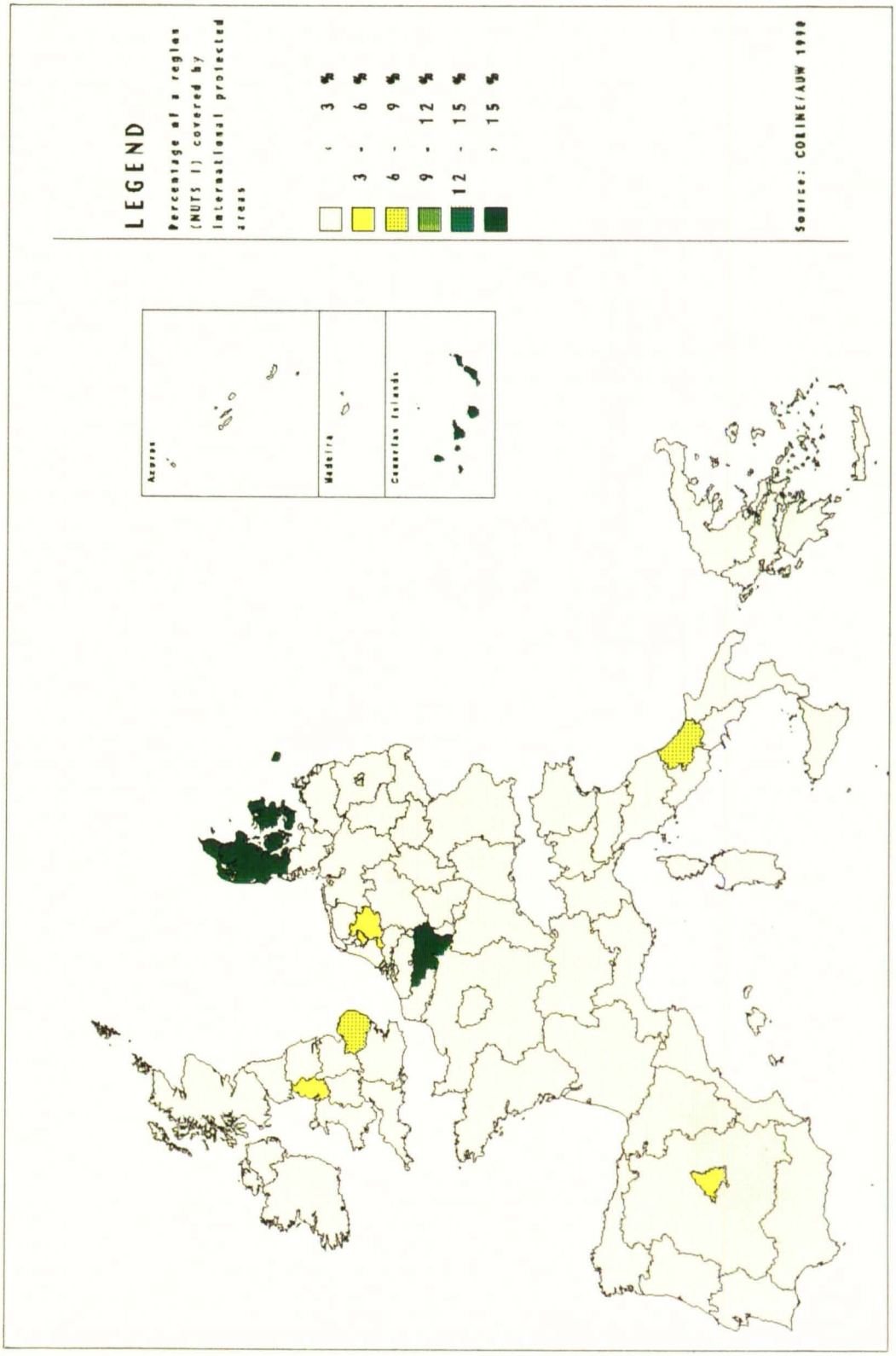
5.3.1 Nature Expansion areas

Nature expansion areas are based on information on both not-protected areas and areas for landscape protection. Results are presented in the Tentative Ecological Main Structure and in a percentage cover map (Figure 5.4). The regions of which less than 3 per cent is covered by habitats that are not protected but included in the CORINE biotope database, can be divided into three groups:

1. the regions with a high percentage of protected areas (The Netherlands, Denmark);
2. the regions with a low percentage of protected areas (France, Italy, Spain);
3. the regions where the inventory is not yet completed (Germany, United Kingdom).

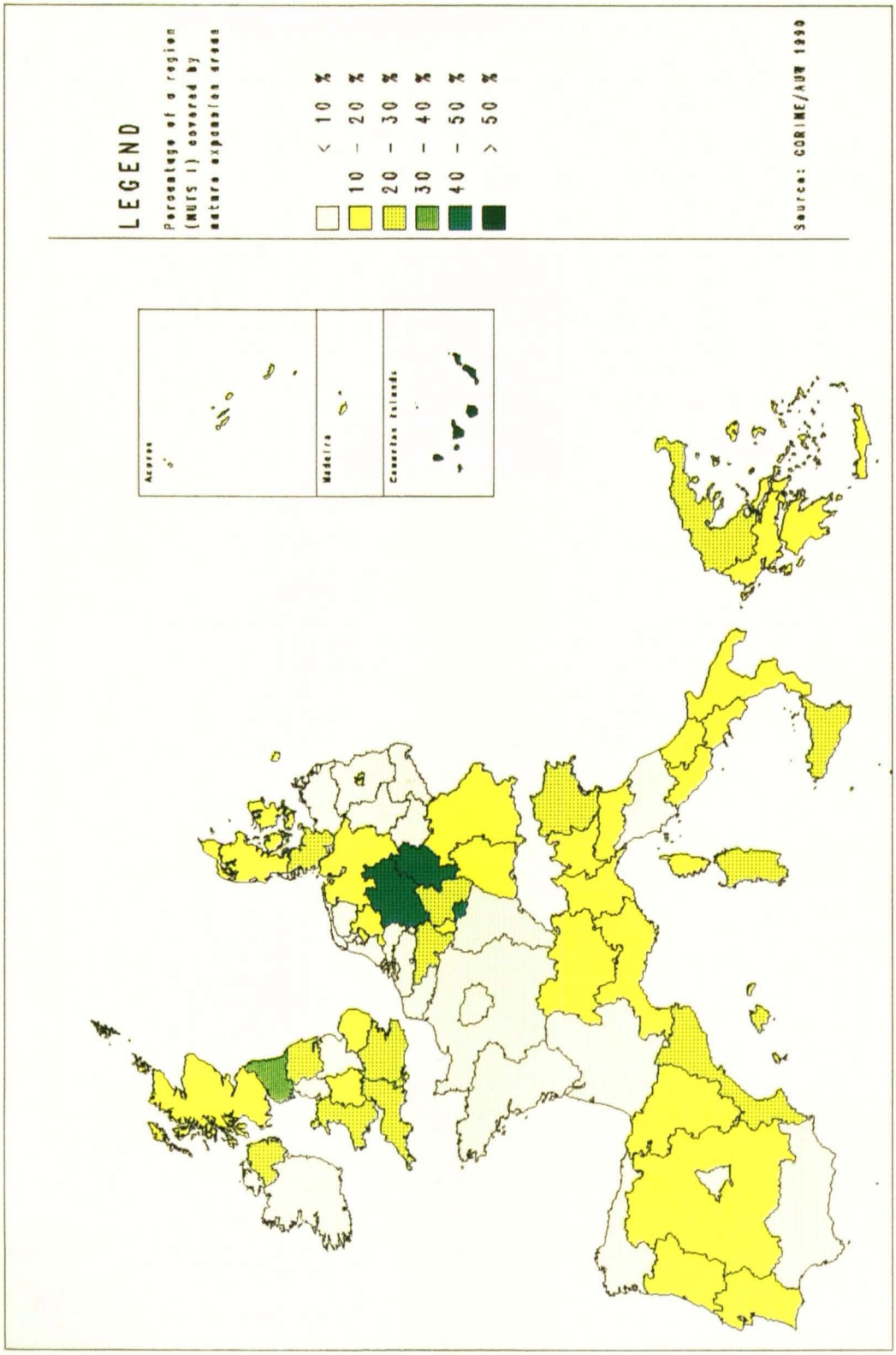
The first group is characterized by a low percentage of important areas for nature conservation outside of the existing protected areas. This is a consequence of land use development and related nature conservation tradition in these countries. In the second group the general protection status is weak. This means that data on the potential nature conservation value are absent or not recognised by national and regional authorities. Consequently these sites might partly not be included in the CORINE Biotope Inventory. No CORINE data are available of the third group. This makes it difficult to interpret the map for these regions.
The regions with a coverage of 3 per cent to 6 per cent of not-protected areas selected from the CORINE database show a comparable situation in nature conservation. France nor Ireland have a strong nature conservation tradition. In Ireland the nature protection is a recent development and in France nature protection is concentrated in the south of the country. The regions with a coverage of 6 per cent to 15 per cent not-protected habitats selected from the CORINE database are concentrated in the southern member states such as Portugal, the southern part of France, Italy and Greece. In these regions large areas are open for nature expansion. In these areas the actual coverage of protected areas is low. The regions that have over 15 per cent coverage of not-protected habitats have large areas that are valuable for nature expansion.

Figure 5.3 International protected areas in the EC



Source: CORINE/Agricultural University, Wageningen, 1990

Figure 5.4 Nature expansion areas in the EC



Source: CORINE/Agricultural University, Wageningen, 1990

The other part of nature expansion areas originates from the protected areas for landscape conservation. These areas may function as ecological corridors or parts of core areas. Not protected habitats are more generally present than the protected areas for landscape conservation in the regions of Portugal, Greece, Italy except Sicilia, Lombardia and Centro, France, Spain except Este and Noroeste and Ireland.
The regions where protected areas for landscape conservation are found more than unprotected areas are at the one hand regions where the inventory has not yet been completed (Germany, United Kingdom) and on the other regions where conservation tradition and land use development have a long history and are strongly linked (Denmark, The Netherlands).
For the former group the nature expansion areas originates totally from protected areas for landscape conservation, because other data are not available. Consequently not-protected habitats have not been included. The latter group does not have a great area of unprotected nature areas. Most have already been protected as nature or landscape protection areas. In these regions nature expansion does not play an important role in the development of the Tentative Ecological Main Structure.

5.3.2 Habitat connection and Nature Development areas

In Figure 5.5 the cover percentage of the habitat connection areas are shown. The regions that have a coverage less than 10 per cent can be divided into two groups:

1. regions with a relative high percentage of nature expansion areas (Germany, Italy, United Kingdom except Northwest);
2. regions with a low percentage of actual natural areas (protected and not-protected).

The former group offers more opportunities for connection zones and nature development than the latter group. Within the former group a further subdivision can be made between regions with a high percentage of not-protected habitats (Italy, East England) and regions with a high percentage of protected areas for landscape conservation (Germany, the rest of the United Kingdom). The connection of habitats is easier to realise in the second subgroup than in the first.

The regions with a coverage of 10 per cent to 40 per cent habitat connection areas can also be divided into two groups:

1. regions with less than 10 per cent coverage by nature expansion areas (Andalucia, Madrid (Spain), Centro (Italy), Est, Nord-Pas de Calais (France), Ireland, Eastern Germany, The Netherlands and Belgium except Wallonne);
2. regions with a relatively equal percentage cover of nature expansion areas and habitat connection areas (Portugal, Spain, France, Italy, Greece, United Kingdom, Denmark, Germany).

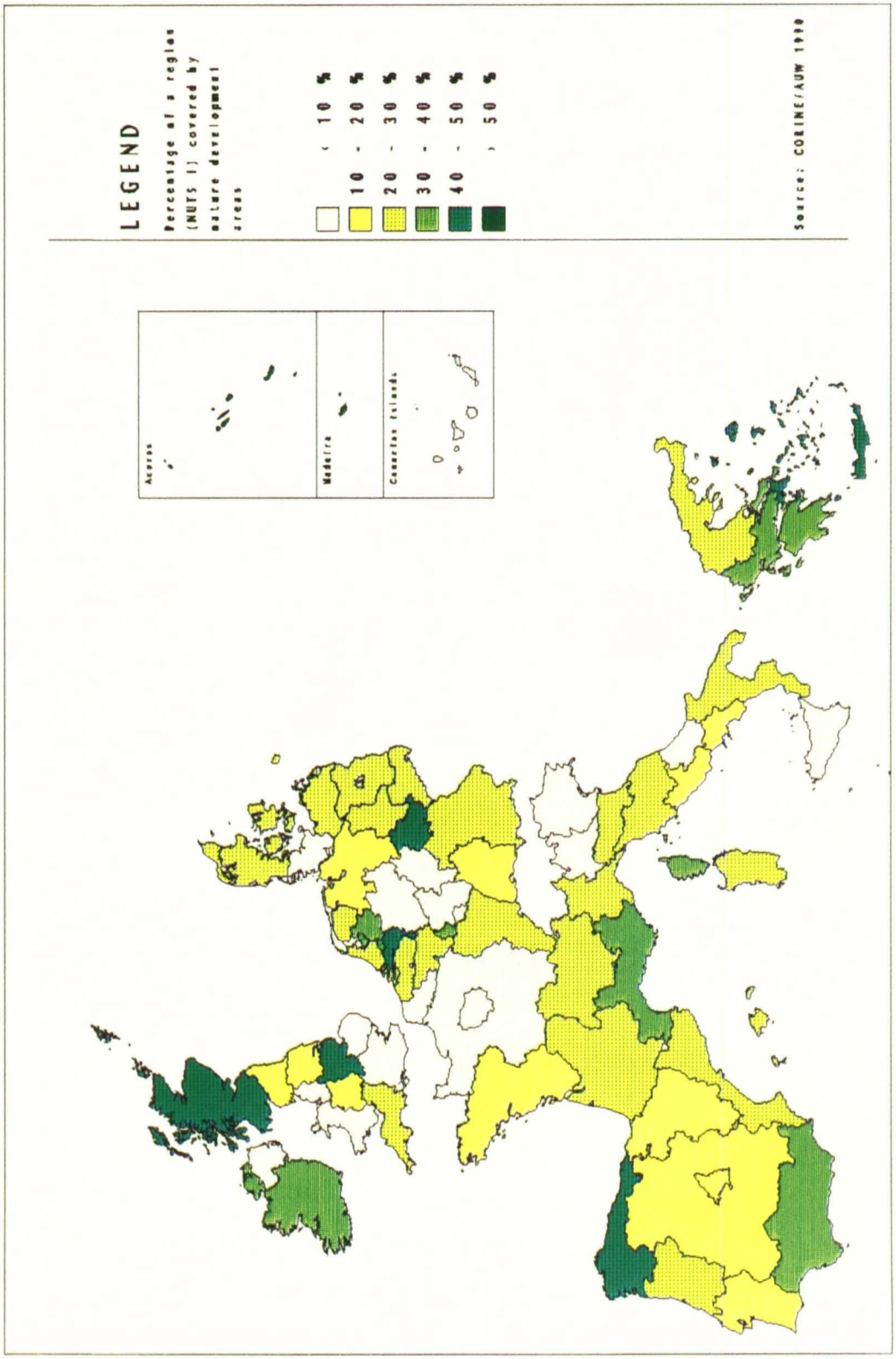
The former group is characterized by a small area of actual natural habitats (partly protected), but the possibilities for habitat connection areas are great and necessary. In some regions the natural value of these habitat connection areas have to be rehabilitated or redeveloped (The Netherlands, Belgium, United Kingdom and France). The regions where over 40 per cent will be covered by habitat connection areas have good conditions for the design of a coherent ecological structure. The available information on the natural situation makes the design possible.

5.3.3 The content of the Tentative Ecological Main Structure

The Tentative Ecological Main Structure has been built on protected areas, nature expansion areas and nature development and nature corridor zones.

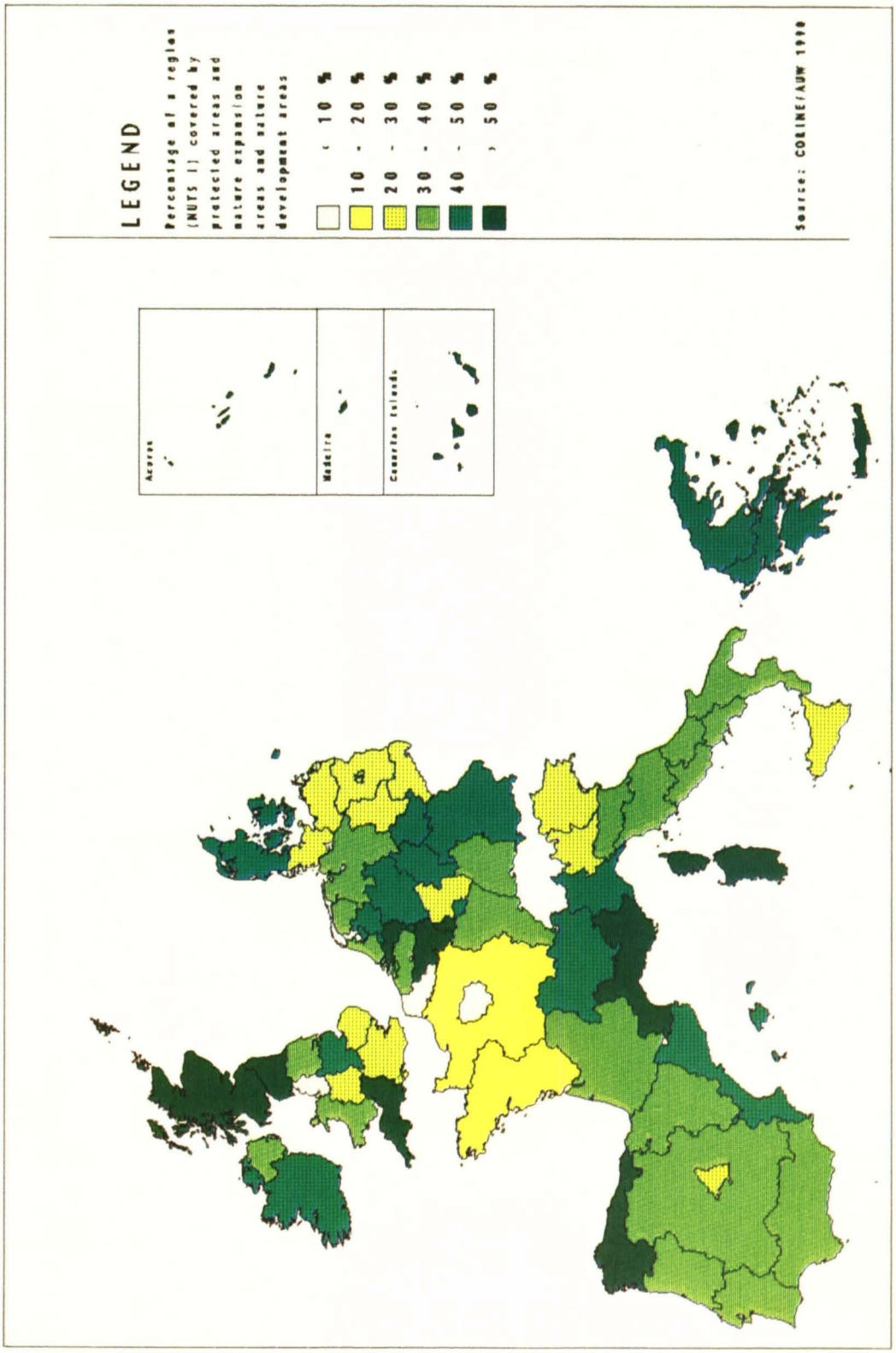
There are rather large differences between the coverage in the member states of the elements of the design (Figure 5.6, Table 5.1). The total coverage is between 0 per cent for urban NUTS regions like Brussels and Berlin and 100 per cent for Ilhas (Madeira e A'ores, Portugal).
In the Tentative Ecological Main Structure all important biotopes have been included for each biogeographical region like wetlands, the forests and rivers. In all biogeographic regions the important habitat types are part of the structure, but not separately indicated (Figure 5.6). In the southwestern part of the Iberian peninsula all broadleaved evergreen forests have been included because this is the most important area in Europe for cork oak forests (*Sanguisorbo-Quercetum suberis*).

Figure 5.5 Nature development and habitat connection areas in the EC



Source: CORINE/Agricultural University, Wageningen, 1990

Figure 5.6 **Percentage coverage map of the Tentative Ecological Main Structure**



Source: CORINE/Agricultural University, Wageningen, 1990

Table 5.1 Area in ha and percentage coverage of the Tentative Ecological Main Structure in the member states of the EC. For the new states of the Federal Republic of Germany no reliable data are yet available on protection status; therefore Germany has been presented in the former east and west part

Country	Total area	Nature Protection		Landscape Protection		International Protection		Nature expansion		Nature development		Tentative ecological main structure	
België/Belgique	3,066,896	40211	1.3	324,060	10.4	328,590	10.7	557,556	19.2	769,369	25.1	1,567136	44,6
Danmark	4,281,259	194,047	4.5	444,056	10.4	559,529	13.1	470,254	11.0	668,525	15.6	1,332826	31.2
Deutschland	35,955,955	352,126	1.0	5,541,166	15.4	26,209	0.1	5,896,205	16.4	6,438,239	17.9	12,686,571	35.2
(west)	24,982,570	352,126	1.4	5,541,166	22.2	26,209	0.1	5,896,205	23.6	3,147,516	12.6	9,395,848	37.6
(east)	10,973,385	-	-	-	-	-	-	-	-	3,290,723	30.0	3,290,723	30.0
Eire	6,982,709	22,782	0.3	29,191	0.4	117,387	1,7	397,114	5.7	2,575,797	36.9	3,002,102	43.0
Ellas	13,278,119	96,040	0.7	45,508	0.3	122,812	0.9	2,364,487	17.8	3,799,638	28.6	6,260165	47.1
España	50,675,005	140,288	0.3	2,388,244	4.7	908,555	1.8	1.86909820	13.6	12,345,374	24.4	19,593,250	38.2
France	54,872,733	647,360	1.2	1,594,201	2.8	4,872	0.0	4,791,092	8.7	10,329,971	18.8	15,768,446	28.7
Italia	30,156,611	559,622	1.9	1,492,841	5.0	364,372	1,2	4,849,318	16.1	3,234,016	10.7	10,652,972	35.3
Luxembourg	264,812	35,655	14.6	36,499	13.8	0	0.0	36,499	13.8	89,430	33.8	164,584	62.2
Nederland	3,496,617	203,482	5.8	258,910	7.4	64,392	1.8	263,641	7.5	1,051,250	30.1	1,518,374	43.4
Portugal	9,200,656	198,976	2.2	321,927	3.5	112,365	1.2	1,113,977	12.1	2,028,250	22.0	3,341206	36.3
United Kingdom	24,349,046	922,314	3.8	4,769,310	19.6	299,781	1.2	4,164,242	17.1	5,528,596	22.7	10,544,741	43.3

Large parts of nearly all the Macaronesian islands have been included because of the importance of their endemic flora and fauna. In Denmark most tidal inlets and fjords have not been included because this salt and brackish habitat is, although unique in Europe and of great importance for migrating birds, not important for land use development. In Germany zonations have been designed that make it possible to develop natural zones from east to west and from north to south. All floodplain forests and undisturbed rivers and deltas have been included because these rather rare habitats are severely threatened in all Europe. Most more or less undisturbed larger rivers are situated in France and Greece.

The function that might be given to the parts of the ecological main structure is not the same as the differentiation in the construction phase. Parts of the Tentative Ecological Main Structure will function as core areas, buffer zones or ecological corridors. Core areas are complexes of natural and semi-natural vegetation that function as an optimal habitat for many species and that are characteristic for a certain biogeographical area or important European environment. They are considered to be of great significance in the ecological structure of Europe. They function as centres of population growth and can compensate for species loss outside the core areas. They can be national parks or nature reserves. According to IUCN criteria a National Park must cover at least 10,000 ha (Kolodziejcok 1985) [1]. A minimum habitat area that offers at the minimal necessary protection for a certain period cannot be stated objectively and is species-dependent (Schreiner 1990) [2]. However, for large birds and mammals a minimum of 10.000 ha can be assumed. Using this size as a rule of thumb, it means that within the ecological main structure it must be possible to select areas larger than 10,000 ha that can function as such and will be protected and managed as nature reserves or National Parks.

In designation and management terms it is not considered necessary that core areas consist of nature reserves inaccessible for the public and other socio-economic activities. The difference with other areas is that the main objective is nature conservation; within that objective other land uses must fit. That means that grassland areas, heathlands and garigues can be included, although they are used for cattle grazing. In many cases extensive agricultural land use is a precondition for the maintenance of present ecological values. This is the case in the Spanish dehesas, in the Dutch lowland peat grasslands, phrygana, garigues and in heathlands. Extensive agricultural management has to be continued if the values related to this type of habitat are considered to be important.

Many species do not need facilities for colonisation of empty habitats. They are pioneer species of dynamic environments and their evolution has made them fast colonisers; examples are sparrows, weeds, rats and muskrats. Other species however are less adapted to dispersal activities: amphibians, many carabid species, many mammals and even forest birds. They need accessible areas as ecological corridors to move from one habitat to another. If dispersal becomes more problematic, isolation will cause less exchange of genetic information and reduced colonisation of empty habitats. The Tentative Ecological Main Structure (Figure 5.7) aims to prevent barriers for these species by maintaining large coherent natural areas. The ideal structure joins the important habitats in Europe into a coherent structure. It takes into account all biogeographical differences, habitats of threatened species and vulnerable habitats. Within this structure also buffer zones around these core areas,

[1] K.G. Kolodziejcok, *Unterschiede zwischen Nationalpark und andere Schutzgebietformen aus rechtlicher Sicht-bezogen auf die Bundesrepublik Deutschland*; in: *Jahrbuch für Naturschutz und Landschaftzplege, Nationalpark: Auforderungen, Aufgaben, Problemlösungen*; Bonn, ABN, Band 37, 1985, pp. 18-23.

[2] J. Schreiner, 'Flächeansprüche des Naturschutzes: Qualifizerung und Quantifizerung'; in: Jahrbuch für Naturschutz und Landschaftplege, *Biotopschutz zwischen traditionellen und neuen Schutzgebietskonzepten*; Bonn, ABN, Band 44, 1990, pp. 9-39.

if needed, as well as corridors or corridor zones can be defined.
Ecological corridors are zones, landscape structures or man-made passways that contribute to the dispersal and migration of species between core areas, but also habitats within core areas or towards and from regionally important areas that are connected with the core areas. The main objective of ecological corridors is to facilitate movements of species through a more or less hostile environment.

The zones that function as ecological corridors are mostly agricultural landscapes that are characterised by a mosaic of small (semi)-natural habitats as for instance woodlots and wooded banks as corridor landscape between forests and agricultural land with ponds fens and ditches as a corridor between marshlands. It will be clear that optimization of agricultural land use in these areas will hamper its function as ecological corridor. It is very important to identify these zones to prevent ecological isolation of core areas and related regionally important nature areas. The main elements of importance for dispersal are habitat quality, the area of a biotope site, distance between sites, presence of corridors and the barrier effect of landscape and land use in between the sites. Area reduction will cause a reduction of the populations and in this way an increased risk of extinction. The influence of the surrounding land use will increase as well causing a change in habitat quality that also can affect the populations.
Within corridor zones or even within core areas, it can be necessary to build structures to facilitate the crossing of technical infrastructure like motorways, urban areas, locks and canals. For migrating fish most European rivers have become inaccessible by the construction of weirs, locks and reservoirs. Reintroduction of migrating fish like salmon (*Salmo salar*) and shad (*Alosa alosa*) into the Rhine is severely hampered by river regulation and over a hundred dams and locks (Saeijs and Logemann 1990) [3]. To make rivers accessible technical solutions have to be built. Fish-ways have to be built in rivers to make it possible for fish to cross weirs and locks. Motorways, canals and railroads can severely hamper migration of mammals and amphibians. Technical solutions can solve this problem; fauna can cross this infrastructure by tunnels and fly-overs. These can easily be included into construction plans. In the Netherlands fly-overs have been built in the migration routes of the red deer (*Cervus elapus*). They have been constructed almost level and traffic noise has been shielded as much as possible. Guiding features facilitate the access of the fly-overs. Research has been done to evaluate the functioning of both fly-overs. These appeared to function well. Red deer, roe deer, wild boar and fallow deer make use of it throughout the year. Besides of these species, presence of Badger, rabbit, fox has been confirmed (Table 5.2).

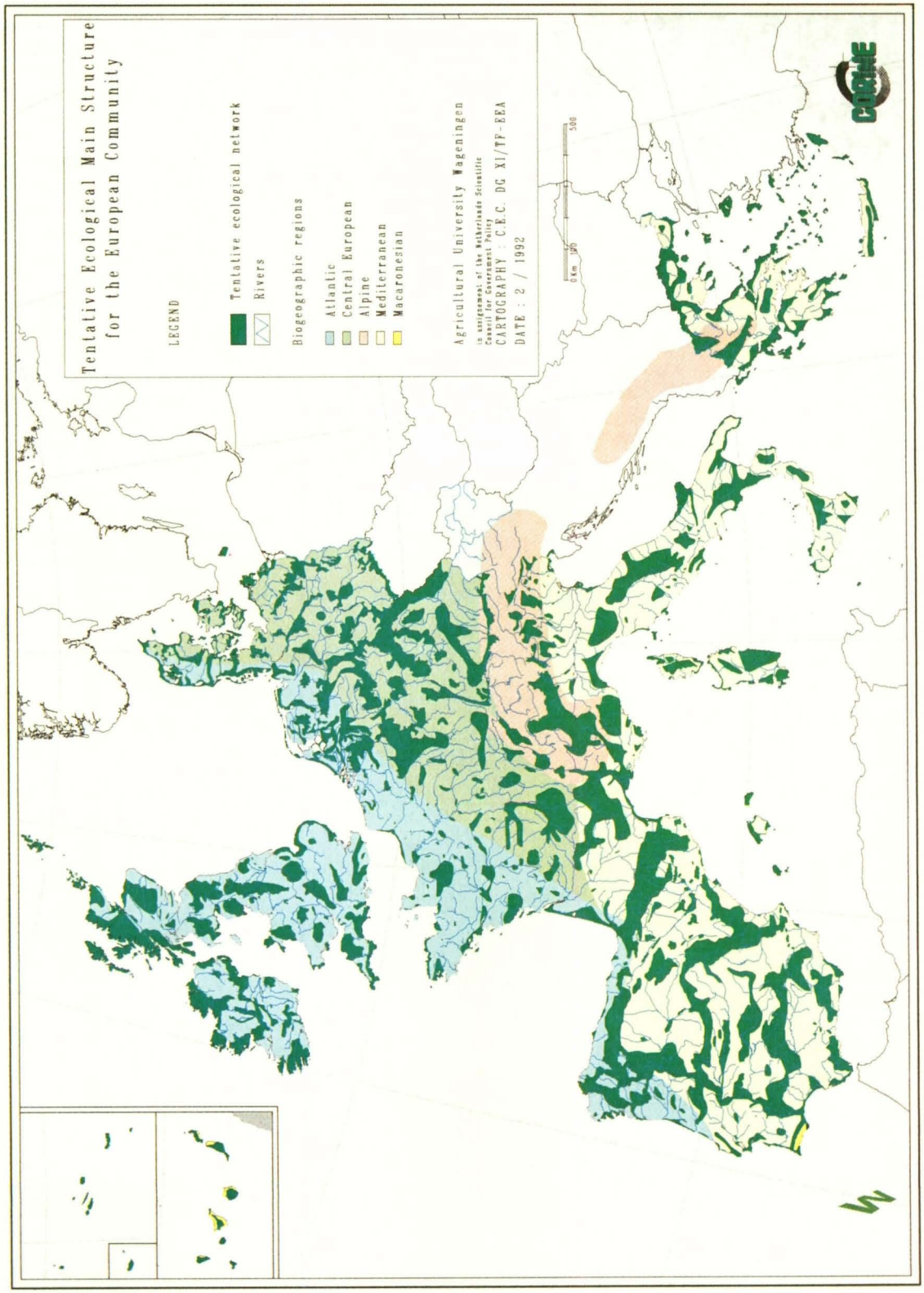
Table 5.2 Passages of the fly-overs over a Dutch motorway by wild fauna in 1989 in both directions

	Terlet	Woeste Hoeve
Red deer	294	153
Fallow deer	--	51
Roe deer	38	130
Wild boar	690	292

This example of man-made ecological infrastructure is part of a nature development plan. Such a plan is based on the objective to develop or restore natural

[3] H.L.F. Saeijs, D. Logemann, *Lebensbericht eines Stromgebietes. Zu einer nachhaltigern Entwicklung des Rheinstromgebietes*; in: *Der Rhein, zukunft und zustand*; B.K. Kamp, J.H. Mooij and J. Swart (ed.), Naturschutzbund Deutschland, Umweltstiftung WWF-Deutschland, Gelderse Milieufederatie, 1990, pp. 12-50.

Figure 5.7 The Tentative Ecological Main Structure in the European Community

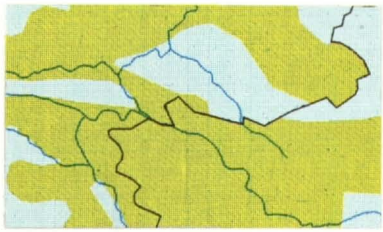


Source: CORINE/Agricultural University, Wageningen, 1990

values that are absent or threatened at present. In the above mentioned example it means adaptation of technical structures to ecological purposes without affecting its function for society. In larger natural or semi-natural areas development of nature can have consequences for land management of the area involved and in this way also for its land uses. In areas that offer realistic prospects for the development of phenomena of ecological value but that do not have them now, it might result in changes of the objective of land use and related to this in the structure and the management of the area.
The ecological main structure has been designed at the European level. This is not the level on which actual decisions on land use and nature management will take place. Decisions are made at three levels: the EC, the national governments and the regional governments. On the EC level only general decisions are taken, such as directives and regulations; on the national level these decisions are worked out for regions and the regional governments do the actual implementation. This means that the map of the ecological main structure on the European level can only cover the European dimension. It might be expected that protected areas will largely be covered by core areas. However, the opposite is not necessarily true: a large part of the core areas might be situated in areas that only have landscape protection or no protection at all. The general ecological structure of Europe can be designed, but it is impossible to delineate core areas, buffer zones and corridors without regional information on nature values and land use. Plans on the national and the regional level are needed as a basis for the European ecological main structure. European, national and regional plans should be worked out in relation to each other. For some areas in the Netherlands the relation between these decision levels can be shown, because national and regional plans on nature conservation exist (Figure 5.8).

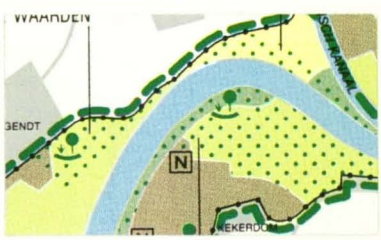
Figure 5.8 **Relation between the Tentative Ecological Main Structure in Europe, the national ecological network of the Netherlands and detailed physical planning at regional level in an example area of the apex of the Rhine delta**

European level



National level

Regional level



forest / nature

agricultural management for nature redevelopment

agricultural management and nature conservation

agricultural land use

nature development area

characteristic landscape element

N nature

Source: CORINE/Agricultural University, Wageningen, 1990

Evaluation 6

6.1 Introduction

The Tentative Ecological Main Structure is the result of an estimation of the spatial claim for nature in the EC. The network has been based on data on nature that are available now. It has been a first approach towards a coherent structure of nature in Europe. Evaluation of such a study is important to improve methodology, to show weaknesses in the procedures and the lacunae in the data sets. This study must be considered as the starting point on a long way towards an 'ideal' coherent network of nature in Europe. Such a network of nature, however, can only arise if politicians and scientists are both willing to work on it. It needs the approval and the instruments of the politicians and the design based on scientific methodologies and reliable unbiased data sets.
In this chapter the evaluation will mainly treat the comparability of the categories of protected areas between member states (par. 6.2) and the availability of data and its consequences for the design procedures (par. 6.3), the next two paragraphs will be devoted to EECONET, a policy report on a European Ecological Network for the Dutch Ministry for Agriculture, Nature Conservation and Fisheries that has largely been based on the preliminary results of this study (par. 6.4) and finally recommendations will be made for an improved methodology and data sets (par. 6.5).

6.2 Protected Areas in Europe

The protected areas have been analyzed and described with the help of a simplified EC-classification. The objective of this simplification was to identify uniform categories of protected areas in Europe. The classification has been based on nature conservation legislation of the member states. The objectives and the implementation of legislation were not the object of study.
The protection of areas can only be evaluated in its historical context. This makes the inventory of protected areas within the European Community complex within the same terms of protection. The twelve member states use different kinds of protection objectives related to their own legislation and nature conservation history. Also management practices can be different in the member states, varying from administrative and legislative protection to intensive management practices. Moreover, land uses that still exist in some countries as agricultural practice are considered to be valuable nature elsewhere (Creemer 1990) [1].
The Portuguese heathlands in Minho and Trás os Montes are still used for cattle grazing and for deep litter houses, while in The Netherlands the old agricultural land uses have been replaced by expensive methods to maintain the heathlands. In this country heathlands are no more valuable agricultural land; on the contrary, they are considered as nature that even suffers of nitrate deposition from the atmosphere (RIVM/RIZA 1991) [2]. That makes it difficult to compare the actual protection with the protection status between the member states. What can be conserved by landscape protection in Portugal Spain or Greece needs intensive nature management in The Netherlands, Germany or Denmark, because of the differences in land use, in available area and in environmental pressure.

[1] M. Creemer, *Natuurbeheer in Europa. Een inventarisatie van doelstellingen, methoden en kosten van inrichting en beheer in beschermde gebieden in de landen van de EG*; 's-Gravenhage, Wetenschappelijke Raad voor het Regeringsbeleid, Scriptie LU Wageningen, Vakgroep Ruimtelijk Planvorming, 1990.

[2] RIVM/RIZA, *Sustainable Use of Groundwater. Problems and threats in the Europeon Communities*; Bilthoven, Report nr. 600025001, 1991.

The definition of protected areas differs between the member states and this prevents a detailed classification. The IUCN-classification (IUCN, CNPPA 1982) [3] of protected areas is the best know. On the European level the classification used by the EC (De Meester-Manger Cats 1979) [4] is the most detailed one. But these systems do not classify protected areas in a way that makes it possible to compare the actual practice of protection and nature management between countries. The classifications are based on legal definitions and land use types that differ between member states.

Although more data are available in the CORINE database than ever, the differences between the member states hampered the results. The CORINE inventory of protected areas has been carried out in all countries on the same basis, but necessarily had to be interpreted by the member states themselves. This means that the existing differences have been included in the database partly without being detected. The only way to develop a reliable classification was therefore to simplify the classification. The CORINE databases on designated areas and on biotopes have been compared with various sources. Despite its imperfection the CORINE database gave a first insight of the protection status in the member states of the EC.
The three maps that have been produced on the actual protection status show a great diversity within the EC but also within the member states. From this inventory can be concluded, that

1. the protection of nature in the European Community is still restricted to small areas;
2. landscape protection is more widely used than nature protection probably due to the limited restrictions for other land use categories;
3. the protection of areas of international importance is in an early phase of development and the area protected in this way is very small.

A number of northern member states have a rather long tradition in nature conservation. This originates from the early impact of urbanisation and agriculture on nature. Many of the protected areas are small because of the historic process of land development and progressive reduction of nature to fulfil other land use demands within the rural areas (agriculture, forestry, recreation, infrastructure). A restricted number of National Parks is found here although not in the most densely populated areas. Mainly in the southern member states of the EC this impact has always been less and so was the need for action. The perspectives for nature conservation are much better. Most of the important nature areas in the southern member states are not yet protected although human impact is strongly increasing now (Bennett 1991) [5].

The main conclusion on protected areas in Europe is that protection by nature conservation law and landscape conservation does not necessarily represent the importance of nature or landscapes within a region or within the EC. It mainly gives information on the priorities of nature and landscape protection. In the northern countries protection is guided by what is left over of nature after land development and in the southern countries by the selections that have to be made from the wealth of nature to protect.
The development of a coherent structure of nature in Europe can only be realised with a reference of what are areas of nature conservation interest and the nature that should be part of the ecological main structure. The map on the Tentative Ecological Main Structure is a first attempt to develop this. It contains specified areas of which actual or potential natural values might be important to be protected in the future at an European level. The three types of

[3] IUCN, CNPPA, *United Nations list of National Parks and Protected areas*, Gland, 1982.

[4] V. de Meester-Manger Cats, *Protected Areas in the European Community. An Approach to a Common Classification (working document)*; Brussel, CEC/ENV/311/80, 1979.

[5] G. Bennett (ed.), *Towards a European Ecological Network*; Arnhem, Institute for European Environmental Policy, 1991.

protected areas are considered to play a role in national and international nature conservation. They also play an important role in the ecological main structure as developed in this project.

6.3 Data and design procedure

For the project data have been used that have been collected for all of Europe in more or less the same way. Their reliability is of the utmost importance. Because of national and regional differences there still are inconsistencies in the data. The best data available now, which cover all the territory of the EC, are the CORINE databases and data of the International Council for Bird Preservation (ICBP) on important bird areas (IBA).

The basic map was made from the CORINE database (Biotopes, Designated Areas, Potential Vegetation, Soils), which provides more or less standardised data for the EC in a geographic information system (GIS). The data set Biotopes provides information on habitats (size, status, species, physical characteristics) except for the delineation of the habitat that is not yet finished. The NUTS-regions, which are the administrative basis of the system, differ strongly and vary from 16000 ha for Brussels to more than 20 million ha for Central Spain. Sea areas that can be important as wetlands are not included in the territory of the NUTS regions. In this study, this has not been a problem, because the project focused on terrestrial biotopes. However, this is an important omission for statistical data on nature conservation and for the development of a complete ecological main structure. Although NUTS regions are not the best basis for ecological comparison between regions, they had to be used by lack of better.

The data sets on Administrative Regions (NUTS), Soil and Natural Vegetation can be considered reliable. These data sets cover all the territory of the EC, have already been used in different research projects and have been processed by CORINE. The data set on Biotopes, however, seems to be less reliable. Thus, the use of this data set met several difficulties.

The CORINE Biotope Inventory has not yet been completed. The progress of the data processing by the member states differs considerably. After the start of the CORINE programme in 1985 it was the responsibility of each member state to establish a team and to provide data. The data collection is completed by Belgium, Denmark and Ireland, whereas most of the other member states are doing the first check and verification of the data collection. For most states of Germany and regions in Great Britain, however, preliminary data set development has not yet been started. This restricts the use of the CORINE data set on Biotopes. Therefore use of the data is not possible without extra information. Knowledge on the singular member states and their procedures and selections is of utmost importance. Information from the CORINE Biotope data set has been supplemented by information from literature sources and experts in the countries and from the CORINE team. A list of consulted experts has been added in Annex I.

An important missing part of the information has been the delineation of the biotopes in the CORINE database and the breakdown of information on large biotopes. This made it impossible to use all possibilities of the GIS for the design of the different types of nature areas within the ecological main structure in detail. Biotope information combined with topographic maps, soil maps and vegetation maps had to be used to delineate the network.

Although the CORINE data set on biotopes is at this moment the most extensive source of actual information on nature in Europe, it still is incomplete and not yet based on scientific methodology for data collection or verified by independent experts. The selection made by the member states might be biased because of national policy on land use or the state of the art in field research. This means also that the data set can only be applied with careful checks using extra sources in cooperation with the CORINE team in Brussels and the check of the results by independent experts.

The application of criteria diversity, rarity and location that have been used could have been much more sophisticated if data from the different countries would be comparable in size and collected with the same accuracy. Now the differences between for instance The Netherlands and Spain are enormous. While in The Netherlands the size of the biotopes is mostly between 50 and 500 ha, the size of many sites in Spain is larger than 100,000 ha. This makes these two countries incomparable. That means that criteria had to be applied without using strict rules. This also restricts the use of the GIS-system.
In this project differences in progress between the member states have been met by the use of supplementary data for Great Britain and Germany for the protected areas inventory. It was well possible to picture the actual situation of nature conservation in these member states. More consequences are connected with the design of an ecological main structure. The nature expansion areas, originating from not-protected areas of nature conservation interest could not be selected from the data sets, but had to be derived from other inventories on actual protected areas for landscape conservation and additional regional data. In these cases special information and comments from experts in most member states provided the necessary check on the avoidance of important lacunae and the reliability of the data (Annex I).
The data set settlements have not been used in the project because the member states used different definitions for villages and urban areas and the information on inhabitants is not always correct and often outdated. Most important, however, has been that spatial information on urban areas is incorrect or lacking. This limitation has been recognized in an early state of the project and did not influence the results. Large urban areas have been excluded from the map as far as possible by using data from topographic maps. However, this means that extensive suburbanization areas as for instance exist in Vlaanderen (Belgium) have not been detected and can be part of the Tentative Ecological Main Structure.

6.4 EECONET, an example study on a European ecological network

There are two important reasons to develop an ecological network in Europe: among the major problems faced now in nature conservation are external influences like pollution and land use changes. Exchange processes between habitats are essential for their well-functioning. Other important threats are even of continental and global character. To face these threats and the related decline of nature a European strategy has been developed of coordination of nature conservation within the EC. Nature does not regard national boundaries and although national conservation strategies might solve many problems they need international coordination to face pollution and land use changes, which both affect habitats in all member states. Border crossing problems have to be solved like river pollution and river regulation and a strategy has to be developed for future threats. The most important one is climatic change that urges nature conservation to develop a strategy of flexible response of nature to the possible shifts in climate zones, sea level rise and changes in hydrology.
Natura 2000 is the proposal in the Habitat Directive for an ecological main structure within Europe. This can be the result of coordination of nature conservation by a European ecological network. This has been worked out in an example study based on the preliminary results of this study under the name EECONET. Scientists supported by policy makers will design a network based on a common basis. The physical result of this European coordination of national priorities and conservation strategies can be a design of priority areas for nature conservation in Europe. The objective of EECONET can be defined as (1) effective protection of the most important habitats and species in Europe, (2) the development of a coherent structure of important habitats within Europe, (3) facilitation of migration and dispersal of species where desired and (4) prevention of further decline of habitats and species. This objective pretends

to be more than the objective of the present study on the claim for nature. But, although the objectives are different, the physical structure of EECONET is much alike the network developed in this study, because this study has been an important basis for it. Differences are that EECONET contains a concept not only of the physical structure of nature in Europe, but also of the scientific and political organization that should be its basis. Besides, EECONET contains not only terrestrial sites like mountain ranges and river valleys, but also coastal wetlands and sea areas.

Conservation of habitats and species in relation to each other means the protection of important areas and of the processes within and between them. Important areas for conservation have to be selected and managed in such a way that natural processes like erosion, sedimentation, succession, colonisation and extinction are possible without being irreversible. Areas must facilitate natural physical processes and related biological processes without influence of man.

In the river deltas sedimentation processes build up a system of wetlands and other humid ecosystems. Rivers connect the main physical structures in Europe, the mountain ranges and hill systems on the one hand and the lowlands and the coastal wetlands on the other. They pass all kinds of landscapes and climates and therefore act as ecological corridors. The Rhone and Po connect the Alps with the Mediterranean region, the Rhine connects them with the Atlantic region and the Danube with the Black sea. They are used by birds as migration routes and they are dispersal mechanism for plant species.

Extinction of species in habitats and their recolonization is a natural process. It means, however, that habitats must be accessible for species. The process of increasing isolation of nature in nature reserves and the importance of ecological corridors has been shown by research in several EC countries. Isolation is, however, not important for all habitats and all species, because some spread very well or need only dispersal over small distances. For some habitats and species, for instance island species, isolation is even a precondition for their survival. However many species and their populations depend on exchange to survive. Their isolation is mainly caused by land use changes as for instance intensification of agricultural land use, urbanization and motorway construction. Isolation prevents optimal development of the habitat and its populations and in this way influences the objectives of the habitat directive.

Shifts in climatic zones in Europe due to climatic change does not only mean a possible desertification and salinization of parts of the Mediterranean area. It also means that habitats will change. Their physical conditions change and part of the species within them will tend to move north. Mediterranean species will get extinct in the desertificating areas and try to colonise parts of France, the United Kingdom, Ireland, Switzerland and maybe Germany. North European boreal species will become partly extinct in the north of the EC and if possible be replaced by South and Central European species. However, this ecological shift can only follow the climatic shift if there are corridors to move through.

A principle of EECONET is that the general objectives and the main structure are designed at the European scale. Its differentiation will, however, be realised in the context of national and regional nature conservation policies. That means, that the large areas indicated on a map of Europe offer possibilities for governments to localise priority areas for nature conservation based on national and regional data and considerations. However, all areas in EECONET are considered to be of nature conservation interest for the European Community. EECONET is part of a hierarchical structure, based on (1) a European strategy, (2) national strategy within the European framework and (3) regional an local strategies.

6.5 Towards an improved methodology

Conservation of important habitats within special areas of conservation means that areas must be selected on the importance of their habitats, the importance of the species that use the area or their biological diversity. Special areas of conservation must sustain development of the ecosystems and populations that are characteristic for the habitats within that area to ensure a satisfactory conservation status (Art 3 Habitat Directive). Special areas for conservation can be defined as areas containing the most representative habitats in a member state or parts of member states.

Wetlands and their species are sensitive to changes in water management. Water quality and water quantity are mutual related and changes in one of the two can have severe repercussions for the wetland system. Raptors prefer quiet habitats for nesting and are easily disturbed by outdoor recreation. Nutrient poor vegetations like bogs, heathlands and many natural grassland types are sensitive for intensive agricultural practices. In general areas of high ecological value can require buffering and the smaller the habitat and the stronger the impact, the more buffering is needed. Buffer zones can be used to prevent negative effects from regional sources like recreation, groundwater extraction, groundwater pollution. Impacts of continental pollution and land use changes, however, can only be regulated by international coordination of nature conservation on the one hand and sustainable development on the other.

In areas where land use is changing or intensifying, habitat protection can be insufficient, because of the small size of the habitats, the rising incompatibility of nature conservation with other land uses and the increasing isolation. This already caused a change in nature conservation strategy in some member states and regions like Denmark, some German states, The Netherlands, Vlaanderen and Piedmonte. Here new areas have been or will be designated for redevelopment of nature (such as native forests, natural floodplains and floodplain forests, brooks, bogs, small rivers and salt marshes). This will be based on national nature conservation strategies and priorities can be different between member states. Nature redevelopment might not be necessary for all member states, but it can be important for some regions and countries that face the above situation. However, prevention of the need for nature rehabilitation is better, easier to realise and less expensive.

Within the context of increasing decline of nature a European Ecological Network can be the strategy to coordinate nature conservation for the territory of the EC within national conservation traditions. The objective is to indicate a zonation in which the most important European nature areas are situated as core areas, to prevent their isolation and to facilitate exchange of species between them. The ideal ecological main structure joins all important habitats in Europe into a coherent structure. It takes into account all biogeographical differences, habitats of threatened species, vulnerable habitats and unique sites considered at a European scale. It must be based on the function of habitats, habitat quality, habitat size and biodiversity as important landscape ecological principles. Ultimately it is part of a hierarchical structure, based on (1) a European strategy, (2) national strategy within the European framework and (3) regional and local planning within the national strategy.

Nature conservation is organised differently in all European countries. A European ecological network might, however, become the unifying concept that is worked out and realised by this diversity in strategies. Within the zonation of the network core areas have to be defined, buffer zones around these core areas if needed as well as corridors or corridor zones. Core areas can be defined as the most important European habitats for nature conservation and zones between them will have a dual function of human land use (forestry, agriculture, road traffic) and ecological corridor. Areas can also be identified as nature development areas or buffer zones.

For the design of the European ecological main structure guidelines are

biogeographical differences, biodiversity and the location of habitats important. It is not necessary that all areas indicated within the network have high natural values already, although most areas will have. In some cases nature (re)development has to be considered. A principle of the network is that the general objectives and the main structure will be designed at the European scale, but that its differentiation will be realised in the context of the national and regional nature conservation policy. This means that the large areas indicated on the map offer possibilities for governments to localise priority areas for nature conservation based on regional data and considerations. However, all areas in EECONET are considered to be of nature conservation interest.

To design a coherent ecological main structure for all the territory of the EC means, that decisions on size and content of areas should be taken on comparable data. Data have to provide insight in biodiversity of habitats, rarity or uniqueness of habitats, their importance in dispersal and migration of species, their sensitivity for external influences and land use changes. Ideal data sets should therefore contain

1. data on soil and physical environment;
2. maps of land use and actual vegetation of Europe;
3. data on biodiversity of selected species groups (fauna and flora) and
4. data on socio-economic activities and trends in the network areas.

Data on soil, physical environment, vegetation and biodiversity can be used to develop the main structure by selecting sensitive areas and priority areas which are important to prevent species from decline. To prevent bias more or less permanent physical data must be the basis for region selection. Regions should cover all abiotic differences within Europe. Data on socio-economic activities (agriculture, forestry, mining, transport) can be used to select priorities within regions and between regions. Moreover it can be used to check if the proposed structure is realistic and to eventually differentiate within it.

These considerations force the coordination of nature conservation within the EC. The actual state of nature in the member states of the EC differs strongly, but the European ecological main structure can become the common agreement that is worked out and realised by this diversity in organization. An ecological main structure provides the opportunity to discuss and solve border passing problems like the protection of river systems or of routes of migratory birds. The European ecological main structure can stimulate not only member states to decide on their own priorities, but also on the overall structure of protected habitats in Europe. The areas that are important for conservation according to the habitat directive could function as core areas for nature protection. National and regional coordination and integration are important, but European coordination is essential because important habitats in one region can be related to important habitats in other European regions.

The design of a European ecological main structure consists of three phases:

- research for and design of an ecological structure at international level,
- discussion and decision making on the results of phase 1 and
- implementation of the results in European conservation policy.

At this moment the phase of research has begun and will require a great scientific effort.

The European ecological main structure must be based on the important European habitats selected on criteria of European biogeography, biological diversity, function, habitat quality, habitat size and location. In some countries it will be difficult to select the most important habitats, because of their rich and important nature. In other countries or parts of countries it will be difficult to design a coherent structure because of recent decline of nature. Here nature rehabilitation might be applied.

ANNEX I

Consulted experts

Consulted Experts

Dr. Ileana Napoleone
Instituto per le Applicazioni del Calcolo IAC
Viale del Policlinico 137
Roma
Italia

Dr. R.H.G. Bunce
Institute of Terrestrial Ecology
Merlewood Research Station
Grange over Sands, Cumbria LA11 6JU
England

Dr. D. Bartlett
Department of Geography
University College of Cork
Cork
Ireland

Dr. K. Bradley
140 Rathdown Park
Greystones, Co Wicklow
Ireland

Dr. J. Primdahl
Agricultural University,
department of Urban and Regional Planning
Bulowsvej 13
DK 1870 Frederiksberg C
Denmark

Dr. W. Bohn
Bundesanstalt für Naturschutz und Landschaftsökologie
Konstantinstrasse 110
D-5300 Bonn 2
Germany

Dr. E. Kuyken
Instituut voor Natuurbehoud
Kiewitdreef 3
3500 Hasselt
Belgium

B. Hallmann
Panagia 45
400 08 Rapsani
Greece

Dr. R. Elena-Rosello
INIA
Departemento de sistemas forestales
Carretera de la Coruna Apdo 8111
Madrid 28040
Spain

Dr. P. Ketner
Agricultural University,
department of Nature Conservation
Ritzema Bosweg 32a
6703 AZ Wageningen
The Netherlands

Prof.dr. I.S. Zonneveld
Vaarwerkhorst 63
7531 HL Enschede
The Netherlands

Drs. J. Kalkhoven
IBN
Postbus 46
3956 ZR Leersum
The Netherlands

Dr. C. Gafeira
Servi'o Nacional de Parques Reservas e ConservacMo da Natureza
Rua da Lapa 73
1200 Lisboa
Portugal

Dr. M. Marques
GEOTA
Rua Ricardo Espirito Santo 1-R
1200 Lisboa
Portugal

Annex II

Description of the Tentative Ecological Main Structure for the NUTS-regions of the member states of the European community

België/Belgique

Physical geography

Belgium rises from the North sea in the west onto the Ardennes in the east, where the highest point (Baraque St. Michel) measures 694 m above sea level. In the west part of the country marine polders and fluvial plains of the Scheldt basin are situated. The Scheldt drains most of the west part of Belgium. Only the utmost southwestern part is drained by the IJzer. The fluvisols are sandy and loamy. Between the sub-basins of the Scheldt low vaultings are found (Goossens et al 1967) [1].

Central Belgium is a table-land, where in the west part clay soils dominate, in the central and north part sand and in the east part calcareous soil. Loamy soils are found In the southeast near the watershed between Scheldt and Meuse.

The valley of the Meuse is situated on the gradient between central and high Belgium. The Meuse drains all the Ardennes, a high table-land. The Ardennes rise from west to east where at the highest point at Baraque St. Michel the Hautes Fagnes is situated, an extensive raised mountain bog. The valleys of the rivers divide the Ardennes by deep small valleys. The utmost southern part of Belgium inclines down to the southwest. The Ardennes are characterised by shallow aquifers.

The climate varies from atlantic in the west to mountainous in the east (Jongman 1991) [2]. Yearly mean temperature differs from 9.9°C in Oostende to 5.7°C in Botrange, in January varies between 3.5°C to −2.1°C. Precipitation ranges from 579 in Oostende to 1510 in Botrange (Müller 1987) [3].

Important habitats

Important habitats in Belgium are springs, brooks and small rivers because of their rather natural character and diversity in species. Other important habitats in Belgium are related to the gradient from the sea to the low mountains.

The vegetation of the northern part of Belgium on the poor sandy soils is an Atlantic oakwood oak-birch forest (*Querco-Betuletum*) and its derivates or oak-beech forest (*Fago-Quercetum*). In Vlaanderen the extensive heathlands, the remnants of dunes and sea related vegetation are characteristic. Large heathlands are still present intersected with rather natural lowland brooks. Here important habitats for birds are situated along the coast (wetlands). The lowlands are important for duck species especially the gadwall (*Anas strepera*).

The natural vegetation in the central part of Belgium is an Atlantic beechwood (*Endymio-Carpinetum*) with hornbeam (*Carpinus betulus*), ash (*Fraxinus excelsior*), field maple (*Acer campestris*) and medlar (*Mespilus germanica*). Parts of the Kempen region are rich of bird species because of rather extensive agricultural land use.

In the Ardennes the natural vegetation is an acidophilous beechwood (*Luzulo-Fagetum*). Here the raised bogs and the natural forest of beech-hornbeam (*Carpinion*) are important. The main areas that are considered of interest for bird preservation are the Hautes Fagnes because of the presence of an important population of the black grouse (*Tetrao tetrix*) and the forests of the Ardennes. Large areas have international protection as bird directive areas. Wallonie has high potentials for conservation of a large area of Atlantic low mountain habitats.

[1] M. Goossens, F. Gullentops and G. Verfaille, *België in de Europese Gemeenschap*; Antwerpen, De Nederlandse Boekhandel, 1967.

[2] R.H.G. Jongman, 'Ecological classification of the climate to the Rhine catchment'; *International Journal of Biometereology*, 1991, 34:194-203.

[3] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

Human influence on the natural environment

Vlaanderen is a flat country with a high level of urbanisation. Important conurbations are Brussels, Antwerp and Gent and there are extensive suburbanised areas. Wallonie is less densely populated. Most of the population is concentrated in the Meuse valley.
The rivers Scheldt and Meuse both merge in France and end in the Netherlands into the North sea. Both river basins have traditional industrial areas characterised by chemical and metallurgic industry.
Especially the Scheldt is heavily polluted because of the high concentration of industrial plants, its high population density and absence of well functioning water purification plants (Ovaa 1991) [4].

Nature Conservation in Belgium

The nature conservation policy of Belgium is focused on nature reserves which are owned by the state or private organisations. The area covered by nature reserves is less than 3 per cent of the total area. The most important nature park, the Haute Fagnes, contains several nature reserves. Large EC bird directive areas are located in Wallonie.
In Vlaanderen a plan has been developed and approved by the regional government on a regional main ecological structure, the 'Groene Hoofdstructuur van Vlaanderen' (Kuijken 1990a) [5]. This plan has been used to check the results and as part of the expert comment for Belgium. This plan contains a strategy for future Nature Conservation for Vlaanderen. The objective is to realise a coherent structure of sites, where policy towards conservation and development of nature is intensified. This policy must be realised by both the regional and the local governments. It recognises core areas, nature (re)development areas, connection zones and buffer zones. There is not yet such a plan for Wallonie.

The Tentative Ecological Main Structure in Belgium

The Tentative Ecological Main Structure, consisting of Potential Areas of Nature Conservation Interest in Europe is build mainly on a large area of nature connection zones (Figure 1). In the northeast an area has been specified that contains most of the brook areas of Vlaanderen and part of the *Endymio-Carpinetum* zone in the south. In the western part of Vlaanderen the last relatively undisturbed part of the dunes is indicated as nature development area. Besides the river of the IJzer is included because of the presence of wet forests and the protection as EC bird sites.
The Voerstreek is a part of a connection zone between the southern part of the Netherlands, the Hautes Fagnes and a part of the Ardennes in Luxembourg. The Ardennes are included because of its partly international protection as bird directive areas and their importance for natural beech forests. The springs of the Dender are included because of the presence of alluvial forests and wet brushes in the spring area. The large area of forests and the high coverage of internationally protected areas make Wallonie on of the regions with the highest coverage of the Tentative Ecological Main Structure in Europe.

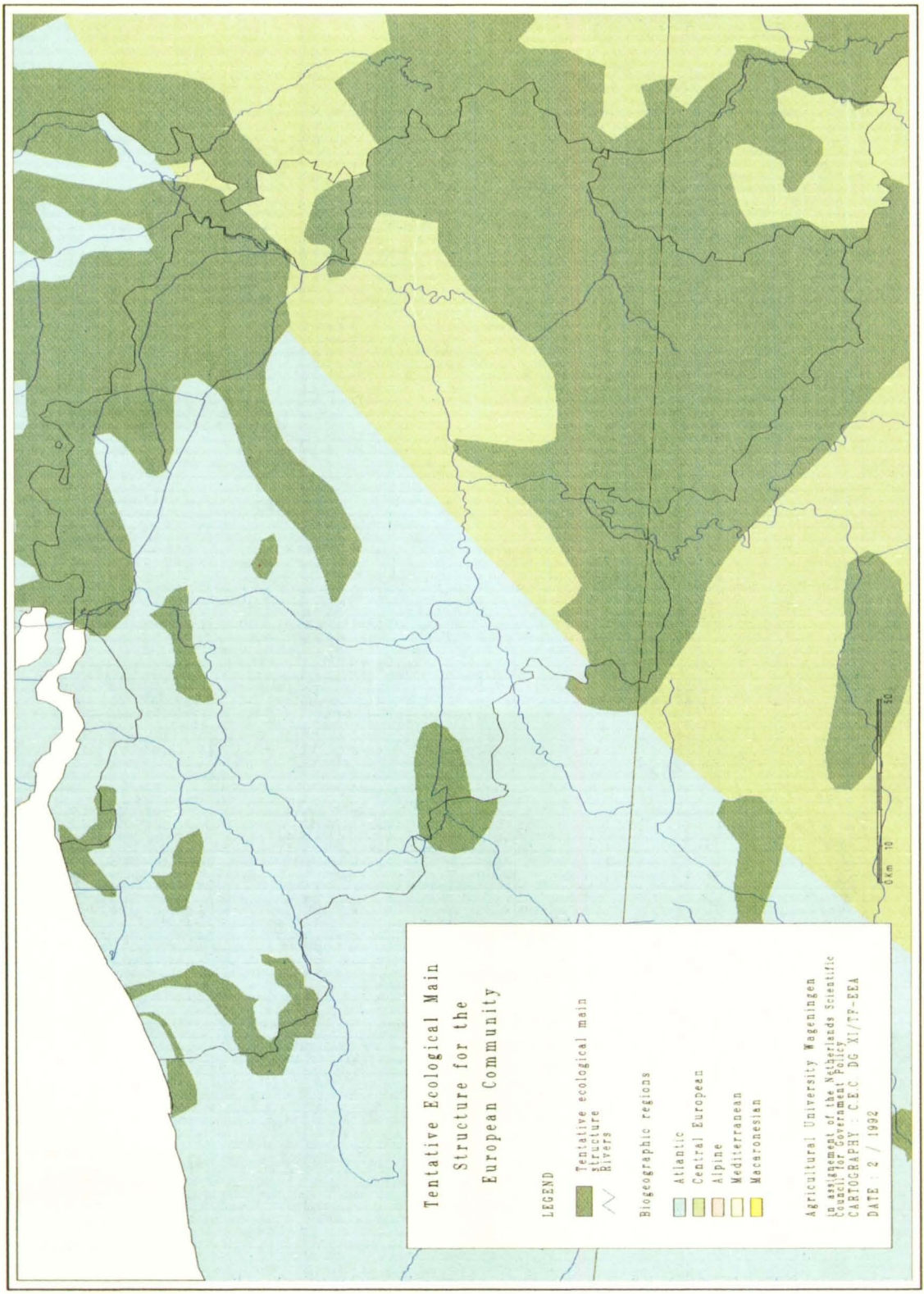
Regions

Belgium consists of three regions of which Brussels is the smallest. Data on protected areas and on the Tentative Ecological Main Structure are given in Table 1.

[4] E. Ovaa, *Naar een samenhangend beheer van het riviersysteem van de Schelde in het perspectief van duurzame ontwikkeling*; Wageningen, Student Report LU-Wageningen, department of Hydrology and department of Physical Planning, 1991.

[5] E. Kuijken (ed.), *De Groene hoofdstructuur van Vlaanderen*; Richtnota van Theo Kelchtermans; Ministerie van de Vlaamse Gemeenschap, Kabinet voor Leefmilieu, Natuurbehoud en Landinrichting van de Vlaamse Regering, 1990(a).

Figure 1 The Tentative Ecological Main Structure in Belgium



Source: CORINE/Agricultural University, Wageningen, 1990

Table 1 The partition of the Tentative Ecological Main Structure in Belgium
The area is given in ha and percentage of the total NUTS-area

Regions	51	52	53
Region Area (ha)	1.360.082	1.690.514	16.300
Protected Area			
Nature (ha)	25.726	14.485	0
Nature (%)	1.89	0.86	0
Landscape (ha)	64.759	250.951	4750
Landscape (%)	4.76	14.84	29.14
International (ha)	90	328.500	0
International (%)	0.01	19.43	0
Nature Expansion Area			
(ha)	129.587	427.969	0
(%)	9.53	25.31	0
Habitat Connection Area			
(ha)	303.769	465.600	0
(%)	22.33	27.54	0
Not-protected Area			
(ha)	64.828	177.017	0
(%)	4.77	10.47	0
Tentative Ecological Main Structure			
(ha)	459.082	908.054	0
(%)	33.75	53.71	0

Vlaanderen (51)

Data that have been used are CORINE habitat data, especially the information on the distribution of broadleaved deciduous forests, alluvial and very wet forests, humid, dry calcareous, dry siliceous grasslands, heath, bogs and marshes. Besides, information from CORINE has been used to is delineate the Bird Directive areas. The European soil map provides restricted information. For development of the Network mostly data have been used from the map of Natural Vegetation of Europe (Noirfalise 1987) [6]. Besides, the Flemish Environmental plan and Nature policy plan have been used (Kelchtermans 1990 [7], Kuijken 1990a, 1990b) [8].

Based on the Natural vegetation map oak-birch forests have been considered to be characteristic for the low pleistocene table land of the Kempen, and subatlantic oak-beech forests are considered to be the main natural vegetation type of higher, calcareous parts of Vlaanderen. South of Brussels an area with Endymio-Carpinion is situated.
Based on both criteria diversity and rarity an area in the northeastern part of this region has been delineated with most of the Flemish springs and small

[6] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

[7] T. Kelchtermans, *Milieubeleidsplan en Natuurontwikkelingsplan voor Vlaanderen*; Voorstellen voor 1990-1995; Brussels, Ministerie van de Vlaamse Gemeenschap, 1990.

[8] E. Kuijken, op.cit., 1990(a).
E. Kuijken (ed.), *Schetskaart voor een groene hoofdstructuur in Vlaanderen; Aanvullende noto bij het Natuurontwikkelingsplan van T. Kelchtermans*; Hasselt, Instituut voor Natuurbehoud, Ministerie van de Vlaamse Gemeenschap, 1990(b).

lowland brooks. To the south the characteristic Endymio-Carpinion zone is included. Also the Voerstreek has been included as a whole for its diverse and rare nature, consisting of small scale elements, like brooks, wet forests and hedgerow landscape. This region is also important as a corridor zone because of its location between the nature area in South Limburg in the Netherlands and the area of the Hautes Fagnes onto Luxembourg.
Dunes and coastal areas have been selected because they are severely threatened. Dunes along the coast are part of a long dune system stretching from Skagen to Calais. Large parts have built-up areas. The leftover parts are therefore considered as rare and threatened remnants. These remnants have been included, because of their location and threats.
All bird directive areas have been included as well as areas on the ICBP shadow list for important wetlands. These are the IJzer and the Zwin. The extent of the area near the Durmen, west of Antwerp have been decided on the basis of ICBP data and the map of the Groene Hoofdstructuur. The extension from the Zwin to the south, the IJzervlakte and the nature area between Brugge and Gent (het Houtland) are selected because their position on the groene hoofdstructuur and regional information (Kuijken 1990a, Kuijken 1990b) [9].

Wallonie (52)

Data have been used from the CORINE database on habitats, especially the distribution of broad leaved deciduous forests, alluvial and very wet forests, humid, dry calcareous, dry siliceous and alpine grasslands, heath, bogs and marshes. For the development of the Nature expansion are use has been made of the map of natural Vegetation of Europe (Noirfalise 1987). In Wallonie the Beech forests (*Luzulo-Fagetum, Stellario-Carpinetum, Melico-Fagetum/ Carici-Fagetum*) are the dominant vegetation types. There is an alluvial zone around the sources of the Dender and in the east there is an extensive raised bog. The European soil map has been used for details, but offers little information on the overall structure. All protected areas according to the EC Bird Directive have been included.
Based on the criterion of diversity the Ardennes in Wallonie have been selected as an important element in the gradient from the coastal zone to central Europe for its characteristic vegetation and its importance for forest birds. For its diversity of alluvial forests and brook forests and rare habitats the area of the source of the Dender is selected.
Rarity of raised bogs in continental Europe and the many threats to them in Europe made it necessary to select the Hautes Fagnes; an extra reason is the presence of the threatened black grouse (*Tetrao tetrix*). A third reason to select this area is the delineation of a continuous nature zone in the east and the south from the Voerstreek and the Hautes Fagnes onto the Sambre north of Chimay and the Luxembourg border.

Brussel (53)

No nature present except urban fringe and urban related nature (parks).

Consequences for agriculture and forestry

The Tentative Ecological Main Structure will have consequences for agriculture and land use. These differ if nature is considered as a product of unmanaged natural developments or as a semi-natural landscape. In Vlaanderen in both cases intensification of agricultural practice in the sensitive brook regions must be avoided, while in the dunes and coastal areas urbanisation has to be strongly regulated being the main disturbing factor. In Wallonie the

[9] ibid

tentative network consists mainly of beech and conifer forests that can develop into rich natural forests and a large area is the bog of the Hautes Fagnes. Core areas are considered to be a special Protection Area according to the Bird Directive. The network is considered to consist of buffer zones and corridor areas as well. In these zones low production forestry is possible (Harris 1984) [10]. The total area of the Tentative Ecological Main Structure is 908.054 ha; fifty percent of it can be considered as buffer zone and corridor area. The Hautes Fagnes is unlike the bogs in the United Kingdom and Ireland no rough grazing area.

[10] L.D. Harris, *The fragmented forest. Island biogeography Theory and the preservation of Biotic diversity*; Chicago-London, University of Chicago Press, 1984.

Danmark 2

Physical Geography

Denmark is is situated between the North Sea and the Baltic Sea and consists of a peninsula (Jylland), connected with continental Europe, the islands Sjaelland and Fyn, many morainic islands and extensive archipelagic waters. The coast is highly indented and characterised by an abundance of fjords, bays, straits and peninsulas. Bornholm is a Baltic island, which marks the eastern limit of Danish territory.
Denmark is dominated by glacial landforms, originated from the last two Ice Ages: lowlands with gentle undulation and with the highest point barely reaching 175 m. Flat plains are not extensive. On the islands and in Eastern Jylland, ground moraines with fertile clay soils prevail. Western Jylland consists mainly of outwash plains and old moraines. Here sandy soils dominate. These landscapes are dissected by tunnel- and glacial water valleys.
Furthermore, areas with original marine soils raised since the latest Ice Age are found in Northern Jylland and other places along the coasts. The southwestern part of Jylland constitutes the northern part of extensive salt marsh area stretching through Germany onto the Netherlands. Exposed bedrock is found only on Bornholm in the Baltic Sea and along a few coastal areas.
Denmark is divided into two biogeographical regions. The atlantic and the Central European climate influence the biogeography of Denmark. The climate in Denmark is northern atlantic (Walter and Lieth 1964) [1]. Only the months January and February have mean temperatures below 0°C, while the yearly mean temperature 7.5°c in the west to 8.7°C in the east. Most precipitation is found in Jylland (Studsgård: 782 mm yearly). The island of Bornholm is the driest part of Denmark with a mean precipitation of only 553 mm (Müller 1987) [2].

Important Habitats

The importance of Danish habitats originates mainly from their function for migrating birds. The shallow water around Denmark are of major international importance for moulting, staging and wintering seaducks. The extensive intertidal areas and adjoining land of the archipelago, eastern Jylland and the Danish Wadden Sea hold internationally important concentrations of non-breeding swans, geese and waders (Grimmett and Jones 1990) [3]. The country's wetlands are also important for a number of breeding species.
The areas of semi-natural vegetation include woods of pedunculate oak (*Quercus robur*) and beech (*Fagus sylvatica*), mostly small and dispersed, sand-dunes, scattered inland heaths and bogs. Besides their vegetational importance they also are of importance for breeding birds.

Human Influence on the Natural Environment

During the last decades the conditions for the Danish flora and fauna have steadily deteriorated. Many species have disappeared, more are endangered. This development is due partly to pollution partly to direct changes in the landscape, including removal of biotopes. In addition, also the visual landscape has changed, so that a levelling of regional differences has taken place in certain areas, in others the differences have been enhanced.

[1] H. Walter and H. Lieth, *Klimadiagramm Weltatlas*; Jena, VEB Gustaf Fischer Verlag, 1960-1964.

[2] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

[3] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

Two-thirds of the Danish land is in agricultural use; 85 per cent – 90 per cent of this is arable farmland. The technological and economical development of agriculture is of major importance in the changes in wildlife and landscape. The increasing use of fertilizers with the consequential leaching of nutrients and the increasing application of chemical sprays have a great impact on the wildlife of the farmland, especially on birdlife and affects the diversity in biotopes adjacent to the fields. Besides the increasing number of heavy machinery per farm unit in combination with an increased average field size have caused the loss of many biotopes, especially ponds, streams and drainage ditches (Primdahl 1985) [4]. Similarly, a reduction of hedgerows has taken place, primarily on the clay soils of eastern Denmark. Both has led to impaired dispersal possibilities for plants and animals.

Protected areas

Denmark is characterised by numerous small nature reserves (managed and strict nature reserves) that are mostly situated in protected landscape areas. The protection aims mainly to the conservation of existing habitats, that are of importance for bird species. The idea of a functional ecological main structure has been worked out for migratory species. An ecological main structure with spatial aspects is designed in the administrative regions, the counties, but these networks differ much in character.
However, the importance of an ecological main structure for the future nature conservation in the future is recognised and projects for (re)development of nature are carried out in Denmark.

The Tentative Ecological Main Structure in Denmark

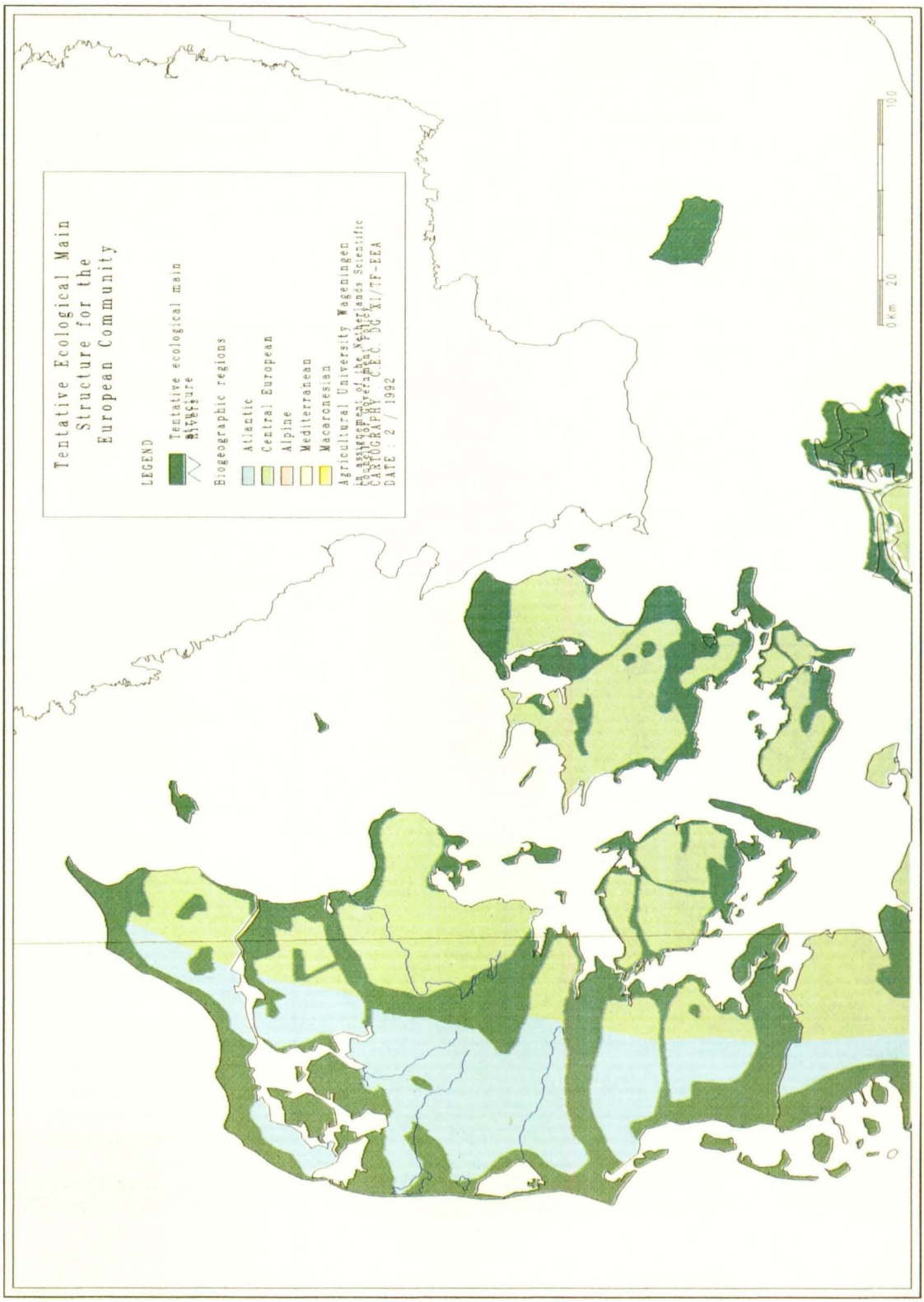
Denmark is only one NUTS-region. The ecological main structure in Denmark has been designed according to the procedure described in the main report. The CORINE biotope data on the distribution of broadleaved deciduous forests, alluvial and very wet forests, humid, dry calcareous, dry siliceous grasslands, heath, bogs and marshes. Besides, information from CORINE has been used to is delineate the Bird Directive areas. The European soil map provides restricted information. For development of the Network mostly data have been used from the map of Natural Vegetation of Europe (Noirfalise 1987) as well as information on important bird areas (Noirfalise 1987) [5]. Besides, regional and national information on protected areas has been used. Regional plans of the 14 counties in the country have been used, because they contain important actual and potential areas of nature conservation interest in Denmark.

The ecological main structure in Denmark consists of large coastal areas, wetlands, hilly landscapes, peatlands and bogs (Figure 2). In Table 2 the spatial claim of the different parts within the ecological main structure is listed.
In Northern Jylland the whole coastline is part of the ecological main structure. It contains numerous nature reserves and special protected areas according to the EC Bird Directive. The habitats of this area are: large sand-dunes, isolated moorland areas and bogs, saltwater and freshwater marshes, coastal meadows, fjord areas with lakes, coastal heaths with sand hills and wetlands and have been selected on the criteria diversity and location. A connection area has been designed to the Feggersund along the Limfjorden.
A large Ramsar site (6000 ha) is situated here.
Based on the same criteria the western coastline has been included into the ecological main structure as a whole from north to south. The fjord areas

[4] J. Primdahl, *Agriculture, Wildlife and Landscape in Denmark*, Frederiksberg, Agricultural University, Institute for Town and Country Planning, 1985.

[5] A. Noirfalise, op.cit., 1987.

Figure 2 The Tentative Ecological Main Structure in Danmark



Source: CORINE/Agricultural University, Wageningen, 1990

Nissum Bredning, Nissum, Ringkobing and the Wadden Sea are important coastal wetlands; the Wadden Sea has not been included. Saltmarsh meadow, intertidal zones, brackish lagoons, dunes, reed-swamps and heathland vegetation, agricultural land, shallow lakes and moor areas are the biotopes of this part of the ecological main structure. In the south the Tentative Ecological Main Structure ranges landward, consisting of small deciduous and coniferous forests, moors with marshes and meadows, raised bogs and agricultural land, a heterogeneous landscape to the border with Schleswig-Holstein.

Table 2 **The partition of the Tentative Ecological Main Structure in Danmark. The area is given in ha and percentage of the total NUTS-area**

Region	9
Region Area (ha)	4,281,259
Protected Area	
Nature (ha)	194.047
Nature (%)	4.5
Landscape (ha)	444,056
Landscape (%)	10.4
International (ha)	680,727
International (%)	15.9
Nature Expansion Area	
(ha)	449,537
(%)	10.5
Habitat Connection Area	
(ha)	642,195
(%)	15.0
Not-protected Area	
(ha)	667,876
(%)	15.6
Tentative Ecological Main Structure	
(ha)	1,862,366
(%)	43.5

Two connection areas have been designed in west-eastern direction to connect the western coast with the eastern coast. One from Ribe to Christianfeld and one from Esbjerg to the Vejle Fjord. Different habitats are part of it: bogs, rivers and streams, wet meadows, agricultural land, deciduous and coniferous forests and heathlands.

Numerous nature reserves and international important areas (Ramsar sites, EC-directive special protection areas) are connected by this part of the ecological main structure. From the Mariager Fjord (Ramsar site) a large nature expansion area based on the criteria diversity and rarity and connection area has been designed, following numerous streams, in south-western direction to the hilly landscape of central Denmark, where forests, with streams and freshwater lakes, heathlands, wet meadows, bogs and peaty wetlands dominate.

In the south this part of the ecological main structure ranges to the Horsens Fjord, a Ramsar site with a shallow fjord and sea area with shoals and banks and small islands with coastal saltmarshes, lagoons and cultivated land. Starting by Nibe a large part of the ecological main structure ranges along the Limfjord to the eastern coastline. It includes the area of Ulvedybet and Nibe Bredning, a Ramsar site with a diversity of habitats, including shallow fjord areas, saltmarsh, reed-swamp, freshwater lakes agricultural

land and the largest raised bog in Denmark and one of the best-preserved lowland raised bogs in north-west Europe, Lille Vildmose (6800 ha). The area is connected with the inland hilly area by the Mariager Fjord surrounded by connection areas with agricultural land and forests.

On the island of Fyn the ecological main structure consists of a narrow area along the coastline except the south of the island and is based on the criterion diversity. In the south a extensive area with deciduous woodland, lakes and agricultural land has been included, partly protected as nature conservation area. Two connection areas have been designed in north-south and east-west direction, that follow important stream areas. There are numerous small lakes and bogs, that are included as stepping stones.

The expansion areas of the ecological main structure on largest island of Denmark (Sjaelland) is based on the criterion diversity and consists of different parts:

- in the north-east a large area comprising heterogeneous forests with glades wetlands and lakes;
- the peninsula in the north, an area with heterogeneous forest with glades, wetlands and coastal meadows;
- the southern coastline with adjacent inland, an area with agricultural land with numerous small lakes, deciduous forests, bogs, freshwater ponds, marshes, meadows and coastal habitats as shoals, saltmarsh, reed-swamps, banks and islands.

Numerous small lakes, wetlands and bogs have been included as stepping stones, because of their actual importance. Based on their location the coastline of Lolland and Falster has been included into the ecological main structure. Besides small inland areas have been designed: on Lolland this inland area connects freshwater lakes with wooded islands and peninsulas, surrounded by deciduous forest and meadows. On Falster a connection between the eastern and western coastline has been designed, comprising of small bogs and meadows. Based on its diversity and rarity the island of Bornholm is included as a whole.

Consequences for agriculture and forestry

The consequences of the ecological main structure for forestry might be restricted because large parts of the structure in the Tentative Ecological Main Structure can be found in the regional plans of the Danish counties. At this moment agriculture makes up a prominent part of the Danish landscape. However, a marginalisation process is expected that will take out 162,000 ha of agricultural land out of production by the year 2010 (Hansen and Primdahl 1992) [6]. If 50 per cent of the land out of production is available for nature conservation, an area of 500,000 ha will then be available, being 40 per cent of the Tentative Ecological Main Structure. Most of this land out of production will be on the sandy soils (Jylland). Conflicts still can occur in the other more fertile and productive agricultural areas. The network in Denmark consists of wet areas mostly along the coasts in connection with coastal waters. According to the available area and the area that is claimed for nature conservation purposes the conflicts will be restricted. However, large areas that will function as corridor areas will meet restrictions in land use.

[6] B. Hansen and J. Primdahl, *EC agricultural structures policy and the environment; Country profile: Denmark*; Frederiksberg, Denmark, Royal Veterinary and Agricultural University, Department of Economics and Natural Resources, 1992.

Deutschland 3

Physical Geography

Germany can be divided into several distinctive landscape zones, the coastal areas, the northern lowland, the secondary mountain ranges, the 'Alpenvorland' and the Alps. Besides there is an extensive area of shallows along the North sea coast, 'das Wattenmer'. It is however, although of nature conservation interest not included in this study, because it is not of agricultural interest.
The northern lowland is situated in two biogeographic regions: the Atlantic region in the west and the Central European region in the east.
The north-western coastal area comprises the German section of the Wattenmer, with the Danish and Dutch sectors, is the largest area of intertidal mudflats in Europe. It includes the estuaries of the Elbe, Weser and Ems and the East-Frisian and North-Frisian islands. The present form of the coast is the result of fight between the forces of the sea and the human activities. Juvenility and instability are the most conspicuous characteristics of the coastal zone. Only the Geestkerne of Sylt, Föhr and Amrum originate pre-alluvial periods; the other sediments and the coastal forms belong to younger periods of the geological history. The coast of the Wattenmer is characterised by deep bays and funnel-shaped open river deltas. The islands, that divide shallows and open sea, differ in many ways.
The coastline along the Baltic Sea is the result of the last glacial period, modified by the current of the sea along the coast and occasional storm tides. The Baltic coastline is flat and broken by numerous bays, peninsulas, islands and contains large areas of shallow water and intertidal mudflats. The coastline is 350 km long and consists of 150 km steep coast and 200 km flat coast.
The western part of the baltic coast is characterized by the 'Föhrden', drowned shallow valleys that run far into the moraine landscape as relatively deep grooves. In the east sedimentation and erosion made the extraordinary arrangement of the lagoon coast with bays and cut off beaches, straits, peninsulas and islands.
The northern lowland is situated between the coast in the north and the secondary mountain chains south of line Venlo (NL) – Dortmund – Bielefeld (except the Teuteburger Wald) – Hannover – Halle – Leipzig – Dresden. This area is rather flat, the highest point being 179 m. It is a deposit area of northern sediments transported by pleistocene glaciers (Krebs 1931). The higher areas originate from glacial moraines as for instance the hills from the 'Lüneburger Heide' via the 'Altmark' to the 'Fläming'. The greatest part of the area is below 50m and the landscape is a soft hilly, open lowland. Important is the hydrological relation between wet and dry environments and consequently the differences in soil and vegetation over small distances. Four river systems influence the landscape of the northern lowland. Three of them flow into the North Sea (Ems, Weser, Elbe), the fourth one flows into the Baltic Sea (Oder). They have their sources in the secondary mountain chains. In the northern lowland the river landscapes are characterized by moorlands in old riverbeds and inland sand dunes along the present riverbeds.
Between the northern lowland and the southern Alpenvorland a secondary mountain chain form a physical boundary. It differs from the high mountains by its less rugged and lower forms and an altitude of on average 400 m. Some peaks reach over 1000 m or onto nearly 1000 m like the Brocken (1142 m) in the Harz, Schneeberg (1051 m) in the Fichtelgebirge, Bensberg (983 m) in the Thüringer wald and the Wasserkuppe (950 m) in the Hohe Rhön (Krebs 1931). Gradients have mostly been formed by rivers that carved their bed into the mountain chains. The rivers had to adapt to the rising mountains. Partly they carved their riverbed into the mountains, partly they changed their bed completely. North of the river Main the mountain chains consists of broken

slates, that rose up and receded resulting consequently in a mosaic of uplands, depressions and grooves. In southern Germany the rock layers were sloping from the Oberrheingraben to the east. Here the river system could develop rather undisturbed (Bonath et al 1989) [1]. During the last glacial period the secondary mountain chains were free of ice, except the Harz and the Schwarzwald. The peaks of both were covered by a small layer of ice. The small glaciers ground the so called Trogtäler and they left behind niches that later filled with water (Feldsee). The Fichtelgebirge is a mountain node in central Europe. Thüringer Wald, Frankenwald, Frankische Alb, Oberpfälzer Wald und Erzgebirge come radial together on this granite mountain chain. It is the watershed of Rhine, Elbe and Danube.

The 'Alpenvorland' is situated between the 'Bodensee' and the river Inn, the Alps and the river Danube. From the Alps it consists of a gradient of moraines, deposit valleys and the Niederbayerische hilly landscape. In the western part of the 'Alpenvorland' the moraine landscape reaches to the Danube. The area of deposit layers is absent and the hilly landscape of the Schwabische Alb is directly connected with the moraine landscape. Many of lakes and moorlands are situated in this moraine landscape as relicts of the last glacial period. In the eastern part of the 'Alpenvorland' the deposit layers are divided into long, flat hilly ridges by rivers that have their sources in the Alpenvorland. The Niederbayerische hilly landscape is a flat wavy landscape. The rivers formed meandering valleys between the hills. The 'Alpenvorland' is drained by the river system of the Danube. Along the Danube numerous moorlands and relicts of alluvial forests can be found.

The part of the Alps situated between the Bodensee and the Königssee belongs to the northern calcareous Alps and is characterized by steep slopes and open peaks: in the west the 'Allgäuer Alps' and in the east the 'Bayerischen Alps', divided by the river Lech. The flysch zone extends from the Alps to the north. This zone consists of folded stratum of soft sediments. In the same way as the mountain chains of the central Alps the valleys run in a west-east direction. More extended rivers as Lech, Isar and Inn traverse the mountain chains to the north in small steep valleys. Other rivers have their sources at the northern side of the Alps. They run without being hindered in northern direction.

Numerous of waterfalls can be found in the rivers, because the side-valleys are often situated on higher altitudes. The glaciers disappeared except some isolated relicts: the 'Schneeferner' and the 'Höllentalferner' at the Zugspitze and the 'Blaueis' at the Hochaltar in the Berchtesgadener Alps. Also numerous small kar lakes (cirque lakes) are characteristic for this area. They are situated at an altitudes of 2000 m. Small lakes can also be found in the valleys (Eibsee, Alpsee). The larger lakes like Königssee and Kochelsee are found in the geological breaks that transversed the Alps (Bonath 1989) [2].

Germany is characterized by a high degree of climatic variability, caused essentially by its geographic position and its uneven topography. The coastal area in the north has an Atlantic climate with low winter precipitation and relatively high winter temperature. The secondary mountain chains are characterized by a climate that is intermediate between the Alps and a Central European climate. In this part of Germany a mosaic of climates reflects the diverse and heterogeneous landscape. That means, Precipitation is high, although lower than in the Alps and shows a peak in winter and in early summer. The cold winter period characterised by mean temperatures below 0°C is from December onto February. The 'Alpenvorland' has a Central European climate with mean temperatures in winter higher than in the secondary mountain chains and less precipitation. In the 'Oberrheinische Tiefebene'

[1] C. Bonath et al, *Flüsse und Seen in Deutschland. Der grosse ADAC Reise- und Freizeitführer*; München, 1989.

[2] Ibid.

a warm climate dominates (Jongman 1990) [3]. In the German Alps an Alpine climate dominates with great differences between valleys (Walter and Lieth 1964) [4].

Important habitats

The extensive area of Germany and the differences in habitats are expressed in a wide variety in biotopes that can be classified as important habitats. These vary from shallows in the north to alpine vegetation in the south. Moreover, important rivers and related habitats can be found in all parts of the country as well as extensive woodland. In the north the raised bogs are important, while in the south landscape diversity increases with the diversity in altitudes and soil types. All important habitats and their species however are threatened (Table 3).

Human influence on the natural environment

The western part of Germany is with an average population density of 247 inhabitants per sq km one of the most densely populated countries of Europe. Eighty per cent of the population lives in cities with over 100,000 inhabitants. The land use is dominated by agriculture, followed by forestry and urbanisation. These three land uses play an important role in the decline of the German natural environment.

Agricultural land use is the main basis for the semi-natural landscape in Germany (heathland, dry grasslands, wet grasslands, hedges etc). The agricultural landscape however, has changed in the last decennia. Water-management, afforestation, altering grassland into arable land, intensive tillage and use of fertilizers are the reasons for the destruction of habitats and the decline of species in the agricultural landscape. Hedges and small forests have been cut with the consequence of fragmentation of natural biotope sites and isolation of populations of all kind of species. Wet environments became rare because of drainage and improved water discharge.

Natural forests are rare in Germany although relatively natural woodlands in larger areas have sustained within the forestry practice over 150 years. Although the woodland area has not changed really, its distribution, its composition and its structure has changed strongly:

- old growth forests have been replaced by young tree plantations, urbanisation, mining, reservoirs etc;
- mixed woodlands are replaced by monocultures;
- broadleaved woodlands have been replaced by coniferous woodlands;
- wet forests have been drained, and
- large woodlands have been fragmented by infrastructural activities (highways, railways, etc).

The influence of urbanisation is increasing. Besides the physical expansion of cities the most important impacts are:

- the input of natural resources and energy;
- the waste of water, heath and garbage and
- tourism and outdoor recreation.

[3] R.H.G. Jongman, 'Ecological classification of the climate to the Rhine catchment'; *International Journal of Biometereology*, 1991, 34:194-203.

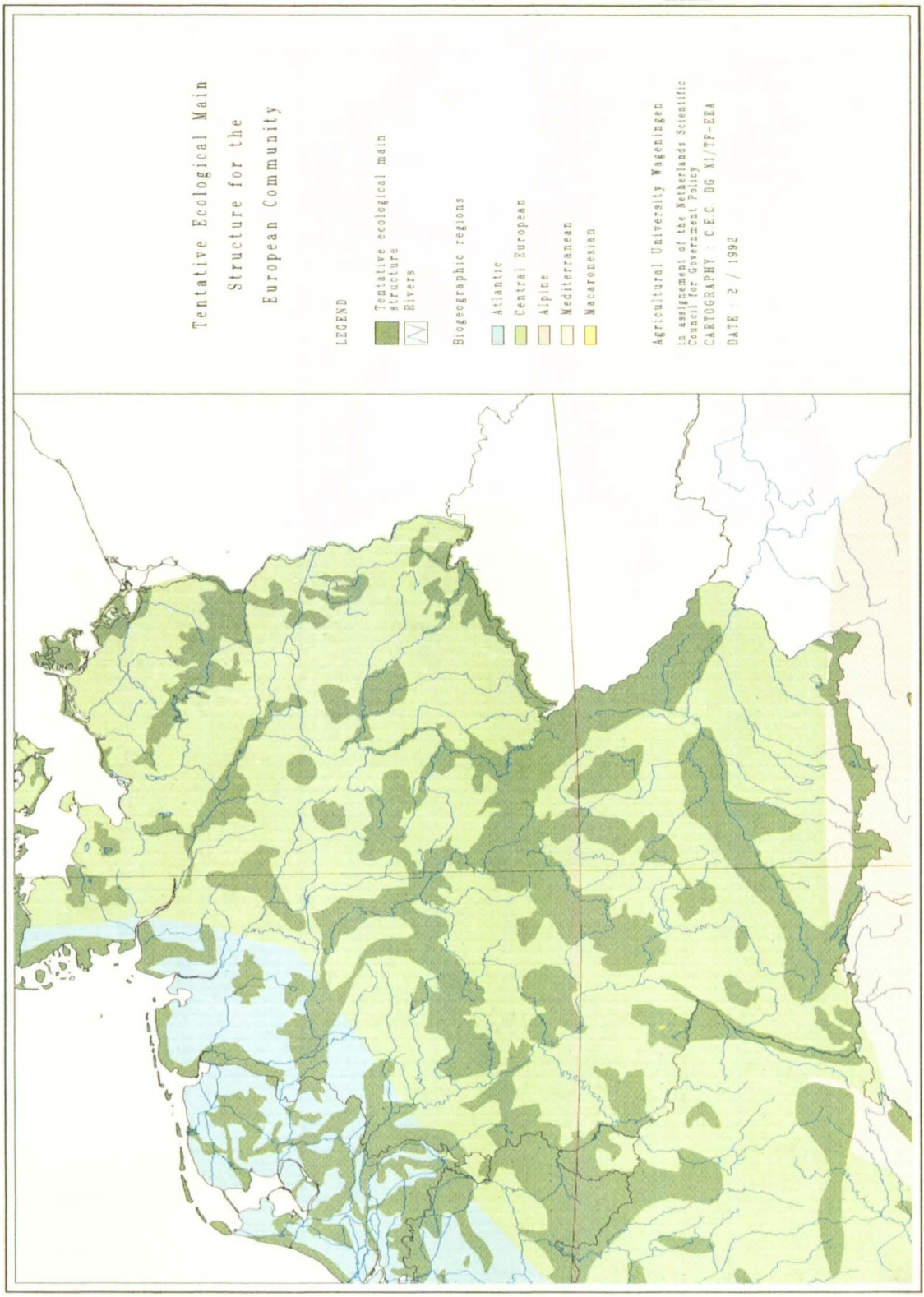
[4] H. Walter and H. Lieth, *Klimadiagramm Weltatlas*; Jena, VEB Gustaf Fischer Verlag, 1960-1964.

Table 3 Vegetation types and related endangered species in Germany (Umweltbundesamt 1990)[5]

Vegetation type	species number	endangered	percentage
oligotrophic water	48	39	81.3
mud flats	39	25	64.1
oligotrophic bogs and marshy forests	177	100	56.5
vegetation of halophytes	84	35	41.6
dry grasslands	477	195	41.0
wet grasslands	203	75	36.9
plough land vegetation and ruderals	268	94	35.1
vegetation of eutrophic water	173	58	33.4
xerotherm bushes	96	30	31.3
low heaths and matgrasses	208	58	27.8
alpine vegetation	308	83	26.9
extra-alpine rock vegetation	94	24	24.6
decumbent vegetation	100	23	23.0
coastal dune vegetation	16	3	18.9
well vegetation	33	6	18.1
marshy and wet forests	170	26	15.3
mesophilic decoduous/conifer forests	310	47	15.1
deciduous/conifer forest of acid soil	158	24	15.1
couch grasslands	70	10	14.3
Bidention communities	30	4	13.3
nitrophilic bushes	260	32	11.9
leys and young grasslands	184	18	9.8
subalpine bushes and brushwood	211	20	9.6

[5] Umweltbundesamt, *Daten zur Umwelt 1988/89*; Berlin, Erich Schmidt Verlag, 1990.

Figure 3 The Tentative Ecological Main Structure in the Federal Republic in Germany



Source: CORINE/Agricultural University, Wageningen, 1990

Protected areas

In Germany nature conservation is one of the tasks of the Bundesländer. That implies that differences can occur between nature conservation within Germany. At present there are three national Parks, Bayerische Wald, Berchtesgaden and the Wattenmer. In most Bundesländer the categories of landscape protection are more important than those of nature protection. The fragmentation of nature, as mentioned above, was one important aspect for the German nature conservation to develop a more offensive nature conservation strategy. The protection of valuable nature in small areas does not appear to be sufficient to conserve the natural values. A new strategy has been started known as the 'Biotopverbundsystem' the ecological main structure as a spatial concept for nature and landscape conservation.
This concept is comparable with this tentative European ecological main structure although it will be worked out at the level of Bundesländer. This means that the need for an ecological main structure has been recognized in Germany.

The Tentative Ecological Main Structure in Germany

The ecological main structure in Germany is not designed by following the procedure described in the main report. The CORINE data of habitats are not yet complete for all the member states and thus another procedure is used for the member states whose data collection is not complete. The basic information is therefore originated in national data (Umweltbundesamt 1990 [6], Haarmann and Pretscher 1987 [7], Anonymous 1985 [8], Böhnert and Reichhoff 1991) [9]. The location of the 'Naturparke' plays an important role for the design. Besides proposed protected areas have been included. The protected areas of the eastern member states have not been listed, because of missing data. The design of the ecological main structure in these member states based mainly on national information and the actual discussion about nature protection in the new member states of Germany.
The ecological main structure in Germany includes large parts of the coastal area and the northern lowland, characterized by wet environments and important bird areas. Besides the secondary mountain chains influence the ecological structure. The large rivers, as Rhine, Danube, Elbe, Ems etc, play also an important role in the ecological main structure. The Alps in the south are included too (Figure 3).

The Regions

Germany is divided into 16 NUTS-regions. The spatial claim for the different parts in the western part of Germany for the ecological main structure has been presented in Table 4. For a large part of Germany the CORINE database on biotopes only contains restricted data. Most field information is lacking and large parts of the network have been designed based of data on protected areas.
In the eastern part of Germany another procedure has been followed to design the ecological main structure. Detailed data on protected areas were not available. However, a map with the location of protected area appeared to be very useful. Besides the discussion about nature conservation in the new part of Western Germany afford possibilities to design an ecological main structure. The five regions of the eastern part of Germany are listed in Table 4.

[6] ibid

[7] K. Haarmann, P. Pretscher, *Naturschutzgebiete in der Bundesrepublik Deutschland*, Kilda Verlag, Greven (BRD), Naturschutz Aktuell, nr. 3, 1987.

[8] Anonymous, *Gestaltung der sozialistischen Landeskultur*; Gotha, Haack Aktuelle Karte, 1985.

[9] W. Böhnert, L Reichhoff, 'Das Nationalparkprogramm der ehemaligen DDR'; *Natur und Landschaft*, 1991, 66(4):195-204.

Table 4 The partition of the Tentative Ecological Main Structure in NUTS-regions of the Federal Republic of Germany before the unification. The area is given in ha and percentage of the total NUTS-area

Regions	11	12	13	14	15	16	17	18	19	1A	1B
Region Area (ha)	1,582,152	65,735	4,788,209	37,976	3,397,039	2,238,340	1,983,077	3,593,306	7,019,633	228,307	48,796
Protected Area											
Nature (ha)	3,226	620	182,326	280	15,539	11,737	7,103	18,235	112,870	30	160
Nature (%)	0.2	0.9	3.8	0.7	0.5	0.6	0.4	0.5	1.6	0.0	0.3
Landscape (ha)	340,458	17,000	914,786	10,008	1,519,522	987,508	666,478	878,000	102,685	95535	9,186
Landscape (%)	21.5	25.9	19.1	26.4	44.7	46.2	48.8	18.6	12.5	41.9	18.6
International (ha)	0,0	0,0	0,0	0,0	26,209	0,0	0,0	0,0	0,0	0,0	0,0
International (%)	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
Nature Expansion Area											
(ha)	356,415	5,495	941,302	10,708	1,413,602	881,503	550,135	685,942	946,382	95,535	9,186
(%)	22.5	8.4	19.7	0.0	41.6	41.2	27.7	19.1	13.5	41.9	18.6
Habitat Connection Area											
(ha)	106,432	0,0	674,078	0,0	0,0	0,0	0,0	410,740	1,953,816	0,0	2,450
(%)	6.7	0.0	14.1	0.0	0.0	0.0	0.0	11.4	27.8	0.0	5.2
Not-protected Area											
(ha)	15,957	0,0	26,516	700	5,821	6,698	5,206	19,464	68,382	381	0,0
(%)	1.0	0.0	0.6	0.0	0.7	0.3	0.3	0.5	1.0	0.2	0.0
Tentative Ecological Main Structure											
(ha)	466,074	6,115	1,797,706	10.988	1,429,141	893,241	557,238	1,114,916	3,013,068	95,565	11,796
(%)	29.5	9.3	37.5	28.9	42.1	41.8	28.1	31.0	42.9	41.9	24.2

Table 5 **The partition of the Tentative Ecological Main Structure in NUTS-regions of the Federal Republic of Germany in the former GDR area. Protected areas not given because of the lack of data on area. The area of the ecological main structure is given in ha and percentage of the total NUTS-area**

Regions	IC	ID	IE	IF	IG
Region Area (ha)	2,951,759	1,870,778	1,612,280	2,085,772	2,452,796
Protected Area					
Nature (ha)	-	-	-	-	-
Nature (%)	-	-	-	-	-
Landscape (ha)	-	-	-	-	-
Landscape (%)	-	-	-	-	-
International (ha)	-	-	-	-	-
International (%)	-	-	-	-	-
Nature Expansion Area					
(ha)	-	-	-	-	-
(%)	-	-	-	-	-
Habitat Connection Area					
(ha)	712,666	546,541	791,800	607,902	631,814
(%)	24.1	29.2	49.1	29.2	25.8
Not-protected Area					
(ha)	-	-	-	-	-
(%)	-	-	-	-	-
Tentative Ecological Main Structure					
(ha)	712,666	546,541	791,800	607,902	631,814
(%)	24.1	29.2	49.1	29.2	25.8

Schleswig-Holstein (11)

The NUTS-region Schleswig-Holstein shares borders with Denmark in the north and the German regions Mecklenburg, Niedersachsen and Hamburg in the south. The region is bordered in the west by the North sea and in the east the Baltic Sea. The ecological main structure in Schleswig-Holstein has partly been based on CORINE data set on biotopes and partly on national information concerning nature parks and protected areas. Besides information has been used on international important areas, especially bird areas (Grimmett and Jones 1990) [10].

Adjacent to the National Park Wattenmeer, a coastal area with hinterland has been is designed as connection area between protected areas for nature conservation and nature expansion areas. The former are very small, often not more than 500 ha (Haarmann and Pretscher 1987) [11]. It is a lowland area with meadows and moorland, which was regularly flooded in the past, but it has been drained now. The nature reserves are mostly situated in moorlands, dry heathland, sand dunes or oak woodlands. The intensification of land use is an important a problem. Therefore this part of the ecological main structure consists of a large area of nature development areas.

The islands within the National Park have also been included as nature expansion areas, but on the European level they are too small to design a detailed

[10] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

[11] K. Haarman and P. Pretscher, op.cit., 1987.

network within them. So the whole area of the islands have been designed as part of the ecological main structure.
The eastern hilly area consists of lakes, relicts of moorland and peatland, heathland and broadleaved deciduous woodlands. The actual nature reserves are isolated by agricultural land use. Three nature parks have been included as nature expansion areas and they are connected by connection areas. The hilly landscape is diverse with eutrophic lakes, marshes, patches of woodland, moors, meadows and agricultural land.
The coastline with the Baltic sea is a narrow connection area, that connects numerous internationally important bird areas. Characteristic habitats are: tidal fjords with saltmarshes and coastal vegetation, flat bays with a sandy and stony coastline, brackish lagoons. The whole area is especially important for breeding species, as wintering area for migratory species.
The nature park Lauenburger Seen has been included into the ecological main structure as nature expansion area. This area consists of lakes surrounded by broadleaved deciduous woodland (interspersed with moorland) and agricultural land. The area is connected with the nature park Drawehn in Niedersachsen and a connection area is designed along the river Elbe.

Hamburg (12)

The NUTS-region Hamburg consists of the city Hamburg with surrounding area. The ecological main structure is based on national information concerning nature reserves. The region is very small and the urban area dominates. Therefore the ecological main structure in Hamburg is only a small area along the river Elbe. This area includes also small nature reserves and a nature park.

Niedersachsen (13)

In the west the NUTS-region Niedersachsen shares borders with the Netherlands, in the east with Magdenburg and in the south with Nordrhein-Westfalen, Hessen and Thüringen. In the north the region is bordered by the North Sea. The ecological main structure has partly on been based on CORINE data on habitats, but the national information concerning protected areas and proposed protected areas plays a more important role. The 476 nature reserves afford opportunities to design an ecological main structure. The natural vegetation map of Europe (Noirfalise 1987) [12] has been used to delineate connection areas.
The largest part of this region is situated in the northern lowland. Consequently most of the ecological main structure consists of wet grasslands, moorland, peatland, lakes and heathland.
In the south the habitats of the secondary mountain chains prevail like broadleaved deciduous forests, calcareous grasslands etc.
Along the border with the Netherlands a large area is situated consisting of wet grasslands, moorlands and bogs. This area is connected with the river Ems, that runs from south to north into the Dollart tidal area. Along several smaller rivers among which the Ems and the Hasel natural grazed river forests on clay and sand are found with mudflats, oxbow lakes, reedbeds, sedge beds, dry and wet meadows and willow copses (Pott and Hüppe 1991) [13]. The area along the Ems is connected with a development area along the coast. In this connection area the agricultural land use dominates.
Starting from the border with the Netherlands in the west a large connection area is situated, that consists of the nature parks Nördlicher Teuteburger Wald and Dümmer in the west and south and Sollinger Vogler, Weserbergland,

[12] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

[13] R. Pott and J. Hüppe, *Die Hudelandschaften Nordwestdeutschlands*; Münster, Westfälisches Museum für Naturkunde, 1991.

Münden and Harz in the southeast. Besides there are numerous nature reserves. The nature parks are very divers. The Dümmer is a lowland area with marshes, wet meadows, moors and bogs, and is known as an important international wetland. The Teuteburgerwald is a hilly area of which 70 per cent is covered by woodland.
In the centre of Niedersachsen the network consists two nature parks: Steinhuder Meer (a eutrophic lake surrounded by wet meadows, moorland and bogs) and Lüneburger Heide (an extensive area with heathland and scrub). The latter is also a nature reserve. Between both sites, a connection area has been designed, that includes also small nature reserves with moorlands, bogs, wet meadows and patches of woodland.
South of Bremen a nature park is situated named Wildeshauser Geest. This nature park has been included into the ecological main structure as a nature expansion area because of its moorlands, bogs, wet meadows and forests of Birch and Scotch Pine. Within the nature park numerous nature reserves mostly smaller than 50 ha are situated (Haarmann and Pretscher 1987) [14]. This size make the surrounding areas of the nature reserves important to conserve or redevelop as nature.
Between the lower tidal reaches of the river Elbe and the Teufelsmoor north-west of Bremen a large connection area has been designed between the numerous small nature reserves. The main biotopes in these nature reserves are lakes with surrounded by wet meadows and bogs. The whole area is important for breeding and wintering waterfowl. The habitat connection area is agricultural land and (re)development of nature or an adapted management can be necessary.

Bremen (14)

For a large part the NUTS-region Bremen consists of the urban area of the city Bremen. No ecological main structure has been designed, because the NUTS-region is too small to design a coherent network and secondly the urban area dominates in such a measure that the ecological main structure has to design on a lower level.

Nordrhein-Westfalen (15)

The NUTS-region Nordrhein-Westfalen shares the borders with the Netherlands in the west, Rheinland-Pfalz and Hessen in the south and Niedersachsen in the north. The region has a high population density concentrated in the Rhein-Ruhr area. The ecological main structure in Nordrhein-Westfalen is based on national information concerning protected areas and information from the member state concerning the proposed nature conservation policy (Minister für Umwelt, Raumordnung und Landwirtschaft des Landes Nordrhein-Westfalen 1989) [15]. The CORINE data have not been used because of incompleteness. The ecological main structure comprises a diversity of lowland areas along the rivers and hilly landscape areas in the mountainous areas.
The Teuteburger Wald ranges from the north-west to the south-east of Nordrhein-Westfalen and connects the northern lowland with the secondary mountain chains of the south. This area is protected as nature park and has therefore been included as nature expansion area characterised by broadleaved deciduous woodlands, coniferous woodland, inland cliffs, calcareous and siliceous grasslands.
The nature parks Rothaargebirge, Arnsberger Wald, Homert, Ebbegebirge, Bergisches Land, Kottenforst-Ville and Nordeifel along the border with Hessen and Rheinland-Pfalz have been included as nature expansion areas.

[14] K. Haarman and P. Pretscher, op.cit., 1987.

[15] Minister für Umwelt, Raumordnung und Landwirtschaft des Landes Nordrhein-Westfalen, *Natur 2000 in NRW – Leitlinien und Leitbilder für Natur und Landschaft in Nordrhein-Westfalen*; Düsseldorf, 1989.

Partly they are already connected to each other, so a small connection area has been selected. The eastern part of this area is the richest woodland area. Broad-leaved deciduous woodlands in which beech dominates, moorlands, mountainous heathlands characterize this area. Mixed woodlands, calcareous upland plains with nutrient-poor and wet grasslands in the lower parts are present as well, while along the streams and rivers alluvial forests can be found.
The Bergische Land is characterized by beech forests, (semi-)natural streams, wet meadows, springs and spring rivers, nutrient-poor grasslands, cliffs, relicts of heathlands and moorlands.
At the west side of the Rhine the diversity of the area is based on small scale geological diversity and consists of alluvial and wet forests, Atlantic heathlands with Juniper and dry grasslands. This area ranges into the neighbouring countries Belgium and Luxembourg via the Eifel. Beech forests on calcareous soil rich with orchids, calcareous pasturages, divided by hedges with beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) and das Hohe Venn (Hautes Fagnes) are the main characteristics.
The Niederrhein area of the ecological main structure extends along the Rhine into the Netherlands. It consists of the Rhine itself and the surrounding area, characterized by wet meadows, flooded meadows, sand banks and wet forests. From there on both sides of the Rhine sandy plateaus, formed by wind erosion in the glacial period, are designed as connection areas. They consist of coniferous forests, heathland, Alder forests, moorlands and agricultural land.

Hessen (16)

The ecological main structure in Hessen has been concentrated around the existing nature parks, that are included as nature expansion areas. The CORINE biotope-data have not been used for the design of the ecological main structure, because of their incompleteness. The main information for the design originates from national information on protected areas and information on the natural environment in Hessen. The ecological main structure consists of areas that are part of larger nature areas in the neighbouring states Nordrhein-Westfalen, Niedersachsen, Thüringen, Bayern, Baden-Württemberg and Rheinland-Pfalz.
Most of the ecological main structure has been designed along the border of Hessen with its neighbouring states. It starts in the Rothaargebirge in the north-west and ranges via numerous nature parks to the south. These nature parks are Diemelsee, Habichtswald, Meissner-Kaufunger Wald, Hessische Rhön, Hessischer Spessart, Hoher Vogelsberg and Bergstrasse-Odenwald. The area is characterized by extensive Beech forests, mixed woodlands and alluvial forests along streams and rivers. The creation of a National Park in the north-western part has often been discussed (Panek 1989) [16].
The Rhine and the Taunus mountains are important because of their environmental diversity and species richness. Starting from the Rhine a connection area has been designed into the north western direction onto the nature park Hochtaunus. The area along the Rhine is characterized by oxbow lakes with riverine forests, wet meadows and orchards, that are protected in numerous small nature reserves. The Kühkopf-Knoblauchsaue is one of the most important stepping stones along the Rhine, characterized by oxbow lakes, with riverine forests, wet meadows and orchards (Dilger et al 1988) [17]. The area is already protected as nature reserve and as EEC special protected area. The nature park Hochtaunus consists of an extensive woodland area with broad-leaved deciduous forests, coniferous forests (Feldberg) and narrow stream valleys with alluvial forests and wet meadows.

[16] N. Panek, 'Ein Laubwald-Nationalpark in Nordhessen?', *Natur und Landschaft*, 1989, 64(7/8):338-343.

[17] R. Dilger, H.M. Stäber, V. Späth, P. Wahl, A. Weiss, *Biotopsystem Nördliche Oberrheinniederung*; Bonn, Karlsruhe, Oppenheim, Wiesbaden, Hessische Landesanstalt für Umwelt, Landesamt für Umweltschutz Rheinland-Pfalz, Landesanstalt für Umweltschutz, Bezirksstelle für Naturschutz und Landschaftspflege Karlruhe en Bundesanstalt für Naturschutz und Landschaftsökologie, 1988.

Rheinland-Pfalz (17)

The NUTS-region Rheinland-Pfalz shares borders with Belgium and Luxembourg in the west, Saarland and France in the south, Baden-Württemberg and Hessen in the east and Nordrhein-Westfalen in the north.
The ecological main structure in Rheinland-Pfalz has been based on the CORINE data set on biotopes and national information concerning protected areas. Habitat information has been compared with data on nature reserves and nature parks. Most described habitats are found in the protected areas. Consequently the nature expansion areas consist in the large parts of the nature parks Nordeifel, Südeifel, Siebengebirge, Rhein-Westerwald, Nassau, Pfälzerwald and Saar-Hunsrück.
The Eifel is characterized by the relicts of the tertiary and quaternary volcanism. The crater lakes of the western Eifel and the crater moorlands are important areas. The steep slopes of the narrow river valleys have a of flora and fauna, that is also found in warm and dry areas of the Black Sea and the Mediterranean Sea.
Along the Upper Rhine oxbow lakes are situated with riverine forests, sedge vegetation and small relicts of wet meadows, hedges and moors. These areas have been included as stepping stones and only the southern part of the Upper Rhine valley is directly connected with a larger area of the ecological main structure.

Baden-Württemberg (18)

The NUTS-region Baden-Württemberg shares borders with France and Rheinland-Pfalz in the west, Switzerland in the south, Bayern in the east and in the north with Hessen.
The ecological main structure is based on national information concerning protected areas and for a small part on the CORINE data set on biotopes. The soil map has been used to design the connection areas along the Danube and the borderline with Switzerland.
The ecological main structure has been built on the river valleys of the Upper Rhine and the Danube. Besides, mountainous areas (Schwarzwald, Schwäbische Alp) and parts of lowland plains are included as connection areas between the nature expansion areas that mainly consist of nature parks.
Along the Upper Rhine relicts of riverine forests, backwaters and meadows are situated (Dilger et al 1988) [18]. The largest alluvial forest is the Taubergiessen. Between these intact river habitats connection areas are designed. These connection areas are mainly used for agriculture. Redevelopment of nature will be important along the Rhine.
Adjacent to the Rhine valley the Kaiserstuhl has been included into the ecological main structure. Here submediterranean habitats can be found because of the warm dry climate. Dry calcareous grasslands and heaths and broadleaved deciduous woodland are the main habitats.
Not the whole Schwarzwald has been included but only a northern and a southern part. The southern part is connected with the Rhine. The area consists of protected nature reserves that are characterized by siliceous grasslands, alpine grasslands and humid grasslands, heaths and scrubs, scattered bogs and alluvial forests, but mainly native coniferous woodlands (Black Forest). The northern part is the surrounding area of the peak Hornisgrinde and consists of coniferous woodlands, dry siliceous grasslands, and humid grasslands. This area consists of numerous nature reserves, that are connected by the designed connection area.
The Danube and surrounding area is a extensive connection zone that includes the Danube with its sources and a large part of the Schwäbische Alp, a secondary

[18] Ibid.

mountain chain north of the Danube. The surroundings of the Danube are very divers. The sources are situated in coniferous woodlands of the Schwarzwald and along the Schwabischen Alp, broadleaved deciduous woodland, exposed rocks and alluvial forest accompany the river. The Schwabische Alp is further covered by extensive calcareous grasslands, juniper scrub and beech forests on chalk soil. Besides a connection has been designed to the Lake Konstanz in the south, ranging through the western part of the foothill region of the Alps. Between the Danube and the lake Konstanz the landscape is dotted with small nature reserves. These are mainly wet grasslands, lakes, meadows and marshlands.
Schnbuch is a relatively small protected nature park in the south of the city Stuttgart. It is a varied landscape with a mosaic of traditionally used orchards, fields, pastures, meadows. The rich orchards are nearly unprotected.
The Schwabisch-Frankischer Wald is a protected nature park, that is connected with the nature park Frankenhhe in Bayern. The connection zone is narrow and consists of small areas of dry calcareous grasslands and broad-leaved deciduous woodlands and alluvial forests along small streams.
The nature park Odenwald-Neckartal is a wooded area with Beech forests, calcareous grasslands boreal grasslands, heaths and sclerophyllous scrub and relicts of alluvial forest along streams and rivers. It is situated adjacent to the larger part of the ecological main structure that ranges into Hessen and Bayern.

Bayern (19)

The NUTS-region Bayern is bordered by the Czechoslovakia in the east, Austria in the south, Baden-Wurttemberg in the west and Hessen, Thuringen and Sachsen in the north. The ecological main structure has been based on national information about protected areas and proposed protected areas and information on the natural situation of Bayern. The CORINE biotope-data have not been used, because they still are incomplete. The ecological main structure includes the most important landscapes in Bayern, the Danube valley, the Alps and the secondary mountain chains.
The eastern part along the borderline with Czechoslovakia is an area consisting of eight nature parks and one National Park (Bayerischer Wald). These nature parks are connected with their neighbouring parks and thus the whole area consists mainly of nature expansion areas. Connection areas have been designed towards the Danube valley.

In the south the network includes the National Park Bayerischer Wald an the nature parks. It is a mountain range with old growth and managed deciduous an conifer forests, mountain lakes, alpine meadows, bogs, rocks and ridges.
The connection of this extensive area with the Danube valley is important to increase environmental diversity. In this area the Danube valley consists of extensive wet meadows, marshes and moors, surrounded riverine forests and oxbow lakes. Between the mountainous area and the river different altitudes, caused by river terraces give rise to environmental diversity.
Adjacent to the river Danube the Naturpark Altmuhltal, is situated, a long river valley with broadleaved deciduous forests, inland cliffs, Juniper scrub, calcareous grasslands although influenced by water management. This is connected to the Naturpark Westliche Walder, that is characterized by broad-leaved deciduous woodland, coniferous woodland, agricultural land and relicts of alluvial forests along the river Zusam. The connection between both crosses the river Danube. Along this trajectory of the Danube large nature reserves (often also Ramsar sites) are situated: between Neu-Ulm and Lauingen, between Hchstadt and Donauwrth and the Lech-Donau Winkel. The area between these protected areas has been designed as habitat connection area. (Re)development of nature will be necessary in this region.
Along the border with Austria a large area has been designed as connection

area between protected areas (Ammergebirge 28850 ha, Karwendelgebirge 19100 ha) and related nature expansion areas. This part of the ecological main structure is a part of the Alpine mountain range.
The area ranges *om the Lake Konstanz in the west to the National Park Berchtesgaden in the east. It is a calcareous region of the northern Alps, comprising mountain slopes with natural deciduous an conifer forest, alpine meadows and rocks and glaciers above the timberline.
Frankenhhe, Steigerwald and Hassberge are three Naturparke, that stretch from the border with Thuringen to the border with Baden-Wurttemberg and they have been included in the Tentative Ecological Main Structure as nature expansion areas. The broadleaved deciduous woodlands of beech an oak cover the main part of this area but also valleys of small rivers are found with meadows, wet grasslands and wet forests. Along the border with Hessen three nature parks, the Bayerischer Odenwald, Spessart and Rhön and the nature park Fränkische Schweiz have been included in the ecological main structure as nature expansion area. Coniferous woodlands, broadleaved deciduous woodland, juniper scrubs, meadows and agricultural land characterize this nature park.

Saarland (lA)

The NUTS-region Saarland is except for the urban regions of Hamburg, Berlin and Bremen, the smallest NUTS-region. It shares the borders with France and Rheinland-Pfalz. In this region only the northern part has been included into the ecological main structure, based on the location of the nature park SaarHunsrück.
This area consists of extensive calcareous grasslands with old orchards, broad-leaved deciduous woodlands, scrubs and traditional agricultural landscapes.

Berlin (lB)

The NUTS-region Berlin is mainly an urban area. The existing protected areas have been included, but an ecological main structure has not been designed. In the eastern part of Berlin a small biotope site is situated. It consists of the three lakes Grosser Müggelsee, Sedding See and Langer Seewith surrounded forests.

Brandenburg (1C)

The NUTS-region Brandenburg borders to Poland in the east, Mecklenburg-Vorpommern in the north, Sachsen-Anhalt in the west and Sachsen in the south. It surrounds the NUTS-region Berlin. The region is characterized by a lowland and soft hilly landscapes. The ecological main structure has been based on information on the protection status before the German unification and the recently proposed protected areas. Besides national information on certain areas have been used.
Flaming is protected as nature park. It is a hilly landscape (altitudes to 200 m) with wet forests in the stream valleys, broadleaved deciduous woodlands and coniferous woodlands, surrounded by agricultural land.
Spreewald and surrounding landscape consist of the proposed Biosphere reserve are already protected as landscape area (DDR-protection). It is an unique lowland area with a wide branching system of streams that is flooded periodically (Weinitschke 1987) [19]. There are extensive natural Alder forests and it is surrounded by agricultural land (meadows and arable farmland).
In the north of the region a large part of the ecological main structure is designed. This area includes the proposed Biosphere Reserve Schorfheide-Chorin, a moraine landscape with extensive beech forests, natural moorlands

[19] H. Weinitschke, *Spezieller Naturschutz als Teil sozialistischer Landeskultur*; in Weinitschke (ed.) Naturschutz und Landnutzung, Jena, VEB Gustav Fischer Verlag, 1987.

and lakes, dry valleys and alluvial forests along rivers and streams, the proposed National Park Untere Oder a large dyked river area with banks covered by reed vegetation and grasslands and polder areas that are flooded during high tides and the protected landscape area Feldberger Seenlandschaft (DDR-protection), an area with many lakes within extensive broadleaved deciduous woodlands and mixed woodlands. These areas are connected by habitat connection areas.

Mecklenburg-Vorpommern (1D)

The NUTS-region Mecklenburg-Vorpommern is bordered by the Baltic Sea in the north, Poland in the east, Brandenburg in the south and Schleswig-Holstein and Niedersachsen in the west. The ecological main structure has been based on information on the protection status before the German unification and the recently proposed protected areas. Besides national information on certain areas have been used.
The region is part of the northern lowland. Thus the ecological main structure consists mainly of wet meadows and bogs surrounded by agricultural land. The coastal zone of the Baltic Sea is part of the ecological main structure in this region.
The Mecklenburger Elbtal consists of wet meadows, oxbow lakes, flooded pastures and riverine forests. It is adjacent to the nature park Elbufer-Drawehn in Niedersachsen.
The Krakower Seenlandschaft and Müritz are part of the ecological main structure and a connection zone has been designed between the proposed nature park Krakower Seenlandschaft and the proposed National Park Müritz. The area is a representative part of the central European holocene moraine landscape with natural lakes (Knapp 1990) [20]. It is one of the less densely populated areas in central Europe and mainly covered by forests. It includes the sources of the Havel, over sixty lakes and numerous bogs. Only a small part is in agricultural use. The lakes are surrounded by swamps, Carex vegetation, sand dunes, juniper heaths and mixed woodlands.
From the Oder in the east to Greifswald a wide area has been designed, that narrows in western direction where only the coastline has been included. This also consists of the proposed National Park Peene Haff Moor, comprising bogs and floodplains interspersed with reed vegetation, and bushes of willow and birch.
The area is characterized by the numerous large and small islands and is a typical Boddenlandschaft with saltmarshes, reedbeds, nutrient-poor grasslands, heathland, forests and wetlands. Some areas are international important wetlands (Westrügen, Hiddensee, Zingst).

Sachsen (1E)

The NUTS-region Sachsen borders to Czechoslovakia in the south, Poland in the east, Brandenburg in the north and Sachsen-Anhalt, Thüringen and Bayern in the west. The ecological main structure has been based on information on the protection status before the German unification and the recently proposed protected areas. Besides information the natural environment of certain areas have been used.
The ecological main structure consists of a coherent area that ranges along the border with Czechoslovakia and continues into to adjacent areas along the Elbe and into the source area of the Spree. The sources of the Spree are situated in Alder forests, swamps, extensive reed vegetation and wet meadows. Besides a small area has been designed at the border with Sachsen-Anhalt, the Dübener Heide. This is a proposed nature park, consisting of a mixture of reed vegetations, forests, scrubs, fens and moors.

[20] H.D. Knapp, 'Nationalparke in der DDR'; *Nationalpark*, 1990, no. 67(2).

The area of the Erzgebirge and the rivers Elbe and Spree consist of the proposed nature parks Erzgebirge-Vogtland and Oberlausitzer Heide- und Teichlandschaft and the proposed National Park Sächsische Schweiz and a habitat connection area along the river Elbe.The mountainous area (to 1000 m above sea level) in the west is covered by coniferous forests, moors, bogs with among others a pine forest (*Vaccinio-Mugetum*), wet meadows, pastures and cultivated land. The forest are severely suffering from the impact of acid rain. In the east the Sächsische Schweiz is dominated by coniferous forests, narrow canyons, rivers and limestone cliffs within the Elbe valley.

Sachsen-Anhalt (1F)

The NUTS-region Sachsen-Anhalt is surrounded by four other German NUTS-regions: Brandenburg in the east, Sachsen in the southeast, Thüringen in the southwest and Niedersachsen in the west. The ecological main structure has been based on information on the protection status before the German unification and the recently proposed protected areas. Besides information the natural environment of certain areas have been used.
The ecological main structure consists of river valleys (Saale, Elbe), a moraine landscape and secondary mountain chains. The diversity of the included landscape types has been the main criterion for inclusion in the ecological main structure.
The Colbitz-Letzlinger Heide is a proposed nature park. It is a flat sandy region with dry soils, covered by heathland, nutrient-poor forests, dry grasslands and surrounded by agricultural land.
The Harz is a secondary mountain chain. This area has partly been proposed as national Park (Oberharz), the remaining area as nature park. The mosaic of the vegetation in this zone is relatively natural and consists of coniferous forests, moorlands, inland cliffs and rocks. The nature park that surrounds the National Park includes agricultural land as well. The foothill zones of the Harz mountains are characterized by mixed forests.
The Saaler-Unstrut Triaslandschaft is also a proposed nature park and includes the rivers Saale and Unstrut. Both cross the Trias landscape. The area is a hilly landscape of shelly limestone soils. The area is covered by meadows, vineyards, solitary trees, calcareous grasslands and some riverine forests. From this proposed nature park a connection zone has been designed along the Saale to the Elbe. In this area redevelopment of nature will be necessary.
Along the Elbe a large Biosphere Reserve is situated (Mittlere Elbe, 43000 ha). This area is one of the largest coherent alluvial forests with deciduous hardwood and willow forests in Germany and one of the largest floodplain areas in Central Europe. The area of the Mittlere Elbe is connected with the proposed nature parks Fläming in the northeastern direction and Dübener Heide in the south. Both are parts of the moraine landscape, characterized by heathland and coniferous and deciduous forests.

Thüringen (1G)

The NUTS-region Thüringen is surrounded the German Nuts-regions Sachsen in the east, Bayern in the south, Hessen in the west and Niedersachsen and Sachsen-Anhalt in the north. The ecological main structure has been based on information on the protection status before the German unification and the recently proposed protected areas. Besides information the natural environment of certain areas have been used.
The Tentative Ecological Main Structure includes the large secondary mountain chains of the Thüringer Wald, parts of the Rhön and the Schiefergebirge. These are important areas for the ecological main structure. Several proposed protected areas have been include: nature park Eichsfeld-Werratal at the border with northern Hessen, Biosphere Reserve Rhön at the border with Bayern and Hessen, nature park Thüringer Wald-Westliches Schiefergebirge,

Biosphere Reserve Vessertal, nature park Östliches Schiefergebirge-Frankenwald at the border with Bayern and the nature park Saale-Unstrut-Triaslandschaft.
The mountainous character of the area, except the nature park Saale-Unstrutt-Triaslandschaft, is emphasised its ecological diversity of extensive deciduous an conifer forests partly under forestry management, floodplain forests along the streams like Vesser, Werra and Saale, calcareous grasslands, heathlands, rocks and agricultural land. The area is connected with the secondary mountain chains in the neighbouring regions an forms an important central European woodland area.
Along the river Saale a connection zone has been designed to the ecological main structure in Sachsen-Anhalt. Nature redevelopment might be necessary here.

Consequences for agricultural land use and forestry

The ecological main structure in Germany includes in general woodland areas, wet and dry grasslands, floodplain, bogs and heaths.
These areas are as well in use for agriculture or forestry as well as protected areas.
The present forest exploitation is mostly more intensive at present than would be if combined with nature management in the areas of the ecological main structure. Low production forestry can be combined with nature in the ecological main structure in the connection zones an the buffer zones. This is especially the case in the states, that are characterized by a high percentage of land covered by woodland (Hessen, Bayern, Nordrhein-Westfalen, Baden-Württemberg. In these Länder a high percentage of the natural and semi-natural forest has been included in the ecological main structure.
In the areas of the ecological main structure that are used as agricultural land, the land use has to be adapted to the objectives of nature management. This is especially so in areas for meadow birds en in floodplain areas. Wet grasslands and dry grasslands can be used for rough grazing with a low exploitation level. Land in river valleys has partly to be changed into low production grasslands and floodplain forests.

Eire

4

Physical Geography

Eire or Ireland is the utmost western member state of the EC. It consists of clearly marked Caledonian and Armorican fold mountains. The Caledonian mountains and hills are aligned from northeast to southwest. The Amorican east-west lines appear in the long ranges of Munster, which reach the coast of Kerry in mountainous peninsulas separated by rias, the drowned ends of deep valleys. Central Ireland, between the Caledonian northland southeastern part and the Amorican south consists of a number of ranges of Devonian and Carboniferous beds folded over a Caledonian floor (Freeman 1960) [1].

More than half Ireland is covered with Carboniferous beds, varied in composition but including large areas of limestones. The older Carboniferous beds generally form lowlands, particularly the great Central Lowland but also the many valleys and corridors that provide easy passageways between the Amorican ranges. Large areas of the country consist of peatland (Glastra 1990) [2].

The Irish coastline is strongly indented in the west and extends over 2700 km. The river Shannon and its tributaries wind their way through the central plain, draining nearly a quarter of the country. There are many smaller rivers and about 4000 lakes and ponds greater than 1 ha in extent.

The climate is heavily influenced by the North Atlantic Drift and Atlantic depressions which give prevailing south-westerly winds. In Malin head in the utmost north the mean january temperature is 5.5°C in the warmest part in Kerry 7.0°C. In August, the warmest month the mean temperature is 14.2°C and 15.4°C respectively. Mean yearly precipitation is between 900 and 1400 mm (Müller 1987) [3].

Important Habitats

Ireland is covered by numerous important habitats: blanket bogs and raised bogs and coastal areas that are often important bird areas. Deciduous forests cover only a small area and consist mainly of two types oak forests with an under-storey of holly (*Ilex aquifolium*) and birch (*Betula pendula*) on acid soils (*Quercion robori-petraeae*) and ash-elm forests on limestone soils (*Fraxino-Ulmetum*). Some of the south-western woodlands are rich in mosses, ferns and liverworts.

The many rivers, lakes and ponds contain a wide variety of aquatic plants and there is a full range of water regimes from oligotrophic to highly eutrophic (latter often due to pollution). Many lakes and slow-moving rivers are fringed with mat rush (*Scirpus lacustris*) and reed (*Phragmites australis*), while the base-rich lakes of the Midlands are often rich in Charophytes.

Callows – damp riverside meadow lands subject to winter flooding and deposits of alluvium – are particularly notable in the central Shannon basin and on some of its tributaries.

Along the coast there are many areas of saltmarsh and sand-dunes, with associated dune grasslands including areas of machair in the west, brackish lagoons and coastal heathlands.

[1] T.W. Freeman, *Ireland – A general and regional geography*; London, Methuen, 1960.

[2] M.J. Glastra, *Hoogveen in noordwest Europa: een kwestie van krimp en groei*; Wageningen, Scriptie Landbouwuniversiteit, 1990.

[3] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

Human influence on the natural environment

Ireland has a population of 3.25 million of which one third lives in the Greater Dublin conurbation. The population density in the rural areas is very low. A large proportion of the land is in agricultural use with the more productive soils and larger farms mainly in the east and south of the country. The western areas have poor soils and extensive peat areas. Over 90 per cent is pasture and the majority of all livestock is cattle. The Irish agricultural landscape is rich in hedgerows, herb-rich grasslands and bird species.
Natural deciduous woodland was nearly all cleared by 1700 and only less than one per cent has been left today (Grimmett 1989) [4]. Across Ireland some five per cent of the land has been afforested with coniferous trees since the beginning of this century and the afforestation is recently increasing due to EC-subsidies. Much of this planting has been on blanket and raised bogs.
The areas which are neither farmed nor afforestated are mostly peatlands, both blanket and raised bogs. Afforestation and large-scale mechanical harvesting of peat for fuel, even for electricity plants and horticulture have greatly reduced and degraded these peatlands. Overgrazing by sheep is one of the greatest problems in the mountainous areas causing erosion.

Protected areas

Ireland has 68 National Nature Reserves, 68 Wildfowl sanctuaries and 5 refuges for fauna all resulting from designation under the Wildlife Act 1976. There are 5 National Parks with a total area of ca. 50.000 ha (Wildlife Service 1988) [5]. Four of these are on the western seaboard - Killarney National Park, the Burren National Park (not yet existing), Connemara National Park and Glenveagh National Park. The fifth National Park is in Co. Wicklow and centred on Glendalough. It was founded in 1990 and its area is currently about 14,000 ha. It includes the Liffey Head Bog (blanket bog) which is of International Importance.
Less than 3 per cent of the area of the Irish Republic is protected and the nature reserves are mostly smaller than 500 ha. It is estimated that about 23,000 ha of more or less intact bog surfaces remain in 141 sites, out of an original area of 311,000 ha. About 19,000 ha of blanket bogs and 928 ha of midland raised bogs are protected in ten nature reserves. The largest extent of native broadleaved woodland is situated within Killarney National Park (Craig 1984) [6].

The Tentative Ecological Main Structure in Ireland

Ireland consists of just one NUTS-region (8). The Tentative Ecological Main Structure in Ireland is according to the procedure, described in the main report (Figure 4). The CORINE biotope data are complete for Ireland.

Use has been made of the information on the distribution of broadleaved deciduous forests, alluvial and very wet forests, humid, dry calcareous, dry siliceous grasslands, heath, bogs and marshes. The European soil map provides restricted information. For development of the Tentative Ecological Network mostly data have been used from the map of Natural Vegetation of Europe (Noirfalise 1987) [7]. This comparison with the potential natural vegetation-units and the soil-units appeared to be useful to design the Tentative Ecological

[4] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

[5] Wildlife Service, *Report for 1987*; Dublin, 1988.

[6] A.J. Craig, 'National Parks and other conservation areas'; in: Jeffrey (ed.), *Nature Conservation in Ireland: Progress and Problems*, Dublin, Royal Irish Academy, 1984.

[7] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

Main Structure. Besides the national information on National Parks and other protected areas (national nature reserves and wildfowl sanctuaries) have been used. In Table 6 the spatial claim of the ecological main structure in Ireland is shown.

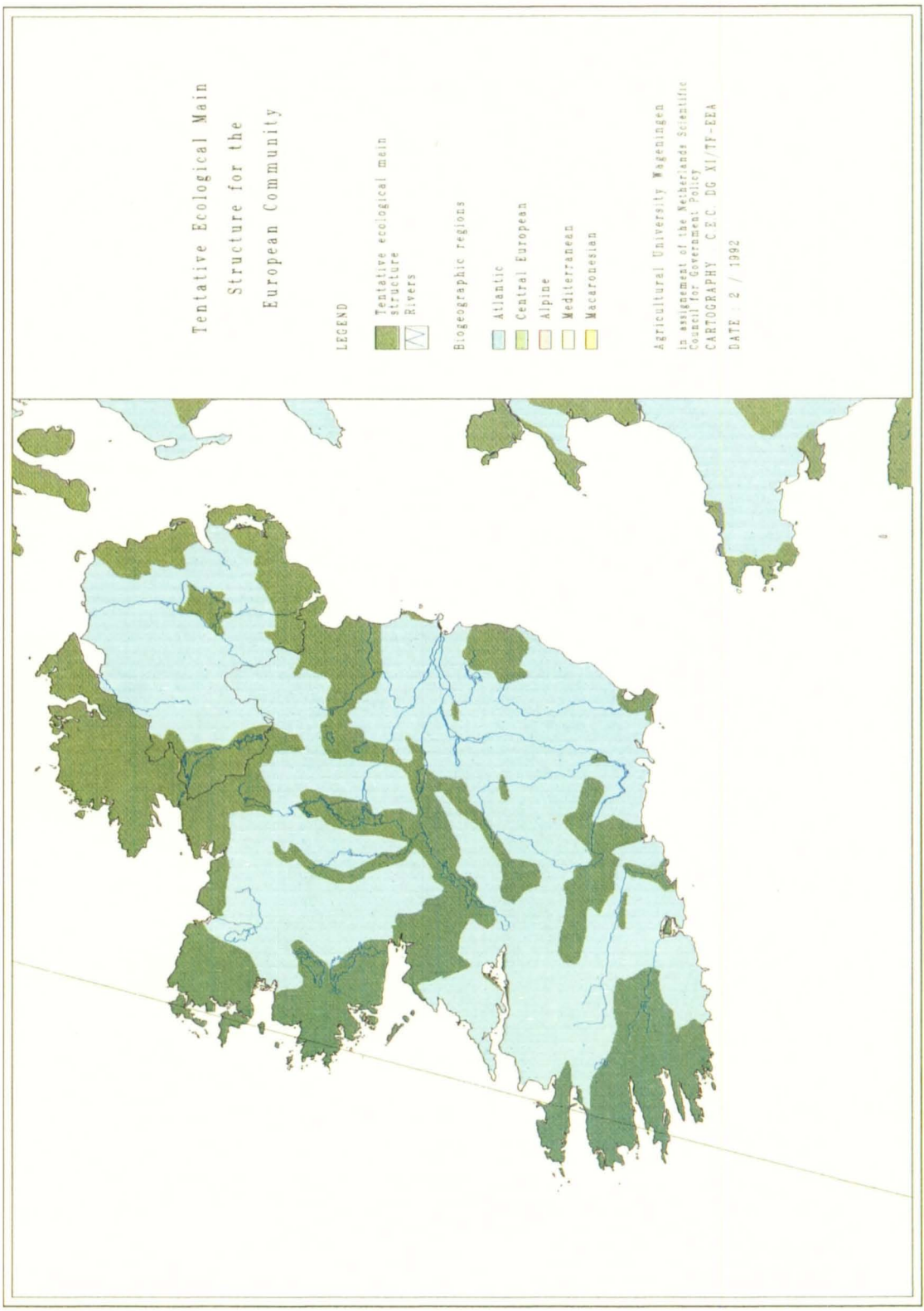
The Tentative Ecological Main Structure consists of mountainous areas with different geological origin, blanket and raised bogs, agricultural landscapes, coastal areas and river catchments (Shannon, Blackwater etc.). The indented coastal area of Donegal includes numerous important areas. These have been included into the network because of their special position in Europe. The National Park Glenveagh is the core of this area that consists of mudflats, sandbanks, lagoons, rocky cliffs rising to 200 m and an inland area covered by scattered alder woodland on the valley floor and hazel/ash woodlands on the slopes, while the oak/birch woodlands at the summits are separated by blanket bog, wet heath and lakes. The area is extends to the south along Upper Lough Erne.

In the northwest (Mayo) the Tentative Ecological Main Structure consists of numerous extensive blanket bogs and mountain pastures. Along the coast of this area the ocean is dotted with small islands and islets. There are rocky cliffs, coastal lagoons and to the south the area contains semi-natural deciduous woodlands of oak (*Quercus robur*) birch (*Betula pendula*) and rowan (*Sorbus aucuparia*). The National Park Connemara is also a part of this area. It is a mountain chain with quartzite as geological underground. Heath and moorlands dominate in the lower areas characterised by numerous rare plant species (endemic but also, arctic-alpine vegetation). In the southeast the area continues along Lough Corrib and Lough Mask, in the northeast towards Lough Conn and Lough Cullin.

Table 6 **The partition of the Tentative Ecological Main Structure Ireland. The area is given in ha and percentage cover of the total NUTS area**

Region	**8**
Region Area (ha)	6,982,799
Protected Area	
Nature (ha)	29,191
Nature (%)	0.4
Landscape (ha)	22,782
Landscape (%)	0.3
International (ha)	117,387
International (%)	1.7
Nature Expansion Area	
(ha)	397,114
(%)	5.7
Habitat Connection Area	
(ha)	2,575,797
(%)	36.9
Not-protected Area	
(ha)	374,332
(%)	5.4
Tentative Ecological Main Structure	
(ha)	3,002,102
(%)	43.0

Figure 4 The Tentative Ecological Network in Ireland



Source: CORINE/Agricultural University, Wageningen, 1990

From the east coast towards the west coast a large area has been designed. It includes two reserves near Gort (Ballynastaig and Coole-Garyland) constitute very important Irish vegetation complexes still because of their combination of deciduous woods, limestone reefs, lakes and turlough (Wildlife Service 1988) [8]. The Burren National Park is botanically one of the most fascinating regions of western Europe, because it is a meeting place between plants of southern distribution and those of northern or alpine affinities (Anonymus 1986) [9]. Dromore (370 ha) is a semi-natural woodland and four major wetland types. Derrycrag Wood is a fragment of a once extensive forest, that contains now stands of oak and ash with an understorey of holly (*Ilex aquifolium*) and hazel (*Corylus avellana*).

The area from the coast to Lough Derg and the Shannon river has been included into the ecological main structure because of its great diversity in biotopes and species and its location. From the Shannon river to the east, via the Esker Riagar System the network contains river environments and floodplains (Shannon, Little Brosna, Suck), raised bogs (Clara Bog, Mongan Bog and Raheenmore Bog) and lakes (Lough Derg, Lough Ennell, Lough Owel, Lough Iron and Glen Lough, Lough Derravaragh). The network area to the eastern coast is designed following the river Boyne, that is also the southern boundary at the coast. At the eastern coastline river estuaries of Broadmeadow and Boyne have been included because they are typical coastal areas and threatened by human activities.

The southwestern part of Ireland is the region of the Hiberno-Iberian disjunction. It is a special region characterised by flora that it shares with Spain and Portugal. This is a special reason for inclusion in the network. The Killarney national Park is the core of the area. The Dingle peninsula has been included with Mount Brandon. The mountain range of Brandon is covered by bog/heath complexes and alpine flora. The southern peninsulas are covered by grasslands, blanket bog/heath complexes and semi-natural woodlands with sessile oak (*Quercus petraeae*).

The ecological main structure includes also the Killarney valley, a large area of ecological interest, because of the best developed oceanic woodland in Ireland, if not in Europe (Craig 1983) [10]. The Killarney National park is situated in adjacent to the Killarney Valley, that is covered by bog/heath complexes and it is the habitat for nearly 400 red deer (*Cervus elapus*).

Besides, this part of the ecological main structure includes a unique extensive alluvial forest, the only one in Europe west of the Rhine, the Gearagh (300 ha). It consists of a network of narrow channels separating islands which are covered with oak (*Quercus robur*), ash (*Fraxinus excelsior*) and birch (*Betula pendula*).

From the Blackwater Estuary in the south, a small estuary with areas of intertidal mudflats and saltmarsh, a connection area has been designed following the river Blackwater. This area consists of the floodplains of the Blackwater river, heath and bog complexes and grasslands.

The Wicklow Hills with surrounding consists of bogs and marshes, rocky habitat and woodland. It has been selected because of its diversity in oak forests, landscapes of acid soils and native hardwoods.

Consequences for agricultural land use and forestry

The ecological main structure consists in general of blanket bogs, raised bogs, woodlands, grasslands and agricultural land. Natural blanket bogs and raised bogs can only stand extensive rough grazing on a very low exploitation level.

[8] Wildlife Service, op.cit., 1988.

[9] Anonymous, *The Burren, County Clare*; National Parks and Monuments Service, 1986.

[10] A.J. Craig, *Killarney National Park*; Killarney, National Park and Monuments Service, 1983.

Species-rich grasslands especially in the river valleys can survive under less intensive agricultural management conditions. This level of exploitation might be less extensive than ion the bogs.
Forestry cannot be combined with the conservation of bogs. Elsewhere it is possible, if it is no high productive tree plantation.

Ellas

5

Physical geography

Greece is situated in southeastern Europe. In the north, it shares borders with Albania, Yugoslavia and Bulgaria and to the east, with Turkey.
Epirus is the northwestern part of continental Greece and is almost entirely mountainous. The Pindus is the main mountain range of which the highest mountain is Smolikas (2637 m) followed by Grammos (2520 m) and Tymphi (2497 m). The Pindus is also the watershed between the waters of the Ionian Sea and the Aegean. West of the Pindus there are smaller ranges that run parallel. The valleys between them are fairly small and some are drained by underground networks as is the case for the Lake of Yannina, that is drained underground to the Thyamis river.
The main geographical feature of Thessaly is its plain. It is surrounded by several mountains, the most famous of which is Mount Olympus, the highest mountain in Greece (2917 m). In the west, Thessaly shares the Pindus range with Epirus while in the east the massifs of Peluion and Ossa are situated (1979 m). The Thessalian plain is drained mainly by the Peneus river which is 205 km long and runs through the eastern range between Olympus and Ossa.
The Macedonian landscape east of the Epirus is rather complicated. Three rivers come down from the north and flow into the Aegean sea, dividing the region into three parts: Western Macedonia from the Pindus range to the Aixos river, Central Macedonia from the Aixos to the Strymon river and Eastern Macedonia from the Strymon to the Nestos.
Western Macedonia is mountainous; it shares the mountains of the northern Pindus with Epirus. Several fertile plains are situated between these mountains. In central Macedonia the main feature is the plain of Thessaloniki which is the largest in Greece after the plain of Thessaly. A large part of Central Macedonia is occupied by the Chalkidiki peninsula. Eastern Macedonia is also mountainous containing two important valleys, those of Sres and of Drama.
Thrace constitutes the northeastern part of continental Greece. It is the continuation of Macedonia to the east, beyond the Nestos river. To the north it is bordered by Bulgaria, to the east by Turkey and to the south by the sea. The main geological feature is the range of the Rhodopi Mountains which forms the border with Bulgaria. The highest peak is Papikio (1443 m). Between this range and the sea the plains of Xanthe and Komotini are situated. The two large rivers, the Nestos and the Evros, rise in neighbouring Bulgaria and flow into the Aegean.
Central Greece consists of Sterea Hellas and Euboea, the second largest Greek island. The western part is a continuation of Epirus. The eastern part is less mountainous. The largest river is the Acheloos (220 km) which rises in the Pindus mountains.
The southernmost part of continental Greece is the Peloponnesos. It is a region of which two third is covered by mountains. The main ranges of the peninsula are geological extensions of the mountains of central and northwestern Greece. Isolated valleys are scattered among the mountains. Islands are situated along the west coast of Greece and from north to south. The islands are peaks of a mountain range running parallel to the ranges of continental Greece. The highest mountain is Ainos in Cefallonia (1628 m). Although there are no rivers or lakes on the islands, there is enough groundwater to supply the needs of its population.
The climate of Greece varies much between north and south, between mountains and valleys and between islands and continent. Although the coast of Epirus and Thessaly has a maritime Mediterranean climate, the central sections have a climate that can be described as Central European. In the high mountainous regions of Greece the climate is clearly mountainous.

The climate of Macedonia in the inland area is continental with cold winters. Along the coast, the climate is mild.
The climate of Thrace is between Mediterranean and Central European, while in Central Greece the differences are between Mediterranean and mountainous climate. In Flórina, a mountain station in the North of Greece the mean maximum temperature is 17.3°C and the mean minimum temperature is 6.3°C with occasionally temperatures of −20°C (Müller 1987) [1].
The Peloponnesos has three climatic zones. The western part has a maritime Mediterranean climate, the eastern part a dry east-mediterranean climate and the central part a Mediterranean mountain climate.

Epirus is one of the rainiest areas of Greece with an annual rainfall of between 1000 and 3000 mm. In Thessaly and Macedonia Trace and Central Greece in the mountainous areas the mean annual precipitation is about 1000 mm, while in the plains it is only 400 to 900 mm. The Peloponnesos is much drier, here the mean annual rainfall ranges from 140 to 190 mm (Anonymous 1988) [2].
The Aegean islands have a warm and dry climate. The southern shoreline of Crete is the warmest area in Greece. The mean maximum temperature on Crete (Iraklion) is 22.4°C and the mean minimum temperature is 14.7°C. Frost is a rarity here, while temperature in summer can reach over 40°C (Müller 1987) [3]. As for the rainfall, the climate of the Cyclades is among the driest in Greece with a mean annual rainfall ranging between 370 and 470 mm. The islands of the eastern Aegean and the Dodecanese are more humid with an annual rainfall of up to 918 mm (Samos). The annual rainfall on Crete varies much. Along the coast, the annual rainfall ranges between 550 and 700 mm. The Ionian islands have a mild and relatively humid climate that produces a rich vegetation. The annual rainfall ranges between 1000 and 3000 mm.

Important Habitats

Greece has one of the richest floras in Europe with over a thousand endemic species mainly concentrated in the mountains and the islands of the Aegean and Ionian seas (eg Crete with 150 endemic species).
Greece was once covered by forest, but now it is mainly covered by maquis, phrygana, secondary steppe, barren rock and wastelands. Forests cover only 19 per cent of the country, most of them are coniferous (13%).
Three main vegetation zones can be distinguished:

- coastal plains and hills: evergreen forests, evergreen scrub, degraded phrygana or garigue;
- middle altitude mountain slopes: broadleaved deciduous woodland, evergreen deciduous woodland, forests of Scotch pine (*Pinus nigra*), cultivated landscape;
- alpine areas above the tree line: alpine grasslands.

Besides, Greece has some of the largest and most important wetlands in the Mediterranean basin. They are a habitat (breeding or feeding) for a large number of avifauna.
The forests of the mountain areas are still habitats for large European mammals as bear, wolve and wild boar.

Human influence on the natural environment

The present vegetation in Greece is the result of the erosion, caused by an enormous destruction of the natural forests. The natural environment is influenced by centuries of forest clearance combined with forest fires. This results in a secondary vegetation that still can develop into the natural original vegetation,

[1] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.
[2] Anonymous, *A fresh look at Greece*; Athens, General Secretariat for Press and Information, 1988.
[3] M.J. Müller, op.cit., 1987.

if the afforestation will be stopped. Afforestation is a new problem in Greece and the exact consequences for environmental and species diversity are not yet clear.
Urbanization in the capital area caused a very high population density (7090 inhabitants per sq.km). The environmental situation in the surroundings is certainly influenced by this fact. But at the other hand, the urbanization is very concentrated to the capital area. Besides this, urbanization in Macedonia causes environmental problems. Today it ranks second after that of the greater Athens area but it is quickly catching up.
The land use of the other regions is dominated by agriculture. The agricultural land use causes problems where it can be intensified. There possibilities are the greatest in the lower parts of Greece (plain of Thessaly and in Macedonia). The rural exodus is a change in land use that has important consequences for the mountain areas. In these less favoured areas of Greece the erosion risk is an important problem. The vegetation, mostly garrigue and maquis, easily gets fire because of the warm and dry climate.
The islands, characterised by a rather extensive agricultural land use, are more and more dominated by increasing tourism. The most evident result of this development is the sealing up of land by hotels and roads. Another problem is excessive shooting, overgrazing and drainage in species rich river systems like the Evros.

Nature protection in Greece is one of the less developed within the EC. Although Greece has 11 national parks and some nature reserves, the protection of nature is not guaranteed. The main problem in Nature Conservation is the scarcity of money. The increasing tourism and the changing agricultural land use will be have consequences for the conservation of the present nature. Therefore it is necessary that the protection of nature will developed strongly. The first action has to be the increasing of management in the already protected areas. Besides the designation of new an ecological main structure of protected areas has to be realised not on an ad hoc basis but based on a general strategy.

The Tentative Ecological Main Structure in Greece

The design of an tentative ecological main structure for Greece is principally done following the procedures, described in the main report. The most important deviation concerned the design on the islands. A detailed design was not possible, because of the missing information and the small areas of the most of the islands.
Important areas for the design were the mountain ranges of Pindos, Rhodopi, Oiti, Parnassos, Parnes and Olympus and the coast of the Peloponnesos, Euboea, Thrace, Epirus and Thessaly. Along the rivers of Thrace (Evros) and Macedonia (Nestos, Strymon and Aixos) connection areas have been designed between the coastal areas and the mountainous areas in the north (Figure 5).

Regions

Greece is divided in four NUTS-regions. In this project the two regions Attiki and Nisia have been fused. In Table 7 the spatial claim of the ecological main structure for the three regions has been listed.

Voreia Ellada (A1)

The Nuts-region Voreia Ellada consists of Thrace, Macedonia and Thessaly. The ecological main structure of this regions is based on the CORINE biotope database and national information on protected areas. CORINE data on biotopes have been used for Alpine grasslands, scrubs, native coniferous forests, broadleaved deciduous forests, broadleaved evergreen forests, mixed

forests en alluvial and very wet forests. The Tentative Ecological Main Structure is build up by different kinds of nature areas. The European soil map has been used, but it only provides restricted information. For development of the network mostly information has been used from the map of natural vegetation of Europe (Noirfalise 1987) [4].

Table 7 **The partition of the Tentative Ecological Main Structure in Greece**
The area is given in ha and percentage cover of the total NUTS-area

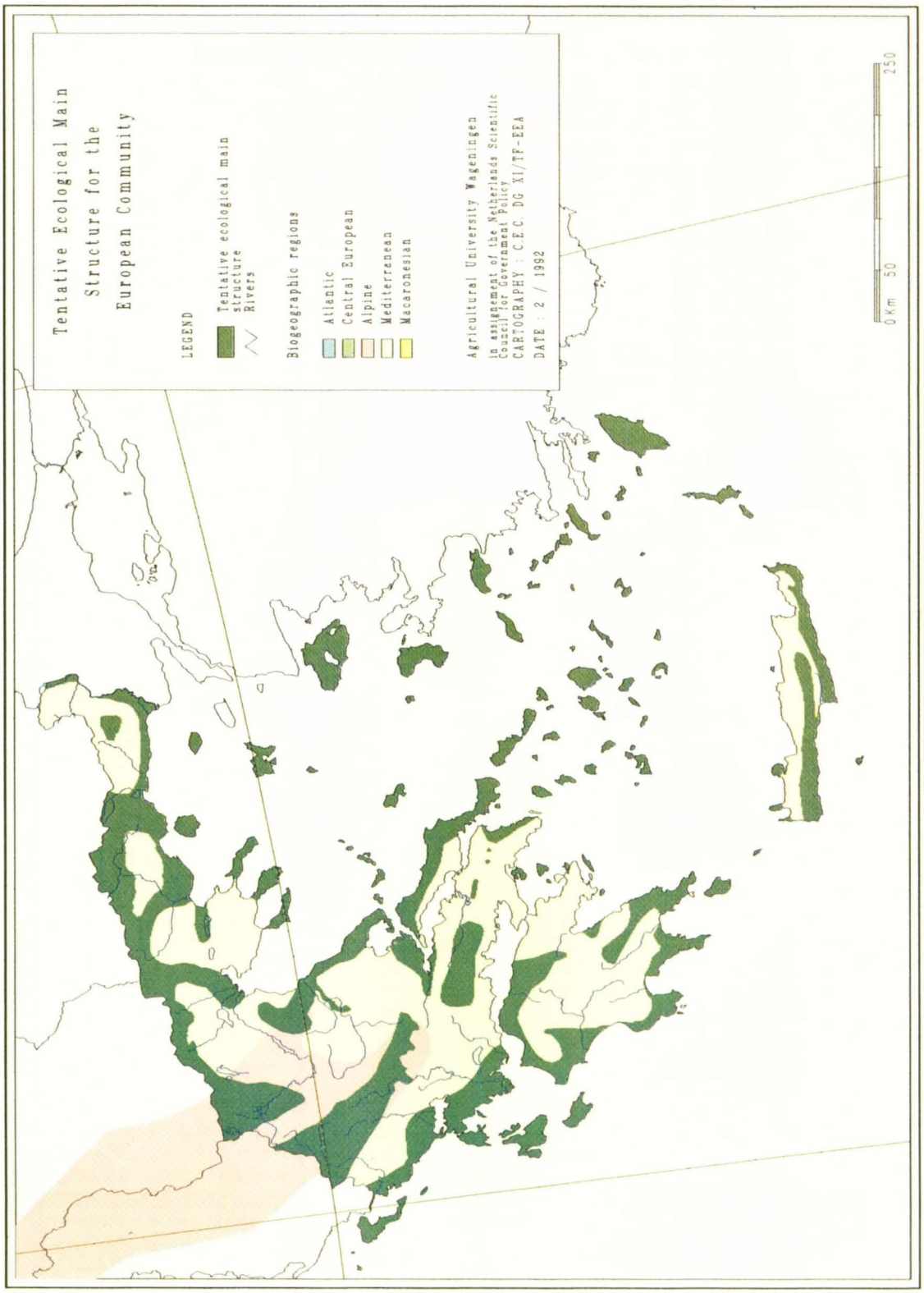
Regions	A1	A2	A3
Region Area (ha)	5,769,299	5,366,828	2,141,992
Protected Area			
Nature (ha)	56,300	30,330	9,410
Nature (%)	1.0	0.5	0.4
Landscape (ha)	42,862	2,126	520
Landscape (%)	0.7	0.0	0.0
International (ha)	56,061	53,130	13,621
International (%)	1.0	1.0	0.6
Nature Expansion Area			
(ha)	1,229,802	722,079	412,606
(%)	21.3	13.5	19.3
Habitat Connection Area			
(ha)	1,241,343	1,639,812	918,483
(%)	21.5	30.6	42.9
Not-protected Area			
(ha)	1,186,940	719,953	412,086
(%)	20.5	13.4	19.2
Tentative Ecological Main Structure			
(ha)	2,527,446	2,392,221	1,340,498
(%)	43.8	44.6	62.6

The Evros delta and the river Evros have been selected because of the diversity of threatened biotopes of islands, sand-dunes, halophytic marshes interspersed with saline lagoons and saltpans. The river Evros is bordered by a strip of gallery woodland and tamarix scrub. The delta is an important area for wintering waterfowl and raptors. The river is the connection with the Evros mountains consisting of large areas of deciduous forest, maquis, and along streams alluvial forests. An important part of this area is already designated as Ramsar site (Evros delta, 10000 ha) and as EEC Special Protection Area (Evros Mountains, 90000 ha). The coastal area next to the Evros Delta onto the Lake Mitrikou has been included in the Tentative Ecological Main Structure as well.

The Lake Vistonis and the Nestos delta, an agricultural area, are included because of their great diversity in biotopes and species. They are adjacent to the Rhodopi mountains that have been included as well as the rivers Kosynthos and Nestos and the Kompsatos Valley. The area is characterized by partly grazed oak forests, deep valleys, dense riverine forests, high cliffs and maquis. The Nestos delta is connected with the Strymon delta by the Limnia hills,

4] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

Figure 5 The Tentative Ecological Main Structure in Greece



Source: CORINE/Agricultural University, Wageningen, 1990

Mount Pangheo, an area with extensive pastures, inland cliffs, streams and forests.
The northern mountainous area of the Rhodopi is important in the design of the Tentative Ecological Main Structure, because it is a core area of an area of great diversity that is connected with the sea by several rivers like the Strymon, Nestus and Kosynthos. The whole area of the Rhodopi mountains in Greece is included into the ecological main structure. The Greek part of the Rhodopi mountains is characteristic for a low mountain range in the Balkan. On the southern slopes of the Rhodopi, the zone of Mediterranean sclerophyllous evergreen trees reaches up to about 300 m.; here the kermes oak (*Quercus coccifera*) forms the basic stock. Higher into the mountains this zone is followed by a belt of oak forests of durmast oak (*Quercus petraea*), white oak (*Q. pubescens*) and frainetto oak (*Q. frainetto*). The characteristics of the higher parts are natural forests of beech (*Fagus sylvatica*) and Scotch pine (*Pinus nigra*) with scrubs at lower altitude, ravines and valleys. It Lake Kerkini (Ramsar site, 12000 ha).

Because of the rarity and diversity of its freshwater and brackish biotopes the river Axios and the estuaries of Axios, Loudia and Aliakmon have been included.
The Prespa national park consists of the Lake Mikri Prespa and the Lake Megali Prespa. This two large mountain-basin lakes, separated by narrow strip of land and surrounded by mountains form the only site in Europe where both the white pelican (*Pelecanus onocrotalus*) and the Dalmatian pelican (*P. crispus*) are present. The national park of Prespa is connected with the eastern part of the network by mountain ranges along the border to Yugoslavia: Paiko, Nidza, Verno. The Prespa national park and diversity and threatened species. To the south it continues in the mountain chains of the Verno, Askio to the Vourinos, a divers landscape with forests and cultivated land around two shallow lakes (Lake Kheimaditis, Lake Zazaris) and the landscape around Lake Vegoritis and Lake Petron, Lake Kastoria. In Mount Vourinos, a large bare-mountain area, isolated forests are found in enclosed valleys.
Because of its environmental diversity the Pindos mountain chain has been included. It includes the national park Pindos, characterized by bare peaks, rocky ridges and valleys, the hills of Zagori, the rivers Aoos and Voidomatis with old oriental plane (*Platanus orientalis*) in the Antikhassia Mountains.
Starting from the national park Olympus, the best protected national park of Greece, a zone has been designed to the Pilio mountains. Many rare and endemic plants and rare herpetofauna as well as many raptors are found here like Eleonora's falcon (*Falco eleonorae*).
The transition zone between both mountain areas ranges via the foothills of Mount Olympus, the Pinios delta and the Mount Ossa. The river Pinios is included from the delta to the Kalamaki Gorge and is characterised by cliffs and riverine woodland. The Peninsulas of Chalkidiki has been included because of its diversified landscape of mountainous areas with bare peaks and gorges.

Kentriki Ellada (A2)

The NUTS-region Kentriki Ellada includes the geographical regions Epirus and Central Greece. The design of the ecological main structure is based on the CORINE data set on biotopes and national information concerning protected areas. The CORINE data have been used for Alpine grasslands, scrubs, native coniferous forests, broadleaved deciduous forests, broadleaved evergreen forests, mixed forests and alluvial and very wet forests. The European soil map has been used, but it provides restricted information. Fore development of the Network, information was used mostly from the map of Natural Vegetation of Europe (Noirfalise 1987) [5].

[5] Ibid.

The whole western coastline of Kentriki Ellada has been included in the ecological main structure. It is a divers area of river estuaries and deltas of the Kalama, Acheron, Achelos and Evinois consisting of salt marches, mudflats, sandbanks, gallery forest along the rivers, Tamarix scrub, sandy heathlands and scrub-covered hills. It includes the famous Gulf of Amvrakia or Arta.
The four mountain areas, Parnassos, Iti, Ghiona and Vardoussia, are part of the Tentative Ecological Main Structure. The Parnassus is a National park with alpine pastures, bare rocks and fir forests (*Abies cephalonica*). The area is important for birds of prey, woodpeckers and alpine birds.
The delta of the river Sperchios and the adjacent Othrys mountains have been included because of their diversity and their threatened biotopes. They are connected with the Sourpis Bay, a coastal marsh with reeds, Salix and Tamarix scrub and riverine woodland of oriental plane (*Platanus orientalis*).
On the Euboea island, the ecological main structure has been designed along the mountain chains. The most important parts are in the north, the small coastal wetland near Istiea (Megalo Livari Lagoon), in the east, Mount Dirfis, a mountain area with bare peaks, numerous cliffs (including sea cliffs) and steep slopes and in the southwest, the Lake Distos, a eutrophic freshwater lake.

Attiki and Nisia (A3)

The NUTS-regions Attika and Nisia includes the geopraphical regions Peloponnese, Crete, the capital area and the Aegean Island. The Tentative Ecological Main Structure in this region is based on the CORINE data set on biotopes and national information concerning the protected areas. The CORINE data have been used for scrubs, native confireous forests, broadleaved deciduous forests, broadleaved evergreen forests, mixed forests, grasslands and alluvial and very wet forests. The European soil map has been used to, but it provides restricted information.
The area of the Lake Stymphalia is a freshwater lake with reedbeds, fed by springs and naturally drained by underground streams. Such lakes are rare in the Peloponnesos and are very important for migratory birds. This area is connected with the Korinthian coastal area via the Aroania mountains and the Panachaikon mountains. Both mountain areas are characterized by numerous gorges. It continues along the coast towards Alyki Lagoon, a small coastal lagoon temporarily drying out in the summer with few zones of reeds and saltmarsh vegetation, the coastal area Kalogria and Lamnia Lakes.
From Lake Kotichi an area has been designed to the Foloi Hills in the midland. Further to the south a small line along the coast is designed to connect the northern part of the ecological main structure with the southern part. It has been selected for its location. In the southern part of the ecological main structure three peninsulas have been included. These are bare mountainous areas with pastures, and Olea groves in the plains, sparsely forested with many cliffs especially on the coast. From the eastern coastline an area has been designed in northwestern direction. This area included sparsely vegetated hills with olive groves and the freshwater lake Taka.
At an European scale the Aegean islands could not be designed in detail, because of their small area. Moreover, because of their endemic species all the islands have been included into the ecological main structure. Only Crete has been designed in detail. In Crete the ecological main structure consists mainly of the mountainous shoreline. From the west to the east two areas designed separated by the river Anapodaris. One internationally protected area is situated within the network (Lefka mountains, Biosphere Reserve and Special protected area, 4850 ha). The mountain area is characterized by bare peaks with cliffs and partly evergreen scrubs. At lower altitude olive groves dominate and at the southern slopes forests of Pinus brutia and Ceratonia siliqua woods are present.

Consequences for agricultural land use and forestry

The Tentative Ecological Main Structure in Greece consists in general of woodlands, maquis, garigue, deltas and estuaries. The woodlands are partly used for forestry. This does not conflict with the areas of the ecological main structure outside the core areas if the exploitation level will be low and the infrastructure will not be extended. High productive forestry cannot be combined with nature management. It is not expected however, that high productive forestry will develop here. The natural woodlands have been included as far as possible in the ecological main structure.
The maquis, garigues and grasslands are often used for rough grazing. This way of agricultural land use is very important for the sustainability of the biodiversity in this country. Its continuation is important, although also in some areas (re)development of natural forest will be an important objective as well. In these areas forestry cannot be combined with nature management.
The delta's and estuaries are important for agricultural development. However, they are also ecologically very important biotopes and species. Agricultural development can easily destroy these important key ecosystems. It is of utmost importance to prevent this.

España

6

Physical geography

The Iberian peninsula is dominated by the Meseta, a geologically old massif, consisting of a range of upland plains (600 m) and several mountain ranges. A central mountain chain, formed by the Sierra de Gredos and the Sierra de Guadarama, divides the Meseta into higher northern plain and a lower southern plain. The Cantabrian mountains situated along the northern edge of the Meseta prevent influences from the Atlantic climate. This mountain range consists of limestone and is covered by extended woodlands and heathlands. In the east it passes over to the Pyrenees, that are the physical and administrative border with France. In the southeastern part of Spain the mountains of the Sierra Nevada are situated. Here climate varies from Alpine in the highest region to semi-arid mediterranean in the coastal lowlands of Murcia. To the west the Sierra Morena stretches onto the Portuguese border, where its continuation is named the Serra de Monchique.

Between the Sierra Nevada and the Sierra Morena in the south the Meseta narrows into a long narrow fertile plain that is drained by the Guadalquivir. In the north-east the Ebro valley forms a lowland with acid soils between the Meseta and the Pyrenees. The inland of the Meseta is a dry region, poorly accessible and sparsely populated. The eroded landscape is characterized by lower hills and indented upland plains.

The Iberian peninsula is drained by several important rivers, the Ebro, Júcar, Duero, Tajo, Guadiana and Guadalquivir. Along these rivers productive farmland is located. Most rivers are regulated and there are many reservoirs for drinking water and agricultural purposes. These reservoirs are often important for waterfowl like the national park Tablas de Daimiel and appear on the shadow list of important bird areas of ICBP.

The islands of the Baleares have two different origins. Formentera and Ibiza have Iberian and Ibero-Mahreb affinities, the other islands Tyrrhenian. They are thought to originate from the Oligo-Miocene. In the view of Obrador (1973) [1] and Ríos (1975) [2] they are a continuation of the Subaetic chain and have been connected with the Sierra Nevada.

The western of the Canary islands are thought to originate from oceanic volcanic activities, while the eastern islands (Fuenteventura and Lanzarote) seem to be of Continental origin. Floristic data confirm this theory (Sunding 1979) [3]. On Tenerife the Teide is situated the highest mountain of Spain (3718 m). It is of volcanic origin and its altitude and its diversity in soil are the other reasons for its great biodiversity.

The climate in the Iberian Peninsula is very variable from atlantic in the northwest to semi-arid in the southeastern part near Murcia. The mountain ranges along the coast and the pyrenees prevent greatly the influence of the oceans on the Meseta. That makes that only the western and northern part of the Peninsula have an Atlantic climate, the Meseta has a continental climate and in the south and east the mediterranean climate dominates (Polunin and Smythies 1973 [4], Rikli 1942) [5]Behind the mountains rain shadow areas are situated.

[1] A. Obrador, *Estudio Estratigráfico y Sedimentologico de los Materiales Miocénicos de lo Isla de Menorca*; Mao', Talleres Gráficos Coll, 1972-1973.

[2] J.M. Ríos, 'El mar Mediterráneo occidental y sus costás ibericas', *Boletin de Real Sociedad Espagnola de la Historia de la Natureza*, 1975, 70:1-473.

[3] P. Sunding, *Origins of the Macaronesian flora*; in: *Plants and Islands*, D. Bramwell (ed.), London, Academic press, 1979, pp. 13-40.

[4] O. Polunin, B.E. Smythies, *Flowers of South-West Europe; A field guide*; London, Oxford University Press, 1973.

[5] M. Rikli, *Das Planzenkleid der Mittelmerländer, Part. I, II, III*; Bern, Haus Hübner Verlag, 1942-1946.

The yearly mean temperature differs from 10.5°C in Las Escaldas in the Pyrenees and Soria in the Sierra de Guaderrama onto 18.8°C in Sevilla. The mean January temperatures differ from 2.3°C in Soria and Las Escaldas onto 10.5°C in Sevilla and 12.5°C in Malaga. The continental character of the Meseta is expressed in the mean lowest temperature: in Valladolid these are below 0°C from October onto May. The highest mean summer temperatures are found in Sevilla and Córdoba, where the mean temperatures in July are 36.4°C and 36.4°C respectively (Müller 1987) [6].

Precipitation differs strongly as well. The lowest yearly mean precipitation is found in Murcia (304 mm), although Valladolid in the rain shadow of the Portuguese mountains (Serra de Peneda, Serra de Lapa, Serra da Estrela) has a very low precipitation as well (364 mm). All the stations on the Meseta show low precipitation data (Müller 1987) [7]. High precipitation occurs only in the northwestern part and in the coastal mountains of Spain. The mean precipitation of Santander is 1198 mm yearly, while la Coruña has 971 mm yearly. In the mountain west of the Meseta and in the Serrania da Ronda precipitation can be over 2000 mm yearly (Rikli 1942 [8], Walter and Lieth 1964) [9].

On the Canarian islands the mean yearly temperatures are over 20°C. The yearly amplitude is small. Precipitation is high between 750 and 1500 altitude. Below and above this zone precipitation and air humidity is less. This is especially the case for parts with the southern exposition (Schaminée and Stortelder 1987) [10].

Important habitats

The vegetation of Spain is related to its climate zones. In the south (Andalucia) the thermomediterranean climate dominates. The climax vegetation is of the carob order (*Oleo-Ceratonietalia*) and is characterized by carob or St Johns bread (*Ceratonia siliqua*), olive (*Olea sylvestris*) myrthe (*Myrtus communis*), various buckthorn species (*Rhamnus spec.*) and mastic tree (*Pistacia lentiscus*). The degradation stages are usually the only ones represented: maquis and garigues, thorny sclerophyllous scrubs and secondary steppes rich in Mediterranean and African species.

The inland of Spain, the Meseta, has a differentiated climate and related differentiated vegetation. This is the mesomediterranean zone. The non-deciduous sclerophyllous oak forests (*Quercion ilicis*) are the climax vegetation in the lower parts. The Meseta is the domain of forests with holm oak (*Quercus ilex*) and evergreen oak (*Quercus rotundifolia*). In the Extremadura forests of cork oak (*Quercus suber*) are the natural vegetation. In the lower mountains these species are replaced by Pyrenean oak (*Quercus pyrenaica*).

The degradation phase of the natural holm oak forests are widespread. These are low, sclerophyllous ligneous formations, collectively referred to as matorrals (Rikli 1942) [11]:

1. Maquis of the order of turpintine treeand buckthorn vegetations (*Pistacia-Rhamnetalia*) with turpentine tree (*Pistacia terebinthus*), olive (*Olea sylvestris*) and on siliceous soils strawberry tree (*Arbutus unedo*), tree heath (*Erica arborea*) and some cistus species;
2. The garigues on calcareous soils (*Ononido-Rosmarinetalia*) with kermes oak (*Quercus coccifera*), rosemary (*Rosmarinus officinalis*), prickly juniper (*Juniperus oxycedrus*) and on siliceous soils with heaths of the *Cisto-Lavan-*

[6] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

[7] ibid

[8] M. Rikli, op.cit., 1942.

[9] H. Walter and H. Lieth, *Klimadiagramm Weltatlas*; Jena, VEB Gustaf Fischer Verlag, 1960-1964.

[10] J.H.J. Schaminée and A.H.F. Stortelder, *Plantengroei op Tenerife; Verslag van een botanische excursie, April 1986*; Wageningen, Rijksinstituut voor Onderzoek in de Bos- en Landschapsbouw De Dorschkamp, rapport nr. 485, 1987.

[11] M. Rikli, op.cit., 1942.

duletalia with green heather (*Erica scoparia*), *Erica multiflora*, various cistus species and French lavender (*Lavandula stoechas*);

3. Grasslands rich in annual species (*Thero-Brachypodietalia*).

In the Meseta there is also a supramediterranean zone. This is characterised by a humid climate which is cooler than that of the mesomediterranean zone. The climax vegetation consists of (semi)deciduous tT oak forests (*Quercetalia pubescentis*).

In the northern mountain ranges and around the Ebro-valley the oak forests contain Lusitanian Oak (*Quercus faginea*). A deciduous supramediterranean Atlantic oakwood with Pyrenean oak (*Quercus pyrenaica*) is extensively present in the higher parts of the Sierra de Gredos, the Sierra de Guadarrama and the Sierra de Gata. Degradation facies with barberry (*Berberis vulgaris*) and juniper (*Juniperus communis*), calcareous grasslands (*Brometalia*), siliceous heathlands with greenweed (*Genista spec.*), heather (*Calluna spec.*) and broom (*Cytisus spec.*). The oromediterranean zone begins above 1600 m altitude and is typified by forests of Scotch pine (*Pino-Juniperetalia*) on siliceous substrate with dwarf Juniper (*Juniperus nana*) and savin (*Juniperus sabina*) and on calcareous substrate with Spanish juniper (*Juniperus thurifera*). Above 2000 m altitude the altimediterranean zone begins. This zone is rich in endemics and is typified by various specific vegetation types (Rikli 1942 [12], Polunin and Smythies 1973) [13]. Spain is important for migrating birds and has many important bird areas (Grimmett and Jones 1989 [14], Langeveld and Grimmett 1990) [15].

The Macaronesian flora and fauna of the Canary islands is famous. It partly originates from the Tertiary and is characterised by several endemic species. The endemic flora of Macaronesia comprise about 685 species out of 3200 species (21%). Species characteristic for this flora are among others *Pinus canariensis, Adianthum reniforme, Davallia canariensis, Persea indica Myrica faya, Smilax canariensis, Laurus azorica* and *Dracaena draco* (Humphries 1979) [16].

The flora and the vegetations of the Balearic islands is typically mediterranean and it also shows a remarkable endemism. About 7 per cent of the flora of the Balearic islands is endemic, among others *Arum pictum, Arenaria balearica, Helleborus trifolius* ssp *lividus, Silene hifacensis* and *Helichrysum ambiguum* (Cardona and Contandriopoulos 1979) [17].

Human impact on the natural environment

The impact of man on the environment in Spain seems small, but actually most of the Spanish nature has been influenced by man. Large parts of the Spanish land are in agricultural use, albeit on many places a very extensive way of agriculture. The old agricultural land uses are cattle and sheep breeding making use of the climatic differences by 'transhumances' between the south and the north. The dehesas, the old common grazing grounds on the Meseta, have a great biodiversity due to grazing. At the moment conservation of the dehesas is an important nature management problem.

Many rivers in Spain have been regulated (Tajo, Duero, Guadiana) by damming. Artificial lakes have been made. This diminished the number of

[12] ibid

[13] O. Polunin and B.E. Smythies, op.cit., 1973.

[14] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

[15] M.J. Langeveld, R.F.A. Grimmett, *Important Bird Areas in Europe; Wetlands for the shadow list of Ramsar Sites*, Cambridge, ICBP and IWRB, 1990.

[16] C.J. Humphries, *Endemism and Evolution in Macaronesia*; in: Bramwell (ed.), *Plants and Islands*, London, Academic Press, 1979, pp. 171-199.

[17] M.A. Cardona and J. Contandriopoulos, *Endemism and Evolution in the islands of the western Mediterranean*; in: Bramwell (ed.), *Plants and Islands*; London, Academic Press, 1979, pp. 133-169.

natural river ecosystems, but on the other hand it also created important resting places for migrating birds in winter. However, in the floodplains of several rivers nature conservation and forestry and agriculture claim the same areas. These grounds can be highly productive, but also are very important for migrating birds and regional biodiversity.
On many ecologically important sites even in nature parks forestry is an important land use. In the higher regions pine is the main species in stead of the natural oak species. In the Mediterranean coastal zone of Spain most of the natural areas are under threat because of urbanisation, citrus plantations and tourism.
Tourism is an important threat for the coastal zones, but the inland areas nor on the continent, nor on the islands have been strongly affected. There are large areas that are undisturbed and that make it possible also for the larger fauna to survive. The most important threat in the near future will be the partition of the land by motorways, railways and urbanised areas.

Protected areas

The protection of nature areas in Spain has long been focused on the five national parks on the mainland and four national parks in the Canarian islands. Spain has according to the nature conservation act four types of protected areas: (1) the strict nature reserves, (2) the national parks, (3) the natural areas of national interests and (4) the nature parks.

However, in the CORINE data set Biotopes Spain has coded 28 types of protected areas. For this project these have been divided into the three types of protected areas. That means, that only the national parks and some of the nature reserves have been included as protected nature areas. The nature parks and the national reserves of wildlife are included in the map of protected landscape areas.
The important wetlands and Ramsar sites of Spain are located in the southern river deltas and in the Guadarrama region. These areas are included in the map of the international protected areas.
Now also thinking on more coherent structures for nature conservation are developed. ADENA/WWF have made an inventory for the mainland of Spain on zones of potential interest for the 'Natura 2000' objective of the EC-habitat directive (Perez and Vela 1991) [18]. This inventory has been translated into an ecological main structure for Spain (Bennett 1991) [19].

The Tentative Ecological Main Structure in Spain

The data that are available for Spain are CORINE data on biotopes. However, some sites are very large (over 100,000 ha) and not yet delineated. This made it only possible to design a rather coarse structure. The total area included in the structure of EECONET is large. This is partly due to the importance of the Iberian Peninsula for various vegetation types and partly by its high number of fauna species that need large habitats like the wolf, the bear, the lynx and raptors.
The pattern of nature areas in Spain is made up by following the natural landscapes within the different mountain ranges: Cordillera Cantabrica, Pyrenees, Sierra de Gredos, Sierra de Guadarrama, Sierra Morena and Sierra Nevada. Along the rivers nature development areas have been specified: Ebro, Tajo, Guadalquivir and in connection with Portugal Guadiana. On the Meseta, along the border with Portugal, nature expansion areas have been indicated to

[18] M.R. Perez, V.G. Vela, *Inventario de zonas de interes potencial para la red 'Natura 2000' en el estado Español*; Madrid, ADENA/WWF, 1991.

[19] G. Bennett (ed.), *Towards a European Ecological Network*; Arnhem, Institute for European Environmental Policy, 1991.

conserve the forests of evergreen oak (*Quercus rotundifolia*) and holm oak (*Quercus ilex*).
Many forest regions that have been included are extensively managed and in this way are already of nature conservation interest. Large areas that have been included are abandoned or very extensively used agricultural land, that is not easily brought into profitably agricultural use.
On the Balearic and Canary islands relative large areas have been designed as potential areas, because of their geological and floristic importance. The lack of detailed information hampered differentiation in the structure (Figure 6).

Regions

Spain is divided in six NUTS-regions that differ considerably in size. The spatial claim for the Tentative Ecological Main Structure has been specified in Table 8. All areas differ in habitats and vegetation types; some differ totally in climate.

Noroeste (B1)

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, heaths and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [20] and the map of Natural Vegetation of Europe (Noirfalise 1987) [21] have been used to trace and delineate the dominating and potentially threatened sites. Besides the national inventory of ADENA/WWF has been used as well (Perez and Vela 1991) [22].
Important vegetation units are for this NUTS-region the Cantabrian beech forests and its degradation phase of south Atlantic heathlands. In the mountains vegetation of Pyrenean oak (*Quercus pyrenaica*) is characteristic; its degradation phase is south Atlantic heathland.

Mediterranean vegetation reaches its utmost northwestern habitats in this region. Data from ICBP and literature data have been used to asses the important areas for fauna protection.
Large mammals like the wolf (*Canis lupus*), the lynx (*Lynx pardina*) and the brown bear (*Ursus arctos*) still live here. They require large natural and semi-natural areas. Besides the region is characterised by some endemic species like the Pyrenean desman (*Galemys pyrenaicus*). Prey birds like the golden eagle (*Aquila chrysaetos*) are found in the mountain ranges.
On the map a large continuous area has been indicated from in the west part north to south (Malpica de Bergantiños onto Miño). There it is connected with the Portuguese Serras de Penéda-Geres and Montesinho. It has been included, because it is important as the central area of the south Atlantic heathlands and in this way for European biodiversity. The CORINE database could not provide enough information on this area. Therefore based on own research and literature data (Braun-Blanquet et al 1956 [23], Braun-Blanquet et al 1964 [24], Rivas-Martínez 1974 [25],

[20] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

[21] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

[22] M.R. Perez and V.G. Vela, op.cit., 1991.

[23] J. Braun-Blanquet, A.R. Pinto da Silva and A. Rozeira, 'Résultats de deux excursions geobotaniques à travers le Portugal septentrionel II'; *Agronomio Lusitana*, 1956, 18(3):167-236.

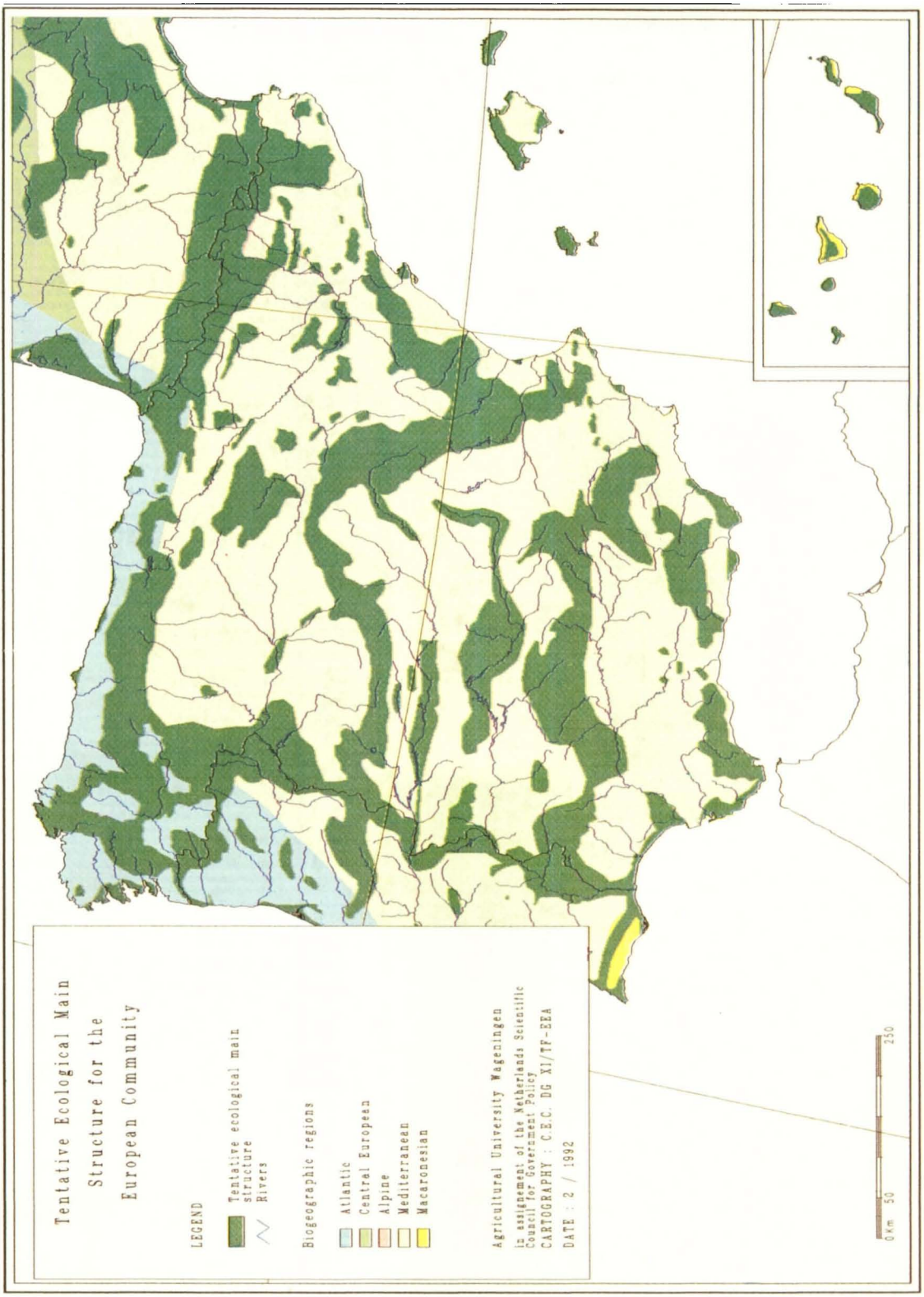
[24] J. Braun-Blanquet, A.R. Pinto da Silva and A. Rozeira, 'Résultats de trois excursions geobotaniques à travers le Portugal septentrionel'; *Agronomia Lusitana*, 1964, 18(4):229-313.

[25] S. Rivas Martínez, 'Observaciones sobre la sintaxonomia de las bosques acidofilos Europeos, Datos sobre la Quercetalia robori petraeae en la peninsula iberica'; *Colloques Phytosociolagiques III*, 1974(a), pp. 225-260.
S. Rivas Martínez, 'La vegetación de la clase Quercetea ilicis en España y Portugal'; *Anales del Instituto Biologico A.J. Cavanilles*, Tomo XXXI, 1974(b), pp. 205-259.

Table 8 The partition of the Tentative Ecological Main Structure in Spain
The area is given in ha and percentage of the total NUTS-area

Regions	B1	B2	B3	B4	B5	B6	B7
Region Area (ha)	4,616,306	7,168,774	806,721	21,628,488	6,098,985	9,606,096	749,635
Protected Area							
Nature (ha)	16,925	15,608	0.0	2,232	27,451	50,720	27,352
Nature (%)	0.4	0.2	0.0	0.0	0.5	0.5	3,7
Landscape (ha)	295,312	354,446	5,754	656,897	419,434	193,233	463,168
Landscape (%)	6.4	5.1	0.7	3.0	6.9	2.0	61.8
International (ha)	16,925	88,670	40,217	207,215	92,145	219,200	244,183
International (%)	0.4	1.2	5.0	1.0	1.5	2.3	32.6
Nature Expansion Area							
(ha)	397,841	1,211,605	68,154	3.046,328	1,285,454	437,269	463,169
(%)	8.6	16.9	8.5	14.1	21.1	4.6	61.8
Habitat Connection Area							
(ha)	1,921,318	1,353,050	159,511	4,167,452	1,608,733	3,092,200	43,110
(%)	41.6	18.9	19.8	19.3	26.4	32.2	5.8
Not-protected Area							
(ha)	102,529	847,159	62,400	2,387,199	866,020	244,036	1
(%)	2.2	11.8	7.7	11.0	14.2	2.5	0.0
Tentative Ecological Main Structure							
(ha)	2,336,084	2,580,264	227,665	7,213,780	2,921,638	3,580,189	533,630
(%)	50.6	36.0	28.2	33.4	47.9	37.3	71.2

Figure 6 **The Tentative Ecological Main Structure in Spain and the Islas Canarias**



Source: CORINE/Agricultural University, Wageningen, 1990

Jongman 1982) [26] a structure has been developed that covers all types of potential forests and heathlands (lowland, low mountains and high mountains). This structure has been adapted by comments from Spanish experts.
East of the Sierra de Mamede and the Sierra de Quiexia the structure comprises the Cordillera de Cantabrica, that continues onto Bilbao. In this area the vegetation is differentiated into Alpine forests and grasslands, bogs, marshes and broadleaved deciduous forests of Pyrenean oak (*Quercus pyrenaica*) and beech (*Fagus sylvatica*). The last area of mediterranean vegetation along the coast near Bilbao has been included as well. Along the northern coast several areas have been included based on expert judgement.

Noreste (B2)

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, heaths, scrubs, mixed forests, alluvial forests and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [27] and the map of Natural Vegetation of Europe (Noirfalise 1987) [28] have been used to trace and delineate the dominating and potentially threatened sites. Besides the national inventory of ADENA/WWF has been used as well (Perez and Vela 1991) [29].
Important vegetation types are for this NUTS-region in the northwestern part south-atlantic vegetation types, Cantabrian beech forests and south Atlantic heathlands as a degradation phase. In the mountains vegetation of Pyrenean oak (*Quercus pyrenaica*) is characteristic. For the east and south part of the region emphasis is laid on the presence of forests of the carob and turpentine tree (*Oleo-Ceratonion*), cork oak forests (*Quercion suberis* according to Noirfalise 1987) [30] north of Barcelona and matorral with Kermes oak (*Quercus coccifera*). Data from ICBP and literature data have been used to asses the important areas for fauna protection. Alpine grasslands and native coniferous forests are found in the high mountains of the Pyrenees, like the forests with mountain pine (*Pinus uncinata*). In the lower mountains forests dominate with evergreen oak (*Quercus rotundifolia*) and in the Ebro valley with Spanish juniper (*Juniperus thurifera*).

In the north an area has been delineated in the Pyrenees, that covers all vegetation zones of the map of the Natural vegetation of Europe (Noirfalise 1987) [31]. According to CORINE data the total diversity of Pyrenean biotopes have been presented in this way. To the west a corridor zone has been designed to connect the Pyrenees with the Cantabrian mountains. This zone contains the mountains of the Sierra de Aralar and the Sierra de Urbasa.
In the southeastern part of this region the Ebro valley and the Reserva Nacional de Puertos de Beseit and el Maestrazgo are part of the structure. These areas have been included for the presence of matorral and the Spanish Juniper zone. Based on comments from the Spanish experts large parts outside these areas have been excluded, because of extensive recent afforestation although they are potentially important according to climate soil and natural vegetation (Noirfalise 1987) [32].
Next to the Reserva Natural de Caça de Muela de Cortes the Montes Univer-

[26] R.H.G. Jongman, *Portugal 1974. Verslag van een excursie van het botanisch laboratorium van de Katholieke Universiteit Nijmegen*; Nijmegen, KUN, Verslag nr. 28, 1982.
[27] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[28] A. Noirfalise, op.cit., 1987.
[29] M.P. Perez and V.G. Vela, op.cit., 1991.
[30] A. Noirfalise, op.cit., 1987.
[31] A. Noirfalise, op.cit., 1987.
[32] A. Noirfalise, op.cit., 1987.

sales and the Sierra de Cuenca are situated. Here matorral is found as well as natural pine forests. Between this area and the Pyrenees the Reserva Nacional de Caja (RNC) de Cameros is situated as part of the Sierra de Demanda. Here important forests of Lusitanean oak (*Quercus faginea*) and matorral of kermes oak (*Quercus coccifera*) are found. Because of their rarity in this region and their importance for biodiversity these areas have been included in the structure.

Madrid (B3)

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, scrubs, mixed forests, alluvial forests and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [33] and the map of Natural Vegetation of Europe (Noirfalise 1987) [34] have been used to trace and delineate the dominating and potential threatened sites. Besides the national inventory of ADENA/WWF has been used as well (Perez and Vela 1991) [35].
In this NUTS-region the forests of carob and turpentine tree (*Oleo-Ceratonion*), the cork oak forests (*Quercion suberis*), and matorral with kermes oak (*Quercus coccifera*) are the dominating but also potentially threatened vegetation. Extensive dry grassland areas with traditional farming (dehesas) are found here. These grasslands are extremely rich in plant species. In the mountains vegetation of natural pine forests is characteristic.
In the Sierra de Guaderrama some areas are protected, like parts of the parque regional de la Cuenca alta del Manzanares. They are positioned in a large east-west directed structure in central Spain. In the lower parts the natural vegetation is a forest of evergreen oak (*Quercus rotundifolia*), at higher sites forest with Pyrenean oak (*Quercus pyrenaica*) are found and in the highest parts of the mountains pine forests with an undergrowth of savin (*Juniperus sabina*) and Spanish juniper (*Juniperus thurifera*).

Centro (B4)

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, heaths, scrubs, mixed forests, alluvial forests and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [36] and the map of Natural Vegetation of Europe (Noirfalise 1987) [37] have been used to trace and delineate the dominating and potentially threatened sites. Besides the national inventory of ADENA/WWF has been used as well (Perez and Vela 1991) [38].
South Atlantic vegetations are found in the northwestern part of the region, Alpine grasslands and native coniferous forests in the high mountains and forests of evergreen oak (*Quercus rotundifolia*) dominate in the lower mountains. Small forests of cork oak (*Quercus suber*) are found as well.
The Cordillera Cantabrica continues from España Nordeste through the Sierra de Mamede and the Sierra de Quiexia in España Centro onto Portugal. Included are the RNC de la Culabra and the Duero valley. Along the rivers Duero, Tajo and Guadiana alluvial forests and their surroundings have been selected on CORINE data.
A core area in the north east is situated around the Reserva nacional de Urbión

[33] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[34] A. Noirfalise, op.cit., 1987.
[35] M.P. Perez and V.G. Vela, op.cit., 1991.
[36] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[37] A. Noirfalise, op.cit., 1987.
[38] M.P. Perez and V.G. Vela, op.cit., 1991.

and the Sierra de la Demanda. Here Alpine vegetation on siliceous soil dominates. South of it onto the Rincón de Ademuz a nature zone is situated around the Parque Nacional de Alto Tajo and the Serrania de Cuenca. The vegetation is of a mediterranean type on calcareous soils.
North of Madrid a zone of potentially important areas is situated including the Sierra de Guaderrama that continues onto the Serra da Estrela in Portugal. In the lower parts the natural vegetation is forest of evergreen oak (*Quercus rotundifolia*), at higher places of Pyrenean oak (*Quercus pyrenaica*) and in the high mountains pine forest with an undergrowth of savin (*Juniperus sabina*) and Spanish juniper (*Juniper thurifera*). Lynxes (*Lynx pardina*) live in this area as well.
In connection with the Portuguese Parque Natural de Mamede (south Portugal) cork oak forests (*Quercion suberis*) are located changing into forests of olive-carob (*Oleo-Ceratonion*) type. Here larger zones have delineated, because of the restricted occurrence natural cork oak forests (*Quercion suberis*) in Europe. Along the Guadiana alluvial forests are found. This zone is important for prey birds, the black stork (*Ciconia nigra*) and the lynx (*Lynx pardina*).
The Sierra Morena is situated in the south along the border with Andalucia. Here dehesas, matorrals and forests of evergreen oak (*Quercus rotundifolia*) are found. In the western part forests of cork oak (*Quercus suber*) can occur as well. In the east part the Sierra de Segura and the Sierra de Alcaraz have been included. These are characterised by olive-carob forests (*Oleo-Ceratonion*) and conifer forests in the higher mountains. In the most eastern part the network area continues in the Reserva Nacional de la Muela de Cortes, an area around the Sierra de Caballa, the Rio Júcar and the Rio Cabriel.

Este (B5)

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, scrubs, mixed forests, alluvial forests and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [39] and the map of Natural Vegetation of Europe (Noirfalise 1987) [40] have been used to trace and delineate the dominating and potentially threatened sites. Besides the national inventory of ADENA/WWF has been used as well (Perez and Vela 1991) [41].
Emphasis has been laid on dominant and characteristic vegetation types. Alpine grasslands and native coniferous forests are found in the high mountains of the Pyrenees, forests with mountain pine (*Pinus uncinata*). In the lower mountains forests dominate with evergreen oak (*Quercus rotundifolia*) and in the Ebro valley with Spanish juniper (*Juniperus thurifera*). In the mountainous zone deciduous forests with Pyrenean oak (*Quercus pyrenaica*) dominate. Besides, olive-carob forests (*Oleo-Ceratonion*), small patches of cork oak forests (*Quercion suberis*) and matorral with kermes oak (*Quercus coccifera*) are used as indicators for the development of the structure.
In the Pyrenees an area has been indicated in which all natural vegetation zones can be found. According to CORINE data the area encloses all important vegetation types. Towards the Mediterranean two areas with forests of cork oak (*Quercus suber*) are connected to this zone.
Alpine grasslands and native coniferous forests are found in the mountains. In the lower mountains on the Meseta forests of evergreen oak (*Quercus rotundifolia*) dominate and in the Ebro basin forests with Spanish juniper (*Juniperus thurifera*). Small area with cork oak forests (*Quercion suberis*) are found. Locally forests with Lusitanean oak (*Quercus faginea*) occur. Based on comments from Spain areas of forest plantations have been excluded.

[39] R.F.A. Grimmett and T.A. Jones, op.cit.

[40] A. Noirfalise, op.cit., 1987.

[41] M.P. Perez and V.G. Vela, op.cit., 1991.

South of this zone the Ebro delta the Ebro basin is situated and the Reserva Nacional de Puertos de Beseit and el Maestrazgo are situated. This area is included because of the matorral, the zone with Spanish juniper (*Juniperus thurifera*) zone and the Ebro. To the south the R.N.C. de la Muela de Cortes is situated connected with the Montes universales and the Sierra de Cuenca. Here natural pine forests and matorral can be found.
The Balearic islands Formentera en Isla de Cabrera are included totally; of Ibiza, Mallorca and Menorca the north parts have been included being least touristic. These areas are supposed to cover all habitats of the islands.

Andalucia (B6)

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, scrubs, mixed forests, alluvial forests and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [42] and the map of Natural Vegetation of Europe (Noirfalise 1987) [43] have been used to trace and delineate the dominating and potentially threatened sites. Besides the national inventory of ADENA/WWF has been used as well (Perez and Vela 1991) [44].
Emphasis is laid on olive-carob forests (*Oleo-Ceratonion*), cork oak forest (*Quercion suberis*), natural vegetation of the semi-arid zone between Cartagena and Almeria, and matorral with kermes oak (*Quercus coccifera*).
Alpine grasslands and native coniferous forests are found in the mountains; native coniferous forests however are also present in the lower Mediterranean coastal zone, where forests of stone pine (*Pinus pinea*) occur. In the lower mountains in the Meseta forests of evergreen oak (*Quercus rotundifolia*) dominate. Small areas of cork oak (*Quercion suberis*) forests are found in this region.
All fluvial plains and vegetations of halophytes on the map of natural vegetation are included in the structure. Partly they have been connected with inland natural zones. The largest and most important area is situated in the west, from the Portuguese border onto Doñana. In the west this zone continues in the Portuguese area around Guadiana and stretches onto Sevilla.
From the Portuguese border in the northwest the Sierra Morena has been included. Here forests with evergreen oak (*Quercus rotundifolia*) and cork oak (*Quercus suber*) dominate. A relation has been made with the river areas between Sevilla and Cordoba along the Guadalquivir. The Guadalquivir basin is very important due to its partly ichtyological fauna (mainly *Cyprinidae*). Threatened and endemic species are found here and in the Guadiana.
From Algeciras and Gibraltar to the north an area has been delineated including the Serrania de Ronda. It is dominated by forests of evergreen oak (*Quercus rotundifolia*) and locally forests of Lusitanian oak (*Quercus faginea*). The area is also important because of vegetation of Serpentine rock. The area continues onto Malaga.
From the Sierra de Teneda a mountain range has been included via the Sierra Nevada onto the Sierra de los Filabres in the east part of this region. It includes smaller mountains like the Sierra de Orce, Sierra de Lúcar, Sierra de Maria and Sierra de Las Estancias in the north. This range is dominated by shrub vegetations, Alpine vegetations (S. Nevada) and in the lower mountains forests of evergreen oak (*Quercus rotundifolia*). North of this range another part of the structure is situated, consisting of the Sierra de Segura and in relation with it the Sierra de Cambrón and the S. de Espuna (Reserva Nacional).

[42] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[43] A. Noirfalise, op.cit., 1987.
[44] M.P. Perez and V.G. Vela, op.cit., 1991.

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, scrubs, mixed forests, alluvial forests and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [45] have been used as well.
Large areas of the Canarian islands have been included because of the importance of the flora and fauna. The Macaronesian flora and fauna consists of many endemic species. The islands have a great environmental diversity. Only the touristic areas of the islands have been left out.

Consequences for agriculture and forestry

The consequences for forestry are restricted. It has been supposed that in corridor areas and buffer zones only low production forestry is possible using native species. That means that this might have consequences especially for the south part of Spain. In the mountains of the Pyrenees large claims have been laid for nature.
In the river areas, that have good growth conditions for many trees claims might be most conflicting with forestry and agriculture. Spain has relatively few but very important undisturbed rivers with well developed floodplain forests and river grasslands. They however are easily turned into areas for forestry and agriculture.
Agriculture in Spain is differentiated through all the country. All regions also are important for (semi)natural biotopes. The Tentative Ecological Main Structure in Spain is rather coarse and consists of mountain areas, coastal zones and rivers. That means that well based conclusions on consequences of the main structure for agriculture cannot be given. In the mountains rough grazings can well be combined with the objectives of large parts of the Tentative Ecological Main Structure. It is even necessary to maintain the biodiversity of the mountain grasslands and the Mediterranean grasslands (dehesas).

[45] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

France 7

Physical Geography

The geological map of France shows several mountain ranges varying in age from Precambrian, Caledonian and Hercynian to Alpine. There are four old massifs, of which the oldest is the Massif Armoricain (Bretagne). The other massifs are Ardennes, Vosges-Alsace and the Massif Central. Alpine ranges are the Alps, the Pyrénees, the Provence and Corse. Besides there are two large basins, the Bassin Parisien and the Bassin d'Aquitaine.

The Bassin of Paris is surrounded by different mountain regions. In the west (Bretagne) the old Armoricain Massif is an eroded sedimental mountain area partly of precambrian origin. In the northeast of the bassin Parisien the Ardennes and the Vosges are situated. Both systems consist of formations partly of Precambrian, partly Ordovician and Silurian origin. Between Paris and the Mediterranean the Massif Central is situated, that covers 1/6 of France. This massif originates from the Variscan orogeny, a part of the Hercynian orogeny. The main formation took place in the Carboniferous and the Permian. In the lower zones in the Mesozoic era there was local sedimentation of dolomite and calcareous sediments. Now this can be recognised by its Karstic morphology. In the Miocene, the Pliocene and the quaternary era until recently volcanic activity has been present (Pomerol et al 1980) [1].

The Bassin de Paris measures about 600 km in diameter. From west to east all geological formations can be found from the Permian to the Oligocene era outcropping especially between Paris and the Vosges. The Bassin de Paris is connected with the Bassin Aquitaine along the interruptions between the different uplands. The Port du Poitou makes this connection possible. The Bassin Aquitaine is a rectangular triangle between the Armorican massif, the Atlantic ocean and the Pyrenees. It has been a sedimentation zone of marine and fluvial sediments from the Mesozoic era on.

In the south and the southeast of the Bassin Aquitaine imposing natural boundaries are found: the Pyrenees and the Alps. These are formed in the Tertiary. The French Alps are situated from the coast of the Mediterranean onto the Lake Geneva. The highest peak of the Alps, the Mont Blanc is located near the Lake Geneva. The basic material consists of granite, gneiss and limestone. The Jura is situated between the Alps and the Black forest and consists mainly of limestone and marl. In the Miocene era much has been eroded. The Pyrenees are situated between France and Spain and show a clear stratification from north to south. This range continues in northwest Spain onto Santander. The Highest point is the Pico d'Aneto in the central Spanish Pyrenees. It is a recent formation from the end of the Mesozoic and the beginning of the Cenozoic era. In the central zone basic variscan orogenic rocks crop out next to other palaeozoic sediments. The mountain ranges are characterised by their own specific flora.

Between the Alps and the Mediterranean sea the Provence is situated. The Provence also has a Palaeozoic basis of granites and gneiss. Its history is strongly related to that of the Alps and the Pyrenees.

Corse is the most southern part of France. It originates from a microcontinent with the Italian island of Sardegna and linked with the eastern Pyrenees and the Balearic islands (Cardona and Contandriopoulos 1979) [2]. The rocks on Corse are mainly schists and granite. It has a great geological variability, varying from hercynian orogenic rocks onto mesozoic and quaternary sediments.

[1] Ch. Pomerol, J. Debelmas, R. Mirouse, P. Rat, C. Rousset, *France Géologique; Grand iterinaires*, Paris, Masson, 1980.

[2] M.A. Cardona and J. Contandriopoulos, *Endemism and Evolution in the islands of the western Mediterranean*; in: Bramwell (ed.), *Plants and Islands*; London, Academic Press, 1979, pp. 133-169.

Its geological history and present variation is expressed in its flora and fauna.
The soils of France are related to its physiographic history and the climate. Dunes occur north of Calais, on the west coast of Normandy, and south of Nantes onto the Pyrenees. The main area of alluvial soils is found in the Bassin aquitaine and along the Loire, Rhone and Rhine. The Bassin de Paris consists mainly of podzolic soils, while west and east of it calcareous soils dominate. Also the Alps, Pyrenees and Provence are rich of calcareous soils (Rendzina), while Corse and the Massif Central mainly consist of granites and basalts (Agavanoff 1936) [3].
The climate of France varies from Atlantic to Alpine and Mediterranean. Along the Atlantic coast of France the temperatures are moderate, varying from 17.1°C in Lille to 19.6°C in Bordeaux in July and from 2.4°C and 5.2°C in January respectively. Potential evapotranspiration is above zero all year long and precipitation is between 600 and 900 mm yearly, except for the south coast of Bretagne. The Vosges, the Ardennes and Alsace still have a sub-atlantic climate with locally high mean yearly precipitation and relatively low temperatures in the winter. In the mountain ranges of the Massif Central, the Alps and the Pyrenees the climate is much more extreme showing long periods with mean temperatures below 0°C and large areas of precipitation over 1000 mm. In the lower regions in the south part of France the mediterranean climate dominates. The timberline in the southern Alps and in the Pyrenees is higher than in the northern mountain ranges. The mean temperature along the mediterranean coast is in July above 23°C and in January still above 7°C. The Provence and Corse have a typical mediterranean precipitation pattern with low precipitation in summer and high precipitation in winter.

Important habitats

Along the French coasts several coastal wetlands are found that are important for bird migration and fish breeding. However, they are not agricultural important and therefore not included in this study.
In Normandy and Brittany beech forest are the natural vegetation on the Ordovician, Devonian and carboniferous schists and Granites. Much of it has been disappeared because of land use changes from nature into agricultural land. In the most western part of Brittany these forests are acidophilous and oligotrophic, characterised by plant species like holly (*Ilex aquifolium*), medlar (*Mespilus germanicus*) and bilberry (*Vaccinium myrtillus*) and as an aspect of its southern position butcher's broom (*Ruscus aculeatus*). In Normandy and the Pas de Calais the forests are mesotrophic and characterised by plant species like primrose (*Primula vulgaris*), stinking hellebore (*Helleboris foetidus*) and spurge laurel (*Daphne laureola*). Since long the forests have been diminished into small remnants and replaced by small scale agricultural landscapes with characteristic tall hedgerows.
North of Paris oak-hornbeam forests are the dominating type of natural vegetation, while in the humid valleys alluvial forests can be found. However, this area is intensively used and natural vegetation is under threat. In the Lorraine and the Alsace on marl, calcareous sandstone and loess oak-hornbeam forests (*Pulmonario-Carpinetum*) and beech forests (*Melico-Fagetum*) are found with locally dry brome grasslands (*Mesobromion*). The landscape is a of mixture of farmland and forests.
In the southern part of the Bassin de Paris onto the Limousin and the Bourgogne several types of beech forests (*Fago-Quercetum*) are found on loam and calcareous soils, but also on gneiss and granite in the Massif central. These forests are all characterised by south-atlantic species like green heather (*Erica scoparia*), gorse (*Ulex europaeus*), bell heather (*Erica cinerea*) and butcher's broom (*Ruscus aculeatus*). In the grit plateaus of the Brie oligotrophic forests are found.

[3] V. Agavanoff, *Les sols de France au point de vue pédologique*; Paris, Dunod, 1936.

The Aquitanian plain is characterised by supramediterranean oak forests with white oak (*Quercus pubescens*) and box (*Buxus sempervirens*). In Les Landes, an area of poor podsolized sand grazing pressure changed the natural forests into south atlantic heathlands. Since the beginning of the nineteenth century these have been replaced by pine forests. Now locally secondary forests are found and the heathlands are strongly declining.
In the Alps and the Pyrenees most natural vegetation is found above the timberline. In the lower mountain regions calcareous beech forests form the natural vegetation in the most of the area (Cevennes, Dauphiné and Auvergne). They also occur in the French Jura, where white fir (*Abies alba*) is part of the vegetation. These woodlands are found on Rendzina soils. The natural vegetation in the southern part of France belongs to the white oak forests (*Quercetalia pubescenti-petraeae*) and its most typical form is the oak forest with box (*Buxo-Quercetum*). The forests that are occurring on the highest places in the Alps are the forests of spruce (*Vaccinio-Piceetum*), larch and arolla pine (*Larici-Cembretum*) and mountain pine (*Pinus uncinata*).
The main areas of alluvial ecosystems are the Loire and the Garonne. Both river systems are rather undisturbed, while other rivers severely suffer under damming and river regulation. The most extensive alluvial plains having natural gallery forests are found here. Beside of these the lower stretch of the Rhone and small parts of the French Rhine are still natural.

Human impact on the environment

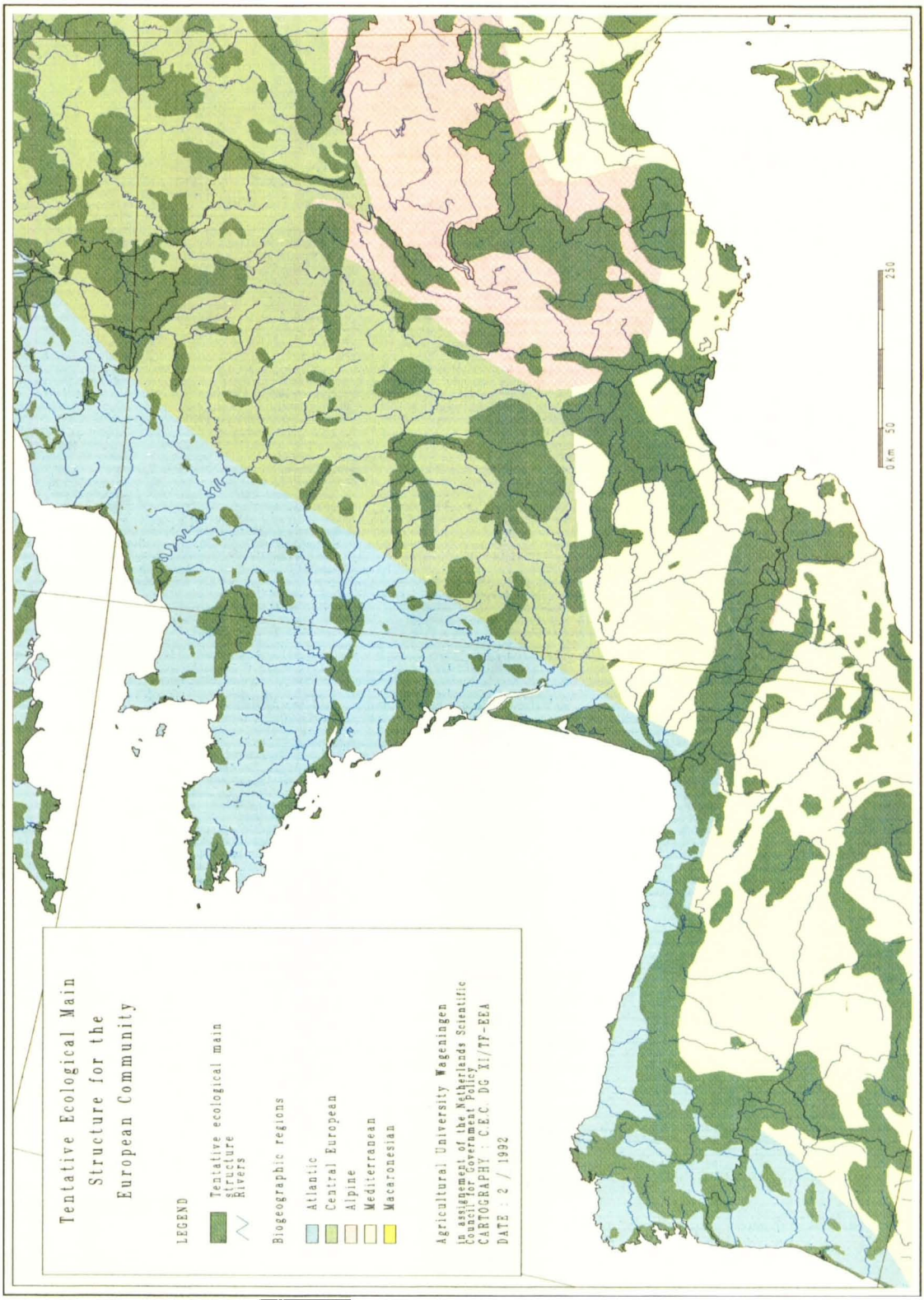
The European part of France measures 537.616 km^2 and has a population of 54 million. Population concentrates in urban areas of Paris, Lyon, Nantes, Lille-Roubaix-Calais, Metz-Nancy and Marseille-Perpignan. These are also the main industrial centres. The population density in the Ile de Paris is 851 per km^2, while it is only 44 per km^2 in the Limousin (Commission of the European Communities 1987).
France is an important country for corn production, especially wheat, that mainly is produced in the Bassin de Paris. Here agriculture is intensive. Bretagne is an important area for pig raising. Important viticulture areas are in the Provence/Languedoc, in the Bordeaux region, Rhone valley, Loire valley and Champagne. In the mountain areas land abandonment and population decline is an important socio-economic problem, especially in the Massif Central. Forests are concentrated in the Alsace, Vosges and les Landes. Two third of the French forests are broad-leaved forests.
The most important river in France in the Loire. It drains a large part of France. Other important drainage basins are the Rhone, the Rhine (Moselle), the Garonne, the Seine and the Meuse. The Scheldt (Escaut) drains Picardie and is rather unimportant for its size and discharge. However, it is very important as a highly industrialised catchment conisting of among others the areas of Lille and Roubaix and its pollution (Saeijs and Logemann 1990) [4].
All French coasts are important for tourism, especially the Mediterranean coast has history in tourist development from the mid nineteenth century on. Nature is severely under pressure in this region due to the combined effect of tourism and industrial development.

[4] H.L.F. Saeijs, D. Logemann, *Lebensbericht eines Stromgebietes. Zu einer nachhaltigern Entwicklung des Rheinstromgebietes*; in: *Der Rhein, zukunft und zustand*; B.K. Kamp, J.H. Mooij and J. Swart (ed.), Naturschutzbund Deutschland, Umweltstiftung WWF-Deutschland, Gelderse Milieufederatie, 1990, pp. 12-50.

Table 9 The partition of the Tentative Ecological Main Structure in France
The area is given in ha and percentage of the total NUTS-area

Regions	21	22	23	24	25	26	27	28
Region Area (ha)	1.197.621	14.614.573	1.234.650	4.845.799	8.603.646	10.388.041	7.101.245	6.887.158
Protected Area								
Nature (ha)	0	37.357	3.011	3.395	16.266	189.977	132.644	264.710
Nature (%)	0	0.26	0.24	0.07	0.19	1.83	1.87	3.84
Landscape (ha)	32.880	229.762	9.904	97.049	199.605	392.498	257.450	325.049
Landscape (%)	2.75	1.57	0.80	2.00	2.32	3.78	3.63	4.72
International (ha)	0	0	0	0	0	3.627	0	1.245
International (%)	0	0	0	0	0	0.22	0	0.72
Nature Expansion Area								
(ha)	79.150	968.565	40.694	319.011	517.983	856.152	984.685	1.024.852
(%)	6.61	6.63	3.29	6.58	6.02	8.24	13.87	14.88
Habitat Connection Area								
(ha)	11.151	1.324.065	29.748	1.194.762	1.014.050	2.265.735	2.004.788	2.485.672
(%)	0.93	9.05	2.42	24.66	11.79	21.81	28.23	36.10
Not-protected Area								
(ha)	46.270	738.803	30.790	221.962	318.378	463.654	727.235	699.803
(%)	3.86	5.06	2.49	4.58	3.70	4.46	10.24	10.16
Tentative Ecological Main Structure								
(ha)	90.301	2.329.987	73.453	1.517.168	1.548.300	3.311.865	3.122.137	3.775.235
(%)	7.54	15.94	5.95	31.31	18.00	31.88	43.97	54.82

Figure 7 The Tentative Ecological Main Structure in France



Source: CORINE/Agricultural University, Wageningen, 1990

Protected areas

A small percentage of the area of France is protected as nature. The nature conservation policy is focused on the creation of national and regional parks. At this moment France has six national parks which are surrounded by protected landscapes. The national parks are situated in the south of France and so the percentage cover of protected nature areas is higher in the southern regions than in the north (Table 9).
Besides the national parks there are many regional nature and landscape parks. Most of them are also situated in the south of the country as well. The international protected areas are located within areas protected by national law areas such as the Camargue. This type of protection does not play an important role in France.

The Tentative Ecological Main Structure in France

In France the map of ecological main structure is characterized by an extensive nature area in the south (Pyrenees, Massif Central and French Alps), many dispersed stepping stones and corridor zones in the centre along rivers (Loire, Rhône, Saône), along the coast and near the springs of brooks and small rivers (Bassin de Paris) and nature expansion areas along the coast of Bretagne (Figure 7). In the Bassin de Paris and Bretagne the area covered is low because of lack of data.
This pattern seems to accord with the nature conservation policy in France: the most designated valuable nature areas are found in the south of France. Supplementary data may show however, that this might be important as well to develop nature areas in the northern regions where protected nature areas still is underrepresented.
The nature expansion areas are located in relation to the most valuable nature areas. The extensive nature area in the south contains however also corridor zones.

The regions

France is divided into eight regions, that differ considerably in size and population. The smallest is Ile de France (1,197,621 ha) containing the urban area of Paris and the largest Bassin Parisien (10,388,041 ha). That means that the data of the regions (Table 9) cannot easily be compared on their area data, but must be compared on percentage data and corrected for population density.

Ile de France (21)

CORINE data on biotopes have been used on grasslands (silicate and calcareous soils) broadleaved deciduous forests and alluvial forests. Besides, use has been made of the natural vegetation map of Europe (Noirfalise 1987) [5] and emphasis is laid on dominant and characteristic vegetation.
The area around Paris is characterised by the alluvial plain of the Seine. In the west oak-beech forests on eutric luvisols are found showing thermophilic characteristics in the south with a.o. box (*Buxus sempervirens*). In the east the natural vegetation is oak-beech forest of silicate soils.
The most important part for the ecological main structure is the area around the Parc regional de la Haute valle de Chevreuse, beside some smaller stepping stones along the Seine and the Esonne.

[5] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

Use has been made of CORINE data on biotopes on grasslands of silicate and calcareous soils, Alpine grasslands, native coniferous forests, broadleaved deciduous forests, mixed forests and alluvial and very wet forests. Other data that have been used are the map of the natural vegetation of Europe (Noirfalise 1987) [6] with emphasis on dominant vegetation types that are regionally characteristic. Besides, data on important bird areas have been used (Grimmett and Jones 1989) [7].

This region varies from higher mountains onto low mountains and lowland. Along the rivers alluvial plains are found. The natural vegetation can be divided into some larger units, like the Armorican and Anglo-Normandic beech forests in the northwestern part. In surroundings of the Loire oak forests with butcher's broom (*Ruscus aculeatus*) and green heather (*Erica scoparia*) can be found. In the coastal zone several small marshes occur. Towards the east the vegetation changes into several subtypes of oak-hornbeam forests (*Carpinion*), oak forests and beech forests.

Based on the available information just a restricted number of larger units mostly around Parcs regionaux can be discerned. It is however reliable to decide on several smaller units, including the summits of the hill systems where many of the regional brook and river systems rise. These systems have been considered characteristic and of utmost importance for the regional diversity.

In the northwestern part the coast has been included from Calais onto Cap d'Antifer because of its importance for birds. Along the coast of Normandy several coastal zones have been included based on expert judgement and regional information. All smaller units in this part of the region are selected to maintain environmental diversity. They are not situated along the coast and contain forests and/or wet grasslands that give rise to rivers and brooks, like the Epte, Bethune, Thironne and Loir. Connected with France Ouest is an area near the Parc Regional de Normandie et Maine. Large parts of the valley and the adjacent hills of the Loire have been included. All these sites are mainly selected for reason of their importance for environmental diversity. They also serve as important stepping stones.

In the southwestern part of the region, south of Orleans, the Forêt de Boulogne is situated with adjacent marshes with sources of tributaries of the Loire and the Cher. West of the confluence of the Allier and the Loire the Forêt de Troncais is situated that changes into an area with wet and dry forests that includes the sources of the Indre, the Arnon and tributaries of the Creuse. In the north the Forêt de Chatauroux is situated. All these sites have mainly been selected for reason of their importance for environmental diversity. They also serve as important stepping stones.

In the southeastern part all sites that were in the Corine Biotope data set and selected for the Bassin de Paris have been included in the structure around the Parc Regional de Morvan as an extension area. On the border with the NUTS-region France Est Revermont and the Forêt de Chaux are situated, both important forests. More towards the north are the Haute Saône, Forêt de Chatillon and the confluence of Yonne and Armançon.

In the northeastern part on the border with France Est the Forêt d'Argonne is situated. Other important areas to maintain environmental diversity are the marshes around Mont Aout, the Parc regional de Montagne de Reims, the Parc regional naturel Forêt d'Orient, the lakes and sources of small rivers like the Ailette and the Armançon. In the utmost north the natural delineation of the Ardennes have been indicated.

[6] ibid

[7] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

Nord-Pas du Calais (23)

Use has been made of CORINE data on biotopes on grasslands of silicate and calcareous soils, native coniferous forests, broadleaved deciduous forests, mixed forests and alluvial and very wet forests. Other data that have been used are the map of the natural vegetation of Europe (Noirfalise 1987) [8] with emphasis on dominant vegetation types that are regionally characteristic. Besides, data on important bird areas have been used (Grimmett and Jones 1989) [9]. The soils are mainly eutric cambisols and orthic luvisols.
The natural vegetation of the coastal zone are vegetation types of dunes and marine clays. More inland a zone of oak-birch forests and a zone of oak-beech forests can be discerned. Oak-hornbeam forests are found in the south towards the region of the Bassin de Paris and there are alluvial plan is along the river Somme. An area in the southwest is characterized by Anglo-Norman beech forests.
In this region only two larger units can be indicated. Connected with the area around the sources of the Dender in Belgium there is a Parc regional around the upper course of the Scheldt characterised by alluvial and wet forests and beech forests. This is the most diverse inland area in this region according to the data available. In the southeastern part there is an extension of the Ardennes complex that has been connected with this complex because of its location. Along the coast there are two important coastal wetlands and from the Baie de la Somme towards the north heathlands and wet and marshy grasslands.

Est (24)

Use has been made of CORINE data on biotopes on grasslands on silicate and calcareous soils, Alpine grasslands, native coniferous forests, broadleaved deciduous forests, mixed forests and alluvial and very wet forests. Other data that have been used are the map of the natural vegetation of Europe (Noirfalise 1987) [10] with emphasis on dominant vegetation types that are regionally characteristic.
The soil of this region consists mainly of eutric cambisols, luvisols and podzols. Large areas of this region are dominated by the natural vegetation of oak-hornbeam forests (*Carpinion*) in the west side changing into thermophilic beech forests in the east part into more acidophilic types. In the mountains beech-pine forests dominate and in the highest parts heathland vegetations. Along a number of rivers, Rhine, Doubs, alluvial plains can be found with related vegetation and bird species. In the south part of the Doubs valley the natural vegetation is beech forest with box (*Buxus sempervirens*).
Adjacent to the Ardennes in Belgium a zone is indicated that contains the Parcs regionaux Côtes de Meuse and du Lorraine. This contains mesotrophic beech forest according to the natural vegetation map (Noirfalise 1987) [11], but according the CORINE information there are also many humid and wet vegetations. Therefore it is considered to be an important zone for regional environmental diversity.
The same can be said of the Parc Regional Naturel du Lorraine and its surroundings, that is situated east of it. Next to the German Pfälzerwald the Parc regional Naturel de Vosges du Nord is situated. This area has been included with the French and German part of the Rhine valley as one important area of potential and actual floodplains and related ecosystems. This unit contains alluvial forests, wet grasslands, former river beds in the river valleys and subatlantic beech forest on the hill sides. It therefore contributes largely to

[8] A. Noirfalise, op.cit., 1987.
[9] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[10] A. Noirfalise, op.cit., 1987.
[11] ibid

the environmental diversity in this part of Europe. It is threatened because of river regulation, excavation and urbanisation. Two other smaller zones along the Rhine have been included as well.

The mountainous areas of the Haute Saône and the Haute Rhin, are the core of this region characterised by important diversity in vegetation and that give rise to the Marne, Meuse, Saône and Moselle.
In the south in the French Jura the area around the Doubs is indicated in the east and on the border with the region Bassin de Paris the gradient towards among others Revermont and the Forêt de Chaux. Both are indicated because of their characteristic vegetation and their great diversity in environments.

Ouest (25)

Data have been used on habitats from CORINE concerning grasslands on silicate and calcareous soils, Alpine grasslands, native coniferous forests, broadleaved deciduous forests, mixed forests and alluvial and very wet forests. Besides information has been used from the natural vegetation map of Europe (Noirfalise 1987) [12], the soil map of Europe and data on important bird areas (Grimmett and Jones 1989) [13]. Dominant and characteristic vegetation types have been selected. The soil is mainly eutric cambisols.
The natural vegetation can be divided into a number of large units. It consists mainly of forests with pedunculate oak (*Quercus robur*) and the semi-natural vegetation is heathland. In the northwestern part the main forests are the Armorican and Anglo-Normandic beech forests. In the southern part along the Loire oak forests occur with butcher's broom (*Ruscus aculeatus*) and green heather (*Erica scoparia*). Local thermophilic forests can be found with St. Lucie's cherry (*Prunus mahaleb*). Along the coast several marshes are situated and alluvial plains can be found in the valley of the Loire.
On the map some larger and several smaller units have been indicated. In Charente maritime the coastal zone between Royan and Rochefort is included because of its importance for coastal heathlands and thermophilic oak forests. Around the rivers Dronne, Né and Charente the alluvial forests and their surroundings are included because of the rarity of alluvial forests. Here also an offshoot is situated of the mountain range of Corrèze. Larger areas are found around the Parc regional du Marais Poitevin and Val de Sèvre et Vendée, around the mouth of the Loire (Parc naturel regional de la Brière) onto Angers around the confluence of the Loir and the Loire.
On the north coast a concentration of sites is found around the Parc naturel regional d'Armorique. Larger expansion areas are found near the Parc naturel regional de Normandie-Maine. The natural vegetation is beech forest.
Scattered over the region small forests have been included as stepping stones. Information on the surrounding agricultural landscape is lacking which hampers the development of a more coherent structure.

Sud-Ouest (26)

Use has been made of CORINE data on biotopes for grasslands on siliceous soils and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests and heathlands. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [14], the soil map of Europe and the ICBP inventory of Important Bird Areas (Grimmett and Jones 1989) [15].

[12] ibid
[13] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[14] A. Noirfalise, op.cit., 1987.
[15] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

Emphasis is given to characteristic and dominant vegetation types and species. Characteristic are from the Spanish coast in the mountainous parts of the Pyrenees deciduous forests of Pyrenean oak (*Quercus pyrenaica*). In the higher mountains pine forests are the natural vegetation (*Pinus uncinata*). The natural vegetation of the coastal zone consists of forests with pedunculate oak (*Quercus robur*) and heathlands as it is in the northwestern part of Spain. In the lower mountains they change into beech forests mixed with pine. In the utmost eastern part of the region an area of white oak (*Quercus pubescens*) forests is found as a gradient towards the mediterranean vegetation. Along some rivers (Garonne, Adour) alluvial plains and related vegetation occurs. In the Garonne basin the supramediterranean forest with white oak (*Quercus pubescens*) penetrates onto the Atlantic coast. In the Causses de Quercy St Lucie's cherry (*Prunus mahaleb*) is an important part of the vegetation.

The Massif Central is characterised by oak-beech forest in the lower parts and Atlantic beech forest and beech-pine forests in the higher regions with a western exposition.
In the Pyrenees the same structure as in the Spanish part has been developed resulting in a comparable zoning on the north and south slopes. Towards the Atlantic ocean a nature zone has been designed that continues along the coast including all dune areas, the river Adour and the Parc regional des Landes de Gascogne. This nature here contains a wealth of diverse environments varying from high mountains onto alluvial vegetations and dunes. The dunes and the alluvial vegetation are rare and threatened because of afforestation and recultivation. The Pyrenees National Parc is an important area for prey birds like lammergeier (*Gypaetus barbatus*), red kite (*Milvus milvus*), black kite (*Milvus migrans*) and peregrine (*Falco peregrinus*).
Along the Garonne zones have been indicated that contain alluvial forests and that can function as cores for nature development. In the east the Parc de Hautes Languedoc and the Parc de Cevennes are situated on the border with the region France Mediterrannee. These are the Monts de Lacaune, the Causses du Larzac, de Causses noires, de Causes de Comtal, a part of the plateau de Lévézou and the upstream parts of the rivers Dourdou and Lot and a part of the Dordogne. Here the natural vegetation is characterised by beech forests, partly with holly (*Ilex aquifolium*), partly with fir and pine. However there is a great diversity in secondary vegetation types like grasslands on silicate soils, hedgerows and coppice forests.
Towards the north a zone has been indicated that connects the calcareous area of the Corrèze with the Charente maritime. Between Clermont Ferrant and Limoges the springs of the Vezère and the Dordogne have been included, because they are important to maintain regional diversity and because of they are vulnerable. In the northwestern part of the region the marshes and wet grasslands of the origin of the Claise, a branch of the Creuse have been included, also because of their vulnerability and on basis of the criterion diversity. The centre of this region is the Parc regional de Brenne.

Centre-Est (27)

CORINE biotope data have been used on grasslands on siliceous and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, native coniferous forests, Alpine grasslands, scrubs and forests and alluvial and very wet forests. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [16], the soil map of Europe and the ICBP inventory of Important Bird Areas (Grimmett and Jones 1989) [17].
Emphasis is given to characteristic and dominant vegetation types and species. In the south the natural vegetation is characterised by white oak

[16] A. Noirfalise, op.cit., 1987.

[17] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

(*Quercus pubescens*) in a gradient to the mediterranean vegetation. Along the Rhône alluvial plains are found. The upper course of Rhône is characterised by oak forests with box (*Buxus sempervirens*). The Massif Central and the Alps are characterised by oak-beech forests in the lower parts and in the high zones Atlantic beech forests and beech-pine forests with a facies of pine.
In the south the cental area of the Ardeche goes over into the Parc National de Cevennes and the related nature zone. Here sources are found of the rivers Loire, Allier and Ardeche. North of this area there is an extensive mountain area that contains a zone with additional tributaries of the Allier among others in the Parc regional des Volcans d'Auvergne and the Parc regional de Livradois-Forêz. Both areas are important for their environmental diversity.
Towards the north the valley of the Allier has been included as an important tributary of the Loire. The Parc Naturel regional de Pilat, where additional sources of the Loire are situated is the centre of this part of the network. North-east of Lyon the marshes of Dombes are found on the confluence of Ain and the Rhône. It is an important wetland of about 100,000 ha for herons, ducks and waders. This area is important for the national and regional environmental diversity. Further upstream and downstream of the Rhône stepping stones are situated.
In the east the Alpine zone has been included in connection with Piedmonte and Mediterranee. Here the beech-fir forests of the western Alps continue and change towards the north into Prealpine mesotrophic beech forests and towards the Rhône valley into oak forests with box (*Buxus sempervirens*).

Mediterranee (28)

Use has been made of CORINE data on biotopes for grasslands on siliceous and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests alluvial and very wet forests, Alpine grasslands, scrubs. Besides this use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [18], the soil map of Europe and the ICBP inventory of Important Bird Areas (Grimmett and Jones 1989) [19]
Emphasis is laid on the selection of characteristic and dominant vegetation types. Bird data have been included when relevant. From the Spanish border along the coast these are the Mediterranean salt marshes (étangs) that are also the only site in Europe where the greater flamingo (*Phoenicopterus ruber*) is found. The lower montainous parts of the Pyrenees are characterised by deciduous forests with Pyrenean oak (*Quercus pyrenaica*). Pinewoods with the mountain pine (*Pinus uncinata*) are found in the highest parts. The natural vegetation of the coastal zone is forest dominated by holm oak (*Quercus ilex*), in the mountains changing into forests of white oak (*Quercus pubescens*). In the east beech forests with box (*Buxus sempervirens*) are found locally. More mountainous parts of the Alps are dominated by mesotrophic pine forests (*Erici-Pinion*) and in the subalpine forests with arolla pine (*Pinus cembro*) and larch (*Larix decidua*). In the most eastern part two areas are found with natural vegetation of cork oak forests (*Quercion suberis*). Besides of these olive-carob forests (*Oleo-Ceratonion*) and related matoral with kermes oak (*Quercus coccifera*) are considered to be characteristic. Along some rivers (Rhône, Adour) alluvial plains en vegetations are found.
In the Pyrenees the structure is connected to the network in Spain. That means that a comparable zonation has been designed on the north and south slopes of the mountains to include the total environmental diversity of the Pyrenees. Towards the Hautes Garonne and Tarn an area has been included with montainous forests of holm oak (*Quercus ilex*) and white oak (*Quercus pubescens*). This is a rather threatened and rare type of forests, characteristic for the

[18] A. Noirfalise, op.cit., 1987.

[19] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

coastal zone in France. In this zone the Parc de Haute Languedoc (Espinouse) has been included. There is a connection zone with the Parc National des Cévennes, the Gorge du Tarne and the Monts de la Margeride situated on the border with The NUTS region Sud-Ouest.
Because of their threatened position and their international importance for the greater flamingo (*Phoenicopterus ruber*) all étangs along the coast have been included. The valley and the delta of the Rhône, the Ardeche and the Durance are part of the structure as one system, because of their importance for this part of Europe as a diverse alluvial system with many type of species-rich ecosystems. They form the connection zone between the Massif Central and the southern Alps. Connected with the Durance is the Parc National de Luberon and de Vaucluse in the Pre-alps of the Provence. Within this zone there is a natural gradient of forests of holm oak (*Quercus ilex*) in the lowlands onto white oak forests (*Quercus pubescens*) in the uplands. These are connected by a rather narrow zone (Montagne de Lure, Lac de Serre Poncon) with the main Alpes du Haute Provence and the Parc National des Ecrins and the Parc du Queyras. These areas are the sites where the natural vegetation of the western Alps can be found, from beech-fir forests in the lower parts (*Galio-Abietetum*) onto forests of arolla pine and larch (*Larici-Cembretum*) in the subalpine parts.
A second alpine zone has been designed around the Parc National de Mercantour and the Alpes maritimes, in direct relation to Piedmonte and this area is characterised by the same forest type. Coastal mountains are the Massif de Saint Baume, Massif de Maures and Esterel. In all areas thermophilic forests and scrubs are found. In the Massif de Baume the natural vegetation is forest of holm oak (*Quercus ilex*). In the Massif de Maures and Esterel the most eastern complexes of cork oak (*Quercus suber*) forest are the natural vegetation. These ecosystems are rare and important in the regional environmental diversity.

Consequences for agriculture and forestry

The consequences of the Tentative Ecological Main Structure for forestry are restricted. It has been supposed that in corridor areas and buffer zones only low production forestry is possible using native species. That means that this might have consequences for especially the south part of France. In the mountains of the Alps, the Pyrenees and the Massif central most claims have been laid for nature.
In the river areas, that have good growth conditions for many trees claims might be most conflicting with forestry and agriculture. France has relatively many rather undisturbed rivers with well developed floodplain forests and river grasslands. They however can easily be disturbed by forestry, agriculture and river regulation.
Agriculture in France is concentrated in the Bassin de Paris, Nord-Pas de Calais and Est. These regions also have restricted data on (semi-)natural biotopes. The network in these regions is rather small and restricted to the region of which information was available. That means that well based conclusions on consequences of the network for agriculture cannot be given. In the mountains rough grazings can well be combined with the objectives of large parts of the ecological main structure. It is even necessary to maintain the biodiversity of the mountain grasslands and the mediterranean grasslands.

Italia

8

Physical Geography

Italy is a peninsula, that borders in the north to France, Switzerland, Austria and Yugoslavia. It includes the islands of Sardinia and Sicily and several small islands. The major geographical zones are the Alps, the Po valley, the Apennines, the coastal areas and the islands.
The Italian Alps are a natural boundary to the north that separate Italy from France, Switzerland, Austria and Slovenia. The Dolomites are situated between the Adige valley and the Piave. The whole area is a mountain region, characterized by high mountain chains (above 3000 m) along the borderline and lower mountain chains in the south of this area. Deep and wide valleys separate the different mountain areas.
The Po Valley is the largest area of lowland in Italy. The Po is the most important and largest river (652 km) in Italy. Its source is at the Monviso mountain in the Alps at 2022 m. Over 100 rivers and streams deliver water to the Po, the northern from the Alps, the southern from the Apennines (De Groot et al 1990) [1]. The Po flows through a delta of five arms into the Adriatic sea. The river valley is flat and surrounded by a soft hilly landscape.
South of the Po Valley the Apennines are situated, which comprise most of the Italian mainland. The mountains of the Apennines are not as high as the Alps. They form a complex of mountain chains, narrow in the north and south, extensive in the centre of Italy. They can be divided into six principal ranges: the Tuscan-Emilian Apennines, Alpi Apuane, the Amiata group in Tuscany, Gran Sasso and the Mailla in Abruzzo, the Serino and the Pollino in Luciana and Sila in Calabria (Bortolini 1950) [2]. At both sides the Apennines are surrounded by coastal areas with a 5000 km long coastline that comprises a mixture of sandy beaches, sand dunes, lagoons and offshore rocky islands. The coastline is broken by a number of estuaries, including those of the Po, Tiber and Arno.

Sardinia is characterized by a great variability landscapes. Sardinia consists on granite rocks and is a peak of an undersea mountain chain. It has been part of a 'Protoligurian Massif' together with a part of the Balearic islands and the Provence. It started to rotate in the period of Alpine orogenesis (Alvarez 1976) [3]. The highest mountains are Monti del Gennargentu (1834 m), Monte Limbara (1342 m) and Monte Linas (1236 m). They are situated in the large mountain chain that ranges from north to the south at the eastern side of the island. The west side of the island is partly lowland.
Sicily is the continuation of the Apennines, characterized by calcareous rocks. Different mountainous areas can be distinguished:

- the strato-volcanic Etna (3275 m);
- the Madonia with the Piz Antenna (1975 m);
- the lower Nébrodi north of the Etna situated in adjacent to the Madonia;
- the Monti Peloritani situated in the north-east of Sicily, adjacent to the Nébrodi with altitudes varying from sea-level to 1100 m;
- the midland mountains with Monte Cammarata and Rocca Busambra;
- the lower calcareous rocks in the north-west of Sicily.

The Italian climate is variable. In the Alps five different types of climate can be distinguished:

- the Alpine climate at the higher altitudes (above 2500 m) with a mean annual temperature of 0°C;

[1] T.C. de Groot, R.J. Havinga, P.G.H. Heslenveld, S.P.R. Kok, V. Loeffen, D.J. Straathof, *River floodplains and policy – a European approach* -; Leiden, Centrum voor Milieukunde, CLM report 68, 1990.

[2] M. Bortolini, *Italy*; 1950.

[3] W. Alvarez, 'The former continuation of the Alps', *Geological Society of America Bulletin*, 1976, 87:891-896.

- the subalpine climate at an altitude between 2000 to 2500 m with a mean annual temperature of 4°C and snow being the main part of the precipitation in the winter;
- the central European mountain climate with a mean annual temperature of 7°C. The annual precipitation ranges between 900 and 1400 mm according to the gradient from the continental inner Alps to the Mediterranean Alps;
- the central European climate in the large river valleys with a mean annual temperature of 10°C and a mean annual rainfall below 800 mm;
- the insubrian climate at the southern part of the Alps, ranging to the city Bolzano. The mean annual temperature is above 10°C and the winters are mild. In the Po valley and the adjacent lowlands the mean year temperature is about 13°C and varies from 2°C in january to 23°C in july. The mean annual rainfall is 1000 mm in Milano and 1600 mm in Venice (Müller 1987) [4]. The Apennines are mountainous with exposition to the Adriatic and the Ligurian sea. That gives it a high climatic variability. The greater part has a Mediterranean climate, but the high parts have a mountain climate Moreover, the climate is in the south dry mediterranean with almost no rain in the summer months while in the north the rainfall is more evenly distributed over the year.
In Sardinia the climate consists of two types. The lower areas have a dry climate with an annual rainfall below 500 mm, concentrated in the spring and autumn. At higher altitudes the annual rainfall can reach 1000 mm (Rikli 1942-1946) [5]. On Sicily also two types of climate can be distinguished: the drier climate in the south and east with an annual rainfall of 400 mm and the mountainous climate on higher altitudes with annual rainfall over 1000 mm.

Important Habitats

In accordance with the geographical regions and the diversity in altitudes the Italian flora and fauna is very divers. Important areas in the Alps are at higher altitude native coniferous woodlands, alpine grasslands, scrub and bare rocks and glaciers, at slopes on lower altitudes native coniferous forests, broadleaved deciduous woodland, evergreen deciduous woodland at the southern slopes, calcareous and siliceous grasslands, river valleys with broadleaved deciduous forests, alluvial forests and lakes, bogs and wet grasslands.
In the Po Valley the important areas consist of alluvial forests, broadleaved deciduous forests and wetlands.
In The Apennines large areas exist of broadleaved evergreen forests, maquis, garigues, native coniferous woodland, dry grasslands in the lowland areas. In the lower hills and mountain slopes they change into broadleaved deciduous forests and evergreen deciduous forests. At high altitudes, above the treeline alpine grasslands and acidophyllous scrub dominate.
The coastal areas are characterised by Mediterranean vegetation of maquis and garigue, sand dunes, brackish lagoons and marshes, cliffs and rocky habitats.
The most important habitats for seabirds are wetlands, particularly the estuaries and lagoons along the northwestern coast of the Adriatic and the offshore islands. The forested areas of the Alps and Apennines are important for bird of prey and forest species, and the cultivated and sheep-grazed plains of Sardinia support the black grouse (*Tetrao tetrax*). Large mammals like the bear, the wolve, chamois, and red deer are present in the forested mountainous areas of the Apennines and the Alps, The populations are partly covered by the existing and proposed National Parks.

[4] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

[5] M. Rikli, *Das Planzenkleid der Mittelmerländer, Part. I, II, III*; Bern, Haus Hübner Verlag, 1942-1946.

Human Influence on the Natural Environment

In some areas Italian agriculture is still traditional and labour-intensive, especially the mountain regions. Some 764,000 ha of wetland existed in 1865 in the coastal areas and the lowlands, but this had been reduced to only 190,000 ha by 1972 (Grimmett 1989) [6]. Mechanisation and intensive monoculture have increased in recent years. Afforestation of marginal land has a major impact in some areas. In southern Italy a large proportion of dry grasslands have been replaced by cultivated field, mostly cereals.
Industrial activities are concentrated in the lowland areas and are still increasing. In the coastal areas and in the centres of European culture tourism expanded in the last decades. Tourism in late spring and summer has a serious environmental impact on areas along the coast and on the islands resulting in the total destruction of large coastal areas. Summer and winter tourism in the Alps is still increasing. The development of tourism in the Alps in the last 100 years made this region the most threatened mountain area in the world.

Protected areas

Italy has five National Parks with a total area of 270,000 ha (WWF Italia 1990) [7]. Besides there are numerous nature reserves, but the categories of landscape protection are more in use to protect areas. There are proposals for twenty-four new national parks to extend the protected nature area to 10 per cent of the country area (Comitati parchi nazionale e riservi analoghe d'Italia 1989) [8]. However, it is not clear whether these reflect a systematic approach to the problem of fragmentation of nature.
The most important bodies which deal with nature conservation are the regional authorities, because the Ministries of Environment and Agriculture have delegated much of their competence according to nature conservation to the regions. A systematic protection, including region overlapping, is therefore more difficult. In 1985 a very important Law was enacted (L. 431/85), that points out rivers and its floodplains as areas of special interest (De Groot et al 1990) [9]. The law orders the regional authorities to make a territorial plan which protects the areas pointed out. This law can be seen as a starting point for the creation of regional ecological main structures based on river systems. The first steps in this direction are done in Piemonte (Instituto Ricerche Economico-Sociali del Piemonte 1989) [10].

The Tentative Ecological Main Structure in Italy

The ecological main structure in Italy has been designed by the procedure described in the main report. The supplementary information consist mainly of maps and descriptions of the protected areas (National Parks, Landscape and Forest Parks) and the proposals for new protection areas (Figure 8). The map of potential natural vegetation is especially used for the mountainous areas, the soil map for the wide river valleys and the deltas. One difficult situation exist in the region Tuscany, because of the low degree of diversity in geomorphology.
Important areas for the design were the Apenine mountain chain, the mountain chains of the Alps and the Dolomites, the rivers (Po, Adige, Bradano, Tevere etc), the Sila and Aspromonte-massif. These areas are important

[6] R.F.A. Grimmett, T.A. Jones, *Importont bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

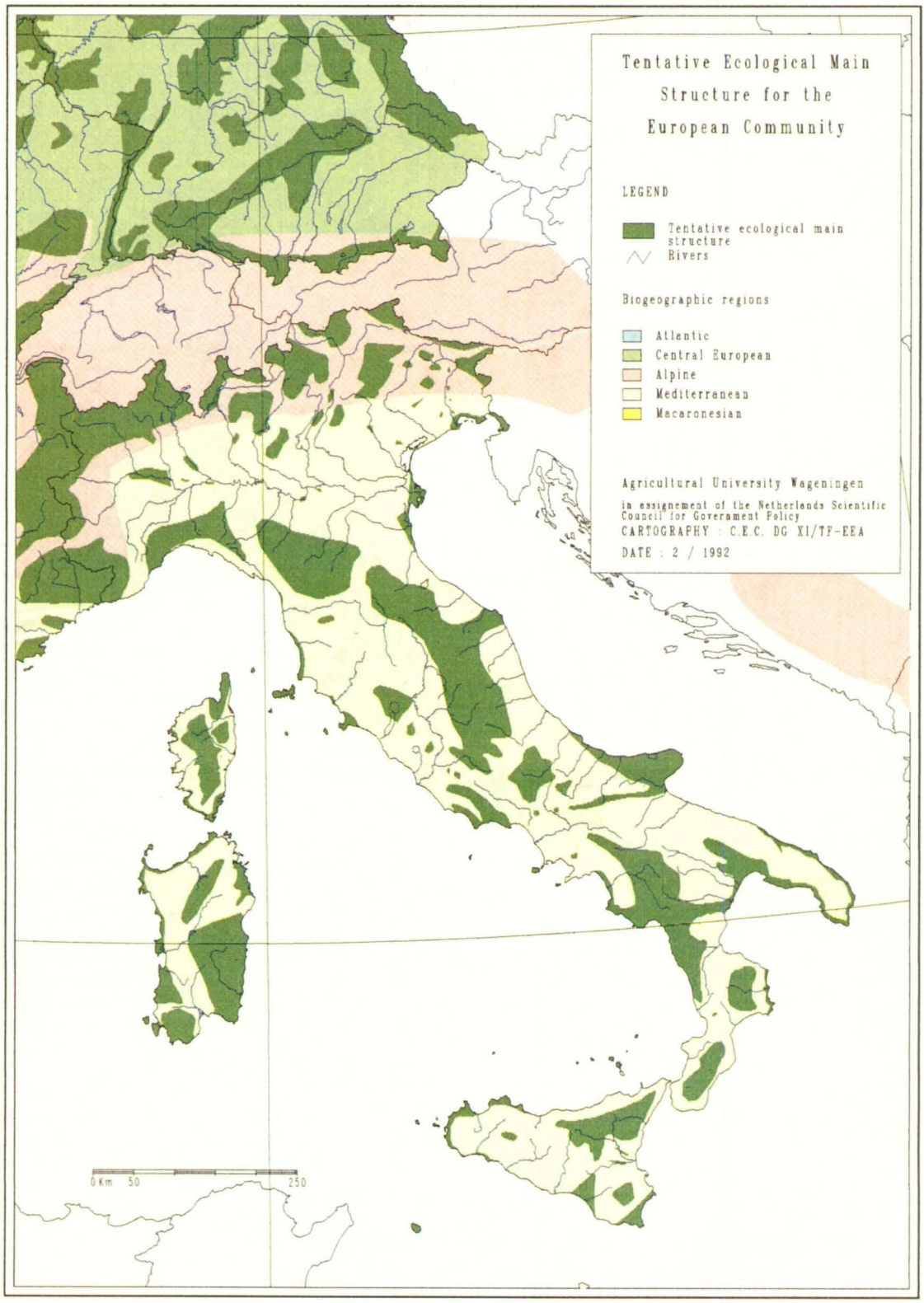
[7] WWF Italia, *Primo censimento delle aree protette in Italia istituite con provedimenti adottati in base ad una normativa regionale*, Roma, 1990.

[8] Comitato parchi nazionali e riservi analoghe d'Italia, *Una Terra di Parchi Verdi*; Roma, 1989.

[9] T.C. de Groot, R.J. Havinga, P.G.H. Heslenveld, S.P.R. Kok, V. Loeffen, D.J. Straathof, *River floodplains ond policy – a European approach* -; Leiden, Centrum voor Milieukunde, CLM report 68, 1990.

[10] Instituto Ricerche Economico-Sociali del Piedmonte, *Progetto Po,- tutelo e valorizzazione del fiume in Piedmonte*; Torino, 1989.

Figure 8 The Tentative Ecological Main Structure in Italy



Source: CORINE/Agricultural University, Wageningen, 1990

because of their internal diversity (variability in altitudes in mountainous areas and natural dynamics in river valleys), the vulnerability (alluvial forests along rivers, fragmentation of forests in mountain areas, afforestation of maquis and garigue in the southern mountain areas, tourism). One of the important features for the inclusion of a large part of the Apennines into the ecological main structure is the presence of large mammals in the mountain areas. It is clear, that the National park Abruzzi is an important biotope for large mammals, but it is also too small to conserve viable populations of wolves and bears in a sufficient way.
The supplementary information from Italian experts did not change to an adaptation of the ecological main structure.

The Regions

Italy is divided in eleven NUTS-regions. In Table 10 the spatial claim for the Tentative Ecological Main Structure has been specified.

Nord Ovest (31)

The NUTS-region Nord Ovest of Italy shares borders with France in the west and Switzerland in the north. The south is bordered by the Mediterranean Sea. The ecological main structure of this region is based on the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands (silicate soils, calcareous soils), broadleaved evergreen and deciduous forests, native coniferous forests alluvial and very wet forests, Alpine grasslands, scrubs. Besides this use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [11], the soil map of Europe and the ICBP inventory of Important Bird Areas.
Except for a small part, the border area with France has been included into the network and it contains several natural parks and nature reserves. From the southern coast large parts have been selected on their diversity and location:

- The area between Cime Selle Vecchie and Monte Alto and the Passo del Turchino and surrounding area. Both are a mountainous area with rivers, streams, woodland and agricultural land;
- The Lagetti di Crava-Morozzo, a regional park with bogs, running water and broadleaved deciduous woodland;
- Val Maira and surroundings, a Biosphere reserve with mixed woodlands, grasslands, inland cliffs and permanent snow and ice;
- The area between Val di Susa, Valle del Chisone and Valle del Torrente Pellice, an area characterized by river streams, broadleaved deciduous woodland and alpine grasslands;
- The National Park Gran Paradiso and Val Soana with native coniferous woodland, mixed woodland, permanent snow and ice and scree.

In between these zones areas have been included based on their location, but although for some parts data are lacking important areas are supposed between them like the proposed National Park Alpi Maritime.

From Gran Paradiso a large area has been designed to the Lago Maggiore, an EEC special protection area at the border to Switzerland and the neighbouring region of Lombardia. In this area some valleys and their mountainous surroundings are included (Val d'Ossola, Valle Anzasca and Val di Antrona). These are characterized by a great diversity of rivers, streams, native coniferous an broadleaved deciduous woodlands.
Along the river Po several (un)protected relicts of alluvial forests, forests of false acacia (*Robinia pseudacacia*) and pedunculate oak (*Quercus robur*) occasionally with alder (*Alnus glutinosa*) and white willow (*Salix alba*) have been included.

[11] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

Table 10 The partition of the Tentative Ecological Main Structure in Italia
The area is given in ha and percentage of the total NUTS-area

Regions	31	32	33	34	35	36	37	38	39	3A	3B
Region Area (ha)	3,345,168	2,409,786	3,970,112	2,223,654	4,103,313	1,730,058	1,377,825	1,537,198	4,457,815	2,596,962	2,404,720
Protected Area											
Nature (ha)	81,218	212,714	73,488	7,798	12,123	37,033	5,072	63,884	44,857	13,355	8,080
Nature (%)	2.4	8.8	1.9	0.4	0.3	2.1	0.4	4.2	1.0	0.5	0.3
Landscape (ha)	156,570	425,884	281,224	75,594	60,803	52,979	14,754	10,389	73,354	337,990	3,300
Landscape (%)	4.7	17.7	7.0	3.4	6.4	3.1	1.1	0.7	1.7	13.0	0.1
International (ha)	79,172	5,971	69,959	19,047	15,311	11,192	3,006	109,492	32,013	1,200	18,009
International (%)	2.4	0.3	1.8	0.9	0.4	0.7	0.2	7.1	0.7	0.0	
Nature Expansion Area											
(ha)	630,146	441,078	865,241	249,311	275,046	327,991	172,396	263,449	531,415	546,788	546,457
(%)	18.8	13.2	21.8	11.2	6.7	19.0	12.5	17.1	11.9	21.1	22.7
Habitat Connection Area											
(ha)	849,253	0.0	91,312	471,614	1,151,160	280,716	260,015	151,246	1,136,636	178,902	673,065
(%)	25.4	0.0	2.3	21.2	28.0	16.2	18.9	9.8	25.5	6.0	28.0
Not-protected Area											
(ha)	473,576	92,624	584,016	173,717	14,243	275,012	157,642	253,060	458,061	208,798	543,267
(%)	14.2	3.8	14.7	7.8	0.4	15.9	11.4	16.5	10.3	8.0	22.6
Tentative Ecological Main Structure											
(ha)	1,560,616	653,792	1,030,041	728,723	1,438,330	645,740	437,484	478,580	1,712.909	739,045	1,227,712
(%)	46.7	27.1	25.9	32.8	35.1	37.3	31.8	31.1	38.4	28.5	51.1

These areas are also important for heronries. Often these areas are small and isolated and surrounded by agricultural land. Adjacent to the river Po and the different river arms, marshy areas are included, because of their importance for bird species and based on their rarity in a European context.

Lombardia (32)

The ecological main structure in Lombardia has been designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE biotope data on grasslands on siliceous soils, calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands, scrubs. Besides this use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [12], the soil map of Europe and the ICBP inventory of Important Bird Areas. Supplementary information consists of maps of protected areas and a description of important bird areas for the river areas (especially the Po).
The ecological main structure in Lombardia consists of mountain areas of the Alps and river areas in the Po valley. The important mountain chains form connection areas, along the river Po numerous stepping stones are situated. The information to design a connection area along the river Po was not sufficient.
Adjacent to the ecological main structure in Nord Ovest, an extensive area has been designed at the border to Switzerland. This part of the ecological main structure connects numerous protected areas and includes a great diversity of mountain areas, lakes, streams, rivers and agricultural land. The important habitats of the Alpine region are all included: coniferous woodland at higher altitude, broadleaved deciduous woodland at lower altitude, alluvial forests in the floodplains of numerous rivers. Included are among others Valtellina, Pian de Spagna and Lago di Mezzola, Val Solda, Monte di Lenno, Monte di Tremezzo, Monte Tabor. In the east, the National Park Stelvio is expanded by all potential native coniferous forests at higher altitudes. The mountainous area of the river Adda is a transition zone between the Alps and the Po Valley. It has a great diversity of high mountain habitats and Alpine grasslands, broadleaved deciduous woodlands changing into broadleaved evergreen forests at the southern piedmont zone, marshlands and open water (Lago d'Iseo, Lago di Lecco).
The mountain area between Lago di Garda and Lago D'Idro is an area with cliffs and exposed bedrocks, deciduous woodland and agricultural land. It has been included as a large stepping stone important for its relative isolation and lack of data on its surroundings.
Several stepping stones have been designed along the river Po and the river Adda. These are important areas for birds, especially for herons. The stepping stones have a common habitat composition: broadleaved deciduous woodlands, alluvial forests, freshwater bodies and marshes, river islands and banks. The lack of information on the river environment is the reason of not connecting these stepping stones.

Nord Est (33)

The NUTS-region Nord-Est shares the borders with Austria, Slovenia and Switzerland. In the south the region is bordered by the Adriatic sea. The ecological main structure has been designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands of silicate soils and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands and scrubs. Besides this use has been made of

[12] Ibid

the map of the natural vegetation of Europe (Noirfalise 1987) [13], the soil map of Europe and the ICBP inventory of Important Bird Areas. Besides descriptions on protected areas (mainly nature parks) have been used. From the borderline with Austria and Slovenia the area consists partly of nature parks These offer opportunities to design a coherent structure. They consist of mountainous areas with river valleys, alpine lakes, bare rocks and pastures.
Between the nature parks parts of the Alps have been included. This high mountain area is characterized by a diversity of vegetation of different altitudes (from bare rocks and alpine grasslands above the treeline via coniferous woodland at higher altitude onto alluvial forests along the rivers.
At the border to Slovenia the proposed national park Alpi Tarvisiane has been included, an area with native coniferous woodland and mixed woodland important for many large mammals. This area offers the opportunity for a connection with the National Park Triglav in Slovenia. South of it along the Slovenian border the Carso Triestino is situated, a forested area with heath and scrub and agricultural land.
From Trieste via Venezia to the Po Delta an area has been designed containing international important coastal areas: The Venezia Lagoon, Lagoon of Caorle and the Lagoon Grado e Marina and the Po Delta at the border to the neighbouring region Emilia Romagna. The lagoons with the special habitats (sand dunes, mudflats, reed vegetation) are threatened by drainage, tourism and hunting. The Po Delta, a proposed National Park, is a vast delta with tidal estuaries, reedbeds, lagoons, sand dunes, sandy beaches and agricultural land.
In the centre of the region a large area has been designated, that consists of the Dolomiti mountains. This area is characterised by a diversity of rocky peaks, alpine grasslands and coniferous woodland at the northern slopes and some evergreen woodlands at the souther slopes. Besides these extensive areas some stepping stones have been designated, especially along the rivers Po, Piave, Adige and Brenta. These areas are partly protected as nature parks or nature reserves.

Emilia Romagna (34)

The NUTS-region Emilia Romagna is situated south of the river Po and in the north part of the Apennines and forms thus the transition area between these two geographical units. The ecological main structure has been designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands (silicate soils, calcareous soils), broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands, scrubs. Besides this use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [14], the soil map of Europe and the ICBP inventory of Important Bird Areas. Besides information concerning important bird areas is used along the rivers (especially along the Po). Information on important biotopes is rather scattered over the region. That makes it difficult to design a coherent structure.
In the region Emilia Romagna the northern ranges of the Apennine mountains form a large area along the border to the NUTS-region Centro characterised by forests, slopes, peaks. The Passo del Cerreto to the S Marcello Pistoise are partly EC-Bird Directive special protection area. Most part however is included based on the criterion location based on the potential natural vegetation map, because insufficient data are available to apply other criteria.
Several rivers flows at the coast of the region into the Adriatic sea (Reno, Sillaro, Po, Bevano, Ghiaia). They form important estuaries with banks, gallery forests of black poplar (*Populus nigra*), wet grasslands, lagoons and marshes and riverine woods. These areas are important for birds.

[13] Ibid
[14] Ibid

Centro (35)

The NUTS-region Centro is bordered in the west by the mediterranean sea and in the east by the Adriatic sea and is situated between the regions Emilia Romagna, Lazio and Abruzzi-Molisse. The ecological main structure has been designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands of siliceous soils and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands and scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [15], the soil map of Europe, the ICBP inventory of Important Bird Areas and information on existing and proposed National Parks.

Adjacent to the proposed National Park in Emilia Romagna (Foreste Casentinesi) an area has been designed following the Apennine mountain chain onto the proposed National Parks, Monti Sibillini and Monti della Laga. This makes that all mountains in NUTS-region Centro have been included. The proposed National Parks are characterised by a great diversity of mountain areas with broadleaved deciduous woodland, native coniferous forests, bare rocks, grasslands, heath and scrub vegetation.
A zone has been included from the high Apennine mountain chain to the lowland of the Adriatic coast. In between low mountains and hills are situated that contain a range of related habitats. These gradients are important to maintain the great diversity of biotopes within the ecological main structure.
Along the western coast two larger areas are included into the ecological main structure as large stepping stones:
The regional – and proposed National – Park Migliarino-San Rossore that is a complex of open and wooded coastal marshes with estuaries of the two rivers Arno and Serchio.
The proposed National Park Maremma, that consists of the large brackish lagoon of La Trappola and the smaller Juncus marshes in the south of the river Ombrone. This area is connected with the Laguna di Orbetello and the Lago di Burano.
The Archipelago Toscano includes the island Capraia, Giglio, Montecristo d'Elba and Palmaiola. These islands are characterized by a great diversity of sclerophyllous scrub, garigue, maquis and sea cliffs and some evergreen deciduous woodland, grassland and agricultural land. Moreover, they are of international importance because of their breeding bird species and their resting areas for migrating passerines.

Lazio (36)

The NUTS-region Lazio shares borders with the region Centro in the north, Abruzzi-Molisse in the east and Campania in the southeast. In the west the region is bordered by the Mediterranean Sea. The Tentative Ecological Main Structure has been designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands (silicate soils, calcareous soils), broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands, scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [16], the soil map of Europe, the ICBP inventory of Important Bird Areas and information on the proposed National Parks.
The ecological main structure in Lazio consists of a large area in the Apennine mountains, adjacent to the neighbouring regions, smaller areas in the mountains of Lepini and Ausoni in the southwest and numerous isolated, volcanic areas.

[15] Ibid
[16] Ibid -

The numerous lakes are of volcanic origin and therefore they are special biotopes in the Italian but also the European context. These lakes and their surroundings have been included based on the criteria diversity and rarity. The most important are:

- Lago di Bolsena at the border with the region Centro (landscape protection area) connected with the smaller Lago di Alviano with marshland and surrounded by cultivated areas.
- Lago di Vico, a freshwater lake with marshes, woodland and agricultural land.
- Lago di Bracciano with adjacent woodland and agricultural land.

These areas are isolated areas, because of their volcanic origin. There is no information available that can be used to connect them with other parts of the network. Therefore they have been included into the ecological main structure as stepping stones.

Monte Lepini and Monti Ausoni with adjacent coastal areas consist of the mountain ranges of Monti Lepini and Monti Ausoni and a group lakes along the coast (partly National Park Circeo). The mountainous area is covered by broadleaved deciduous woodland and agricultural land. The lakes are connected to the sea by narrow channels. The marshes and wet meadows around the lakes dry out in summer. There is also an important area of seasonally flooded lowland forest adjacent to the Lago Saubadia.

The Monti Circeo, a hill of 540 m height, is covered by maquis and evergreen deciduous woodland. Between these well-known areas an area has been designed based on the criterion location over the mountain range of Ausoni and Lepini.

Adjacent to the area in the region Centro the Apennine mountain chain has been included into the ecological main structure. It includes some protected forest areas, (Monti Reatini, Monti del Cigolano, Monte Giano, Monte Cabbia) and a part of the National Park Abruzzi. The whole area is mountainous with broadleaved deciduous woodland, areas of exposed bedrocks, mediterranean scrubs, grasslands, rivers and streams.

Campania (37)

The NUTS-region Campania shares borders with the NUTS-regions Lazio, Abruzzi-Molisse and Sud. The region has a coastline along the Mediterranean sea. The Tentative Ecological Main Structure is designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands (silicate soils, calcareous soils), broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands, scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [17], the soil map of Europe, the ICBP inventory of Important Bird Areas and information on the proposed National Parks.

The region Campania has one large area that is an important part of the Tentative Ecological Main Structure, the proposed National Park Cilento with its surroundings. This area consists of the proposed National Park and other nature expansion areas. They are characterised by a diversity of broadleaved deciduous forests, grasslands, agricultural land, rivers and streams that dominate the landscape. Important threats are the development of tourism, road building and intensification of forestry.

Besides there are some smaller but not less important areas partly because of their rare environmental conditions: Vesuvio, Isola di Capri and the Monti Matese at the border to Abruzzi-Molisse adjacent to the National Park Abruzzi.

[17] Ibid

Abruzzi-Molisse (38)

The NUTS-region Abruzzi-Molisse shares the borders with the region Centro in the north, Lazio in the west and Campania and Sud in the south. In the east the region is bordered by the Adriatic Sea. The Tentative Ecological Main Structure has been designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands of siliceous soils and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands and scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [18], the soil map of Europe, the ICBP inventory of Important Bird Areas, information on the proposed National Parks and the National Park Abruzzi. Most of the CORINE data on biotopes concern this National Park.
The large part of the ecological main structure in Italy, the Apennine mountains, ends in this region. The protection of the National Park Abruzzi is mainly directed to the conservation of the population of the wolve (*Canis lupus*) and the brown bear (*Ursus arctos*). These large mammals need however a larger area, they use also areas outside the park. The park itself is covered by broadleaved deciduous forests and on lower level evergreen deciduous woodland. large areas of maquis are also present. The surrounding area of the National park does not differ much. Therefore the area of the National Park has been expanded and connected with the proposed National Park Mailla, that includes nearly the same biotopes as Abruzzi.
Connected with the extensive central mountain areas in the regions Centro and Lazio a part of Abruzzi-Molisse has been included around the proposed National Parks Gran Sasso and Monti della Laga. Both are characterised by broadleaved deciduous woodlands, native coniferous woodlands, Alpine meadows, streams and exposed rocks.

Sud (39)

The NUTS-region Sud is the largest of the Italian regions and shares the borders in the north with Abruzzi-Molisse and Campania. The region has a long coastline. The ecological main structure is designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands of siliceous and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands and scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [19], the soil map of Europe, the ICBP inventory of Important Bird Areas, information on the proposed National Parks.

Along the coast a narrow zone has been designed as part of the ecological main structure. Starting from the coastal area in Molisse a large area is designed in the Promontorio del Gargano. It consists of a coastal area that is characterized by two large, adjacent lakes, both connected to the sea by a few channels and the Promontorio del Gargano itself. This is a headland with sea cliffs, broadleaved deciduous woodland, sclerophyllous scrub, garigue, maquis, coastal sand-dunes, sand beaches, native coniferous woodland, exposed bedrock and inland rocks.
Along the coast in the south an area has been designed to the wetlands along the Gulf of Manfredonia. This is partly a remainder of formerly large wetland areas, that are now partly drained and partly used as fish-ponds. Based on the criterion diversity the Saline di Margherita di Savoia is the largest saltpan-

[18] Ibid
[19] Ibid

complex in Italy, and forms one complex together with the Alma Dannata, a lagoon north of it. This whole area is important for breeding species and as wintering area for waterfowl. In the west an area has been included along the river Ofanto onto the Apennine mountains.
Between the river Bradano and the city Taranto an area has been included with lower hills characterised by a diversity of maquis and garigue, rivers and streams. It is a lowland area with a hilly landscape in the north, that is threatened by agricultural development and urbanisation. From the Gulf of Taranto to the mountainous area of the Massicio del Monte Pollino a zone has been included along the river Agri and its surrounding landscape. The area of the Monte Pollino is connected with the complex of the Mont Sirino, Monti Alpi and Monte Raparo in the north, the Mont Orsomarso and Monte Verbicaro in the west. This extensive part of the ecological main structure is very divers and includes coniferous woodland, broadleaved deciduous woodland, mixed woodland, heath and scrub, exposed bedrock, inland cliffs, rivers and streams. It connects the eastern coast with the western coast.
In Calabria two parts of the ecological main structure can be distinguished, that include both partly the national park of Calabria. This National Park consists of three parts, two of them are situated in the Massif of Sila, the third part is situated in the Aspromonte-massif. According to this differentiation in the National Park, the ecological main structure has been designed partly on the Sila-massif, partly on the Aspromonte-massif and includes both parts of the National Park. In the Sila-massif native coniferous woodland with Scotch pine (*Pinus nigra*) dominates. In lower altitudes deciduous broadleaved forests occur and above 1500 m altitude beech forests substitute the conifer forests. An important mammal is the Apennine-wolve, but there are also wild boar, wild cat and numerous birds of prey. The Aspromonto-massif is rugged, but the vegetation is comparable to that of the Sila-massif.
The coast between Torrente Lipuda and river Neto is a narrow zone of the ecological main structure but very important because its diversity in bogs and marshes along the coast.

Sicilia (3A)

In Sicilia the ecological main structure is designed by using the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands of silicate and calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands and scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [20], the soil map of Europe, the ICBP inventory of Important Bird Areas, information on the proposed National Parks.
The Tentative Ecological Main Structure at Sicily consists of mountainous areas, including the volcanic Etna and coastal areas. The mountainous areas are situated in the wide surroundings of the Etna and is a unique environment in Europe. Broadleaved deciduous forests, sclerophyllous scrub, garigue and maquis are the main vegetation types of these areas.
The coastal area consists of sea cliffs and inlets, stony beaches, coastal sand dunes and sand beaches. The inland part of the coastal zone is dominated by sclerophyllous scrubs, garigue and maquis.

Sardegna (3B)

The Tentative Ecological Main Structure on the island Sardegna is based on the CORINE biotope data and regional information concerning protected areas. Use has been made of CORINE data on grasslands of silicate and

[20] Ibid

calcareous soils, broadleaved evergreen and deciduous forests, native coniferous forests, alluvial and very wet forests, Alpine grasslands and scrubs. Besides, use has been made of the map of the natural vegetation of Europe (Noirfalise 1987) [21], the soil map of Europe, the ICBP inventory of Important Bird Areas, information on the proposed National Parks.
The ecological main structure is dominated by the Monti del Gennargentu that have been connected with the neighbouring mountain areas in the south and west and with the coastal area in the east (Golfo di Orosei). The mountain areas is a hardly accessible area with coniferous forests of Scotch pine (*Pinus nigra*), evergreen deciduous woodland of cork oak (*Quercus suber*), maquis and containing many endemic specie plant species. The hilly landscape of Iglesiente in the southwest is covered by forests, sclerophyllous scrubs, garigue and maquis and agricultural land. The landscape is divided into a southern and a northern part, separated by the river Cixerri along which cities and roads are concentrated.
The eastern coastline is characterised by sea cliffs and sea inlets, mixed woodlands, scrubs, broadleaved deciduous forests and traditional agricultural land. In the south the wetlands around Cagliari are included into the ecological main structure. This is a salt-extraction complex with evaporation basins and saltpans. The area is dominated by halophytic vegetation such as Salicornia. Along the western coastline a long and narrow zone has been designed, that connects different important coastal areas, partly protected partly unprotected: wetlands of the Sinis Peninsula, Gulf of Oristano, Coast of Cagliari, coastal area from Bosa to Capo Marargui and Porto Tangone, the peninsula of north-western Sardinia. The whole coastline and the nearby inland is characterized by coastal lagoons, inter-dunal saltwater ponds, sea cliffs, islets and rock stacks, sclerophyllous scrub, maquis, garigue. The northern coastline connects the peninsula of northwestern Sardegna to the north-eastern coast of Sardinia, that consists of the same habitats as the western coastal zone.
In the north another area has been designed, that starts from the Altopiano di Campeda and ranges along the river Tirso with adjacent mountains. This area consists of both cultivated and uncultivated land, hedges, areas of scattered cork oak (*Quercus suber*).

Consequences for agricultural land use and forestry

The Tentative Ecological Main Structure has different consequences for the agricultural land use and forestry in the eleven regions. Natural forests can only exist if it is not influenced by man. However many semi-natural forest types can survive and show a great species diversity if extensively used (low exploitation level). Rough grazing can be important to maintain species diversity of garigues, dry grasslands and wetlands.
Especially in the southern parts of the country the mountain areas are characterised by maquis and garigue and here a low human impact can be important. Rough grazing can be continued in the present form. It even can be necessary for nature management.
In the lowland areas and low hilly areas (Po valley, Bradano-valley) the relicts of alluvial and wet forests, being considered as potential core areas, cannot be combined with forestry. In areas that in future will function as corridor zones, low exploitation forestry is supposed to be possible. Management of wetlands and wet grasslands can be carried out by rough grazing.
In the lowland areas and hilly forested landscapes forestry with fast growing tree species can not be combined with the objective of the ecological main structure. An adapted form of forestry (low exploitation level) is possible in corridor zones and buffer zones.
In Nord Ovest, Lombardia, Nord Est, Centro this means that problems can be expected in the development of forestry. The areas of the ecological main structure

[21] Ibid

in these regions are mainly used for forestry and this is beside tourism the most threatening factor in these areas. Besides the areas of the ecological main structure consist of alpine grasslands, mountainous meadows and wet grasslands in the lowlands. In these areas rough grazing can be continued for nature management.

In Emilia-Romagna in the Po valley the remnants of alluvial forests cannot be used for high productive forestry. Forestry on the northern Apennine slopes fits into the network on a low exploitation level.

In the NUTS regions Sud, Sardegna, Sicily, Lazio, Campania, Abruzzi-Molisse the ecological main structure consists mainly of areas with maquis, garigue dry grasslands and natural forests. Garigue and dry grasslands need low exploitation level agriculture (rough grazing) for their maintenance.

Luxembourg 9

Physical Geography

Luxembourg is only one region, that measures 2586 km^2. The landscape of Luxembourg is dominated by the secondary mountain chains of the Ardennes. This mountain area consists on sandstone and volcanic rocks (Eifel). Its highest point is 562 m above sealevel, while Luxembourg town is situated at about 300 m above sealevel. In the north Devonian rocks prevail, while the central and south part mainly consists of Triassic and Jurassic formations. Most tectonic lines in Luxembourg show a south-west to north-east direction (Waterlot et al 1973) [1]. In the north part small aquifers and in the south large aquifers occur.
The climate of Luxembourg is mountainous in the north, expressed in a mean year temperature of 8.3°C, mean minimum temperature of 3.6°C and a precipitation of 1754 mm (Clairvaux) and comparable with the Harz and the Rhön (Jongman 1991) [2]. The climate of Luxembourg town is more comparable with the Eifel and northeastern France.

Important habitats

The natural vegetation of Ardennes is an acidophyllous beechwood (*Luzulo-Fagetum*). This woodland still form subnatural forests, but large parts have been transformed into oak coppice woodlands for the production of tanbark or replaced by heathlands (*Calluno-Vaccinietum*) with heather (*Calluna vulgaris*), bilberry (*Vaccinium myrtillus*) and needlefurze (*Genista pilosa*) and from approximately 500 m upwards cowberry (*Vaccinium vitis-ideae*). Even small areas of Alpine grasslands are found in the higher parts of the Ardennes (Ösling) The most important part of Luxembourg is the north because of its large forests, its brooks and semi-natural grasslands.

Human impact on the natural environment

In the north Luxembourg is situated in the Ardennes while in the south an undulating country is found that continues in France into Lorraine. In the northeast of the Eifel-Ardennes massif remainders are found of fen and wetlands. A third part of Luxembourg is occupied by woodland. The south of Luxembourg (Gutland) is dominated by the urbanisation of Luxembourg town and farming. River pollution is restricted to the Alzette in the neighbourhood of Luxembourg town. Tourism is important in all the country.

Protected areas

Luxembourg has one nature park, the German Luxembourg nature park, that is classified as protected landscape area. The nature reserves cover an area of 12-15 per cent of Luxembourg. This percentage includes the nature reserves which are located in the nature park. Two nature parks have been proposed. It is the country with the highest coverage of protected areas in the EC.

[1] G. Waterlot, A. Beugnies and J. Bintz, *Ardennes-Luxembourg, Guides géologiques régioneaux*; Paris, Masson & Cie Editeurs, 1973.

[2] R.H.G. Jongman, 'Ecological classification of the climate to the Rhine catchment'; *International Journal of Biometereology*, 1991, 34:194-203.

The Tentative Ecological Main Structure in Luxembourg

The spatial claim of the Tentative Ecological Main Structure in Luxembourg has been specified in Table 11. Use has been made of CORINE habitat information from the Biotope data set. The characteristic natural habitat is broad leaved deciduous forests, while along the SEre alluvial forests can be found. Also humid, dry calcareous, dry siliceous are and alpine grasslands, heath, bogs and marshes are considered to be important, because they represent the natural gradient in biodiversity and represent rare habitats. Besides this use has been made of the Corine Land cover map Luxembourg 1:100000 for estimation of the habitat connection areas.

Table 11 **The partition of the Tentative Ecological Main Structure in Luxembourg. The area is given in ha and percentage of the total NUTS-area**

Region	6
Region Area (ha)	264,812
Protected Area	
Nature (ha)	35,655
Nature (%)	14.60
Landscape (ha)	36,499
Landscape (%)	13.78
International (ha)	0
International (%)	0
Nature Expansion Area	
(ha)	36,499
(%)	13.78
Habitat Connection Area	
(ha)	89,430
(%)	33.77
Not-protected Area	
(ha)	0
(%)	0
Tentative Ecological Main Structure	
(ha)	164,584
(%)	62.15

The results of this analysis have been checked by using the map of the vegetation of Europe, that shows the dominating vegetation types to be beech forests (*Luzulo-Fagetum* and *Melico-Fagetum/Carici-Fagetum*). The soil map has been used for information on the location of alluvial soils because of their potentials for alluvial forests and related ecosystems.

The Tentative Ecological Main Structure includes the German-Luxembourg Park and the two proposed nature parks in the west and in the south of Luxembourg. The existing nature park is specified as nature expansion area, the other two as corridor zones and partly nature expansion areas. The river Sûre and the areas of the acidophyllous beech forests are also specified as nature development areas (Figure 9).

Because of their environmental diversity the river Sûre as well as the potential areas for the species rich calcareous grasslands and in the north the rare Alpine grasslands have been included in the Network. The areas with extensive Beech forests, partly within the Deutsch-Luxemburgische Naturpark and

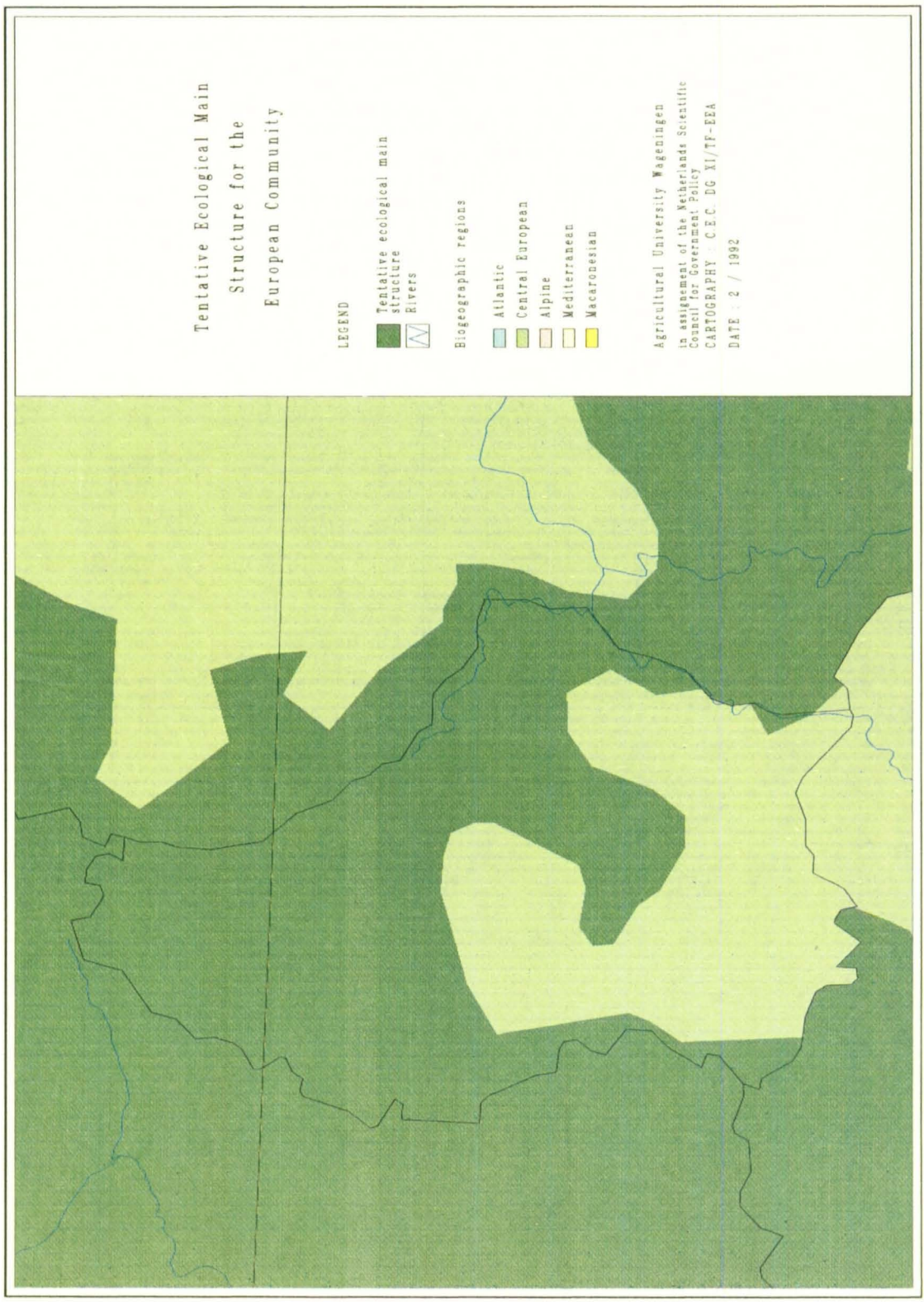
areas adjacent to the bird directive areas in Wallonia have been selected for their location, being the centre of the extensive northwestern European natural zone.

Consequences for agriculture and forestry

The ecological main structure will have consequences mainly for forestry. The consequences can be differentiated into two ways of nature conservation: nature considered as a product of unmanaged natural developments and as a semi-natural landscape. The ecological main structure in Luxembourg mainly consists of forests, beech forests and conifer forests that can develop into rich natural forests. The total area of the ecological main structure is 164,584 ha, of which over 74,000 ha is protected nature area and protected landscape area. These zones are considered to develop in a natural way. Core areas are considered to be the nature reserves in the Nature parks. About fifty per cent of the ecological main structure can be considered as buffer zone and corridor area. In these zones forestry is possible in an adapted way (see Harris 1984) [3].
Because there are no data on large areas of rough grazing, this type of semi-natural habitat can not be separated from other natural areas. However, most intensive farming is in the south, that is no part of the ecological main structure.

[3] L.D. Harris, *The fragmented forest. Island biogeography Theory and the preservation of Biotic diversity*, Univ. of Chicago Press, Chicago-London, 1984.

Figure 9 The Tentative Ecological Main Structure in Luxembourg



Source: CORINE/Agricultural University, Wageningen, 1990

The Netherlands 10

Physical geography

The Netherlands is mainly of Holocene and Pleistocene origin. Older formations only reach the surface at very small areas. However, the country is very differentiated on small scale and over small distances.
The Netherlands is divided by an extensive river delta of the Rhine and the Meuse, that has his apex in the east part of the country. In the south-west the Scheldt river joins this delta. It is characterised by alluvial soils, varying from sandy clay in the east to heavy clay in the west. Here also large areas occur consisting of marine clay. In the central and the northern part of the country this clay area is separated from the Pleistocene soils by lowland peat. One branch of the Rhine, the IJssel extends into the north and forms a small delta before it enters the IJsselmeer, the former Zuiderzee. In the IJsselmeer young clay polders are situated.
The most northern spur of the Ardennes is situated in the most southern part of the country. In the eastern and southern part of the country the rivers dissect a sandy Pleistocene area, that can be characterised as a small scale landscape highly differentiated by small forests, farmland, wooded banks small raised bogs and lowland brook systems. Only one large forested area is left, the Veluwe, dominated by non-productive pine woods, heathlands and recreation settlements. In the north and the south in two former peat areas remnants of raised bogs are found.
To the west and north this sandy Pleistocene area is bordered by extensive lowland peats. Here natural conditions restrict intensification in farming and this region is very open and characterised as a landscape of grasslands and water. In the central river area, the southwestern and northern part of the country fertile clay soils occur and here the landscape is very open. Nearly all the country is surrounded by dunes. In the North and south extensive coastal wetlands are situated.

Important habitats

The natural vegetation of the most southern part of the country is mesotrophic beech forest (*Melico-Fagetum*). It still is found on a few stands and related to that are the dry brome grasslands (*Mesobromion*), that extend far into the north-west along the rivers Meuse and Rhine. Alluvial forests are nearly absent. The alluvial area is important for wintering birds (geese, swans and ducks) and an important area for some grassland birds.
In the Pleistocene area the dominating forest vegetation is beech-oak forest (*Fago-Quercetum*) with some areas of beech-hornbeam forests (*Carpinion*) and several types of beech forests (*Alno-Padion*) on the richer soil types and large birch-oak stands (*Querco-Betuletum*) on the poor sandy soils of the ice pushed hill systems. Former extensive heathlands of heather (*Calluna vulgaris*) and cross-leaved heather (*Erica tetralix*) are disappearing because of high N-deposition.
In the lowland peat areas the vegetation is dominated by eutrophic to mesotrophic permanent grasslands on wet sites changing into reed and marsh vegetation (*Phragmition, Calthion*). These areas are important for grassland birds; several species have their largest population in the Netherlands. However, most are under severe pressure. Water pollution, eutrophication and intensification of farming and management made the otter (*Lutra lutra*) extinct.
The clay areas are mainly in agricultural use; only very small remnants of salt water creeks are left over; the tidal influence has mostly disappeared.

The Dutch coast is characterised by an almost continuous dune landscape, that at places measures several kilometres in width. It is part of large dune areas from Calais onto Skagen. The dune areas are partly undisturbed ecosystems consisting of a high diversity of environments and related vegetation types of barberry scrubs (*Berberidion*), oak forests (*Convallario-Quercetum dunense*), birch forests (*Crataego-Betuletum*) and grasslands. In the north the Dutch coast is characterised by shallows, the Waddenzee, that continues in Germany and onto Denmark. In the south, in front of the former estuaries of Zeeland a new area of shallows is developing.

Human influence on the natural environment

The Netherlands is densely populated and strongly industrialised. Most urbanisation is situated in the west part of the country where the historic towns of Holland are situated in a circle around the lowland peat area. More recent urbanization is found in the south part of the country. Besides, large parts of the Netherlands are in agricultural land use and this is the most intensive agriculture in all the EC. The Dutch landscape is strongly influenced by man. There is nearly no natural habitat left over. Meandering rivers are rare, semi-natural forests are small in area and number and all natural bogs have disappeared. However, there still is nature left, mostly in small areas.
Energy use and use of nutrients is among the highest of the EC. Nitrate and phosphate use in agriculture is the highest in the EC. This has a strong influence on nature by acidification and eutrophication (RIVM-RIZA 1991) [1]. Especially in the Pleistocene area a fast intensification process in farming has taken place leading to severe problems of groundwater pollution. Here NH_3 emission is an important source of pollution and acidification. Falling water tables caused a strong decline in phreatophytic vegetations in the last decades. Over 50 per cent of the groundwater-dependent vegetation is affected (Van Gool et al 1990) [2].
The high population pressure, the intensive land use and the accessibility of the country causes public access on many places. Human influence and disturbance is found nearly everywhere. There are many important bird areas, however, bird populations are often disturbed by agricultural land use and outdoor recreation.
International pollution is caused by transport of nutrients by the rivers Rhine, Meuse and Scheldt. The amount of pollutants in the Rhine is decreasing and the pollution in the Meuse stabilizing (RIVM 1990) [3]. The pollution of the Scheldt however is still alarming (Ovaa 1991) [4].

Protected areas

Protected Areas in the Netherlands have been taken from the CORINE database and checked on the registered data of the nature conservation organisations. In the Netherlands there are three national parks, although they do not conform the IUCN criteria. The largest wetland is the Waddenzee, that is not included in this study, because it is not of actual agricultural importance.
There are several thousands of nature reserves varying from very small (less than one hectare) to several thousands of hectares. Much of the nature area is protected by law or by ownership of nature conservation organisations. State owned and private nature reserves cover several hundred thousands of hectares totally. Nearly all existing nature is under protection; that makes the area of Nature expansion very small.

[1] RIVM/RIZA, *Sustainable Use of Groundwater. Problems and threats in the European Communities*; Bilthoven, Report nr. 600025001, 1991.

[2] C.R. van Gool, C.L.G. Groen, J. Runhaar, A.R. van Amstel, 'Verdroging in Nederland, deel I: inventarisatie van het probleem', *Landschap*, 1990, 7(3):145-163.

[3] RIVM, *Nationale Milieuverkenning 1990-2010*; Alphen aan den Rijn, Samson-Tjeenk Willink, 1991.

[4] E. Ovaa, *Naar een samenhangend beheer van het riviersysteem van de Schelde in het perspectief van duurzame ontwikkeling*; Wageningen, Student Report LU-Wageningen, department of Hydrology and department of Physical Planning, 1991.

In the Netherlands nature conservation originates from the beginning of the twentieth century. The foundation of the *Vereniging tot Behoud van Natuurmonumenten in Nederland* took place in 1905. Although the state did not officially participate in Nature conservation until 1929 the State Forestry cooperated very well with the Vereniging tot Behoud van Natuurmonumenten (Gorter 1986) [5]. Many state nature reserves were designated in this time. Although there was no law on nature conservation and the protection was only an administrative one, it was an effective way of nature protection.
Now the area of protected nature is large, albeit that the number of small reserves is dominating and natural species are still declining. To prevent further decline now a national Nature Policy Plan has been developed aiming at conservation and restoration of nature in a coherent structure (Ministry of Agriculture, Nature Management and Fisheries 1990) [6].

Table 12 **The partition of the Tentative Ecological Main Structure in the Netherlands. The area is given in ha and percentage of the total NUTS-area**

Regions	41	42	45	47
Region Area (ha)	862,028	1,007,209	918,049	709,331
Protected Area				
Nature (ha)	34,886	53,280	81,542	33,774
Nature (%)	4.0	5.3	8.9	4.8
Landscape (ha)	34,415	103,771	62,664	58,060
Landscape (%)	4.0	10.3	6.8	8.2
International (ha)	20,121	33,717	6,506	4,048
International (%)	3.4	2.3	0.7	0.6
Nature Expansion Area				
(ha)	37,298	104,121	63,542	58,680
(%)	4.3	10.3	6.9	8.3
Habitat Connection Area				
(ha)	243,647	303,817	190,161	313,625
(%)	28.3	30.2	20.7	44.2
Not-protected Area				
(ha)	2,883	350	878	620
(%)	0.3	0.0	0.1	0.1
Tentative Ecological Main Structure				
(ha)	315,832	461,218	335,245	406,079
(%)	36.6	45.8	36.5	57.3

The Tentative Ecological Main Structure in the Netherlands

The core of the structure of the Ecological main structure is based on CORINE data, that coincide well with the structure of the Map on the National Ecological main structure in the Nature Policy Plan of the Netherlands (Ministry of Agriculture Nature management and Fisheries 1990) [7]. Most of the nature reserves and the national parks have been included. Landscape protection

[5] H.P. Gorter, *Ruimte voor natuur, 80 jaar bezig voor de natuur van de toekomst*; 's-Graveland, Vereniging tot Behoud van Natuurmonumenten in Nederland, 1986.

[6] Ministry of Agriculture, nature Management and Fisheries, *Nature Policy Plan of the Netherlands*; The Hague, 1990.

[7] Ibid

areas have been used to delineate nature expansion areas, although these are small in area. Outside the protected area most land has been indicated as nature development area because it is situated in purely agricultural land. In these areas restoration of nature is necessary to prevent total isolation of the many small nature reserves. The spatial claim of the Network has been specified in Table 12.
The major natural zone that have been included in the north is a zone consisting of grasslands on peat soil alternating with lakes and connected with a large nature reserve area in the central of the Netherlands (Wieden-Weerribben). On the Pleistocene lowland brook systems have been included in Drente, Twente and in Brabant. The river area along the Waal is indicated as nature development area, because of its position in the National network. Its position is not confirmed yet by large reserves or landscape protection areas but by plans for nature redevelopment (Jongman and Rademakers 1992) [8]. The ice pushed hills of the Veluwe and Utrecht are connected along the river Rhine to combine ecological corridors of Pleistocene and river area. In the western part of the country all dune areas and the central area of the lowland bogs are included in the network. In the south a connection is suggested with the Ardennes in Belgium (Figure 10).

The regions

Nederland noord (41)

Data that have been used are CORINE biotope data on the presence of broadleaved deciduous forests, alluvial and very wet forests, humid, dry calcareous, dry siliceous and grasslands, heath and bogs and marshes. These data have been checked by use of the map of the natural vegetation of Europe (Noirfalise 1987) [9] on which birch forests (*Querco-Betuletum*) and subatlantic beech forests (*Fagetalia*) are the most important vegetation type for the Netherlands. On this map The Netherlands is further differentiated in dunes, marine clay polders, peat areas and fresh water marshes. The soil map is very detailed and offers little information on the scale that is needed. Besides of these the Dutch Nature Policy Plan has been used (Ministry of Agriculture Nature Management and Fisheries 1990) [10].

The structures on the map are based on CORINE data but also agree with the Ecological main structure. Based on the criterion diversity all islands in the Wadden sea have been selected. The islands are important for their vegetation and for migratory birds. As a corridor zone the Frisian lake area and surrounding peaty wet grasslands have been selected onto the Lauwersmeer based on the Dutch Ecological main structure. For its rarity the raised bog of Fochteloo and its surroundings have been included as well as the lowland peat area in the southwest. For its rarity and environmental diversity the brook-system area in Drente with partly still more or less unregulated brooks have been selected.

Nederland oost (42)

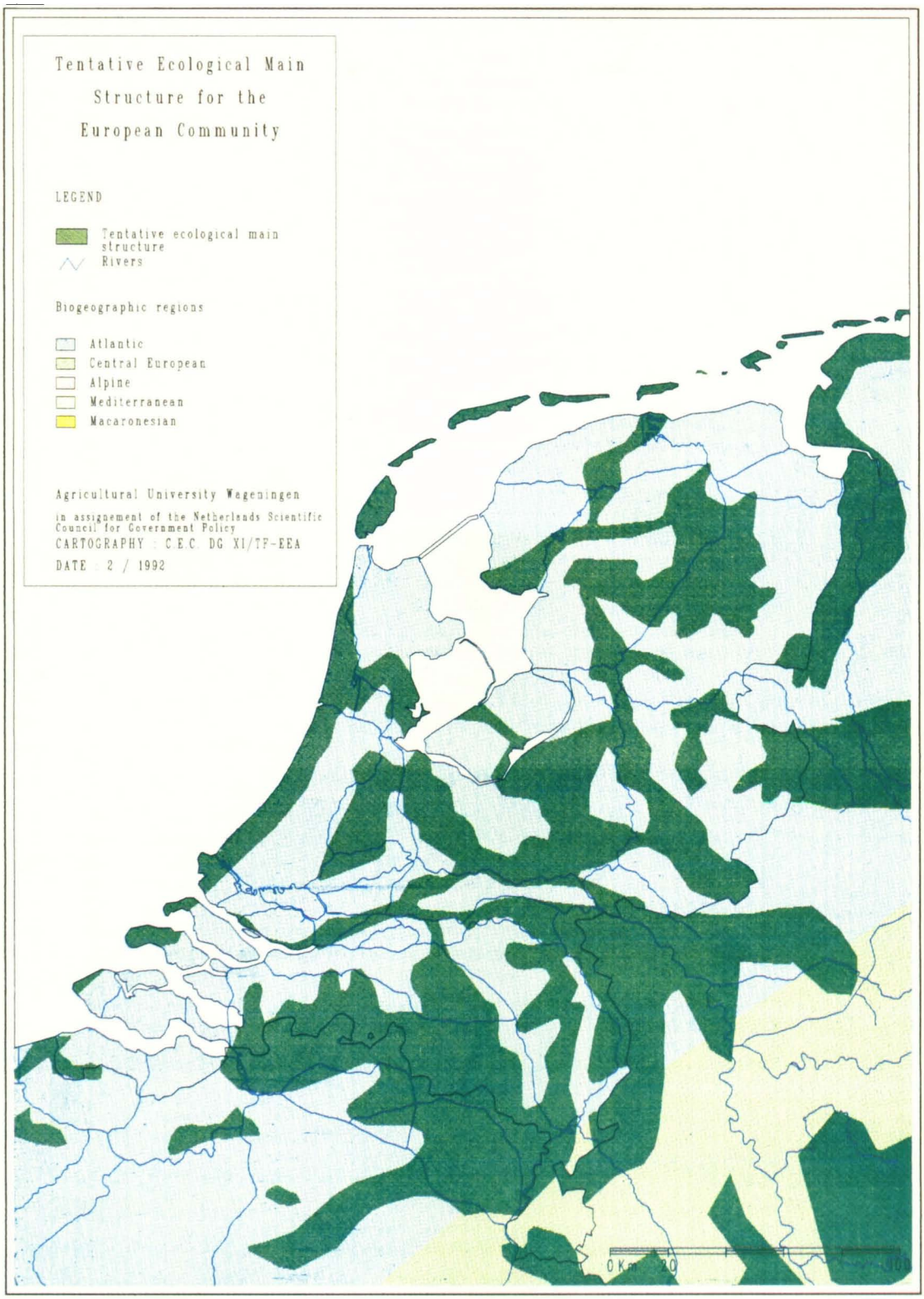
CORINE biotope data have been used on the presence of broadleaved deciduous forests, alluvial and very wet forests, humid, dry calcareous and dry siliceous grasslands, heath bogs and marshes. These data have been checked by use of

[8] R.H.G. Jongman, J.G.M. Rademakers, *Naturentwicklung in den Niederländischen Flußauen, Fortschritte und Erfahrungen*; (in press), 1992.

[9] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

[10] Ministry of Agriculture, Nature Management and Fisheries, op.cit., 1990.

Figure 10 The Tentative Ecological Main Structure in the Netherlands



Source: CORINE/Agricultural University, Wageningen, 1990

the map of the natural vegetation of Europe (Noirfalise 1987) [11] on which birch forests (*Querco-Betuletum*) and subatlantic beech forests (*Fagetalia*) are the most important vegetation type. Small areas of beech-hornbeam forests (*Carpinio-Stellarietum*) are present. Extrazonal units are peat areas and fluvial plains. The soil map is very detailed and offers little information on the scale that is needed. Besides of these the Dutch Nature Policy Plan has been used (Ministry of Agriculture Nature Management and Fisheries 1990) [12].
The structure on the map is based on CORINE data except for the river Waal and more or less in accordance with the Ecological main structure for the Netherlands. The Waal, that is indicated in the Ecological main structure as Nature redevelopment area is not covered by CORINE data. It is totally based on regional information and its position in the Dutch Ecological main structure. It continues from the German border, where it is connected with the German Ramsar site Niederrhein onto the Biesbosch in the west. It is a potential Ramsar site and parts of it appear on the shadow list of important bird areas (Langeveld and Grimmett 1990) [13].
Besides of this structure the brook valleys of Achterhoek and Twente included based on the criterion diversity and location. For the same reason the nature reserves and the National parks of the Veluwe and the Utrechtse heuvelrug have been selected. Because of the comparable structure of both areas a corridor zone is projected through the agricultural area of the Gelderse Vallei.

Nederland zuid (45)

Data that have been used are CORINE biotope data on the presence of broad leaved deciduous forests, alluvial and very wet forests, humid, dry calcareous and dry siliceous grasslands, heath, bogs and marshes. These data have been checked by use of the map of the natural vegetation of Europe (Noirfalise 1987) [14] on which birch forests (*Querco-Betuletum*) and subatlantic beech forest (*Fagetalia*) are the most important vegetation type. Small areas of beech-hornbeam forests (*Carpinio-Stellarietum, Melico-Fagetum* and *Carici-Fagetum*) are present. Extrazonal units are fluvial plains. The soil map is very detailed and offers little information on the scale that is needed. Besides of these the Dutch Nature Policy Plan has been used (Ministry of Agriculture, Nature Management and Fisheries 1990) [15].
The whole area is characterised by relatively high environmental diversity. The structure on the map is based on CORINE data and in accordance with the Ecological main structure for the Netherlands. Included are the most important catchments of Belgium-Dutch lowland brooks. These are in most cases in accordance with the Ecological main structure for Vlaanderen (Kuijken 1990a) [16]. Besides, parts of the terrace of the Meuse has been included, especially the zone with wet forests. South Limburg is included as a whole, because of the relative importance within the Netherlands. In a European context it is part of a larger structure, that continues over the Voerstreek to the Ardennes, the Eiffel and the north of France.

[11] A. Noirfalise, op.cit., 1987.

[12] Ministry of Agriculture, Nature Management and Fisheries, op.cit., 1990.

[13] M.J. Langeveld, R.F.A. Grimmett, *Important Bird Areas in Europe; Wetlands for the shadow list of Ramsar Sites*, Cambridge, ICBP and IWRB, 1990.

[14] A. Noirfalise, op.cit., 1987.

[15] Ministry of Agriculture, Nature Management and Fisheries, op.cit., 1990.

[16] E. Kuijken (ed.), *De Groene hoofdstructuur van Vlaanderen; Richtnota van Theo Kelchtermans*; Brussel, Ministerie van de Vlaamse Gemeenschap, Kabinet voor Leefmilieu, Natuurbehoud en Landinrichting van de Vlaamse Regering, 1990(a).

Nederland west (47)

Data that have been used are CORINE biotope-data on the presence of broad-leaved deciduous forests, alluvial and very wet forests, humid, dry calcareous and dry siliceous grasslands, heath, bogs and marshes. These data have been checked by use of the map of the natural vegetation of Europe (Noirfalise 1987) [17] on which birch forests (*Querco-Betuletum*) and subatlantic beech forests (*Fagetalia*) are the most important vegetation type for the Netherlands. On this map The Netherlands is further differentiated in dunes, marine clay polders, peat areas, fresh water marshes and fluvial plains. The soil map is very detailed and offers little information on the scale that is needed. Besides of these the Dutch Nature Policy Plan has been used (Ministry of Agriculture Nature Management and Fisheries 1990) [18].
Based on the criterion of diversity including nature redevelopment areas have ben selected for ⅔ of the island of Texel, all dune areas and in the fresh water marsh areas. For nature connection and redevelopment areas the 'green heart of Holland' is an important area and has therefore been included. For the same reason wet grassland areas and alluvial and wet forests in the south are connected along the Lek. The structure on the map is largely based on CORINE data, but also coincides more or less with the Ecological main structure of the Nature Policy Plan. Small patches are left out and the structure is more generalised.

Consequences for agriculture and forestry

Most of the Dutch forests have been considered to be part of the Ecological main structure, partly because they are semi-natural deciduous forests and partly because they are conifer forests on characteristic podzolic soils. These last categories are the only large forests, which makes them important for large fauna. In the west part of the Netherlands most forests are intensively used for outdoor recreation. Selection of core areas within them is important.
The main claims on agricultural land is in the west an north part of the country, where a large part of the grassland area has been included. However, low production cattle breeding and diary farming can partly fit into the structure, because of the importance of grasslands for meadow birds.

[17] A. Noirfalise, op.cit., 1987.

[18] Ministry of Agriculture, Nature Management and Fisheries, op.cit., 1990.

Portugal

II

Physical geography

Portugal is situated at the west side of the Iberian Peninsula. Most part is situated on the west side of the Iberian Meseta. Only small parts are actually situated on the Meseta (Trás os Montes). The Portuguese landscape is characterised by mountain ranges that are mainly situated in NNE – SSW direction and in the North part of the country they gradually slope into the younger coastal plain. The old mountains of northern Portugal (Serra do Gerês, Serra do Marão) are partly forested, partly vegetated with south European heath species. The mountains reach from 1000 to 2000 m and are deeply indented by narrow valleys. The Serra de Estrela (highest peak Torre 1991 m) is the continuation of the Spanish Sierra de Guadarrama that divides the Meseta in a south and north part. It consists of two ranges both of Precambrian origin.

Between the Douro and the Tejo the land is divided in a mountain area (Serra de Estrela, Serra da Lapa) and a lowland plain (Beira baixa, Beira litoral, Estremadura). The geological base in the northern part of the country is schist and granite. Beira Litoral mainly consists of pliocene sands and south of Aveiro to Setúbal calcareous soils and limestone formations dominate. In Estremadura several calcareous mountains are found that have strongly been eroded by many small brooks. Famous are the coastal cliffs of Figueira da Foz, Cabo da Roca and Sintra.

Most large rivers in Portugal flow through narrow ravines and valleys. South of the Tejo the Serra de Monchique divides the country in two parts, north the extensive undulating landscape of Alentejo and Ribatejo and south of it the coastal landscape of the Algarve. Alentejo consists of pliocene and miocene sediments and partly of alluvial plains (Tejo - Sado plain). The Algarve consists of a east-west bound coastal mountain range of Carboniferous and origin, an undulating zone (Barrocal) and a coastal zone.

The climate of Portugal is characterised by a gradient from Atlantic climate in the North to Mediterranean climate in the South (Polunin and Smythies 1973) [1]. Mild winters and warm dry summers are typical for the mediterranean climate. In the North the influences of the colder Atlantic climate are expressed in temperature and precipitation. Trás-os-Montes and Beira Interior are characterised by the colder more continental climate of the Meseta. The Atlantic climate influences all the coastal ecosystems from north to south. In the north the differences between the climate of Porto and Bragan'a are great. Mean yearly temperature is 14.4°C and 11.6°C respectively, while the mean lowest temperatures for Bragança indicate the possibility of severe frost from December onto February. Precipitation is higher in Porto (1153 mm yearly) than in Bragança (973 mm yearly). In the Serra do Gerês and the Serra de Estrela yearly precipitation reaches easily values over 2000 mm (Walter and Lieth 1964 [2], Rikli 1946) [3].

The Alentejo is characterised by an Atlantic-Mediterranean climate along the coast and a dry mediterranean climate in the inner parts. Famous for their Atlantic-Mediterranean climate are Guincho, Cabo da Roca, Cabo Espichel and Cabo de São Vicente. Climatic and geological characteristics are expressed in the floristic richness of these capes. In the Alentejo four dry months occur in summer and precipitation is low. Campo major has a yearly mean temperature of 16.5°C and a mean July temperature of 25.1°C while the

[1] O. Polunin, B.E. Smythies, *Flowers of South-West Europe; A field guide*; London, Oxford University Press, 1973.

[2] H. Walter and H. Lieth, *Klimadiagramm Weltatlas*; Jena, VEB Gustaf Fischer Verlag, 1960-1964.

[3] M. Rikli, *Das Planzenkleid der Mittelmerländer, Part. I, II, III*; Bern, Haus Hübner Verlag, 1942-1946.

yearly precipitation reaches only 520 mm (Müller 1987) [4].
The Algarve also has a low mean yearly precipitation (Praia da Rocha: 414 mm) and a high mean yearly temperature (16.6°C), but the mean July temperature is 22.8°C caused by the exposition to the south and the Atlantic Ocean that damp climatic fluctuations strongly.

Important habitats

Portugal is characterized by three biogeographical zones, the Atlantic domain the Mediterranean region and the Macaronesian region. The vegetation is an expression of this climatic gradient from north to south (Rivas Martinéz) [5].
In the northern part of the country southern Atlantic heathlands dominate. The natural vegetation of the forests in northern Portugal belongs to the south-western Atlantic oak forest (Quercion occidentale) of which different associations can be defined according to altitude (Braun-Blanquet et al 1956) [6].
In general these Atlantic forests are rich in Mediterranean species, hemicryptophytes and lichenes. Dominating tree species are Pyrenean oak (*Quercus pyrenaica*) and pedunculate oak (*Quercus robur*). Dispersed forests of Pyrenean oak (*Quercus pyrenaica*) and pedunculate oak (*Quercus robur*) occur with heath undergrowth and an abundant lichene vegetation.
Especially the Portuguese heathlands are rich of Atlantic species like cross-leaved heather (*Erica tetralix*), Lusitanian heath (*Erica lusitanica*), bell heather (*Erica cinerea*), Cornish heather (*Erica vagans*) and gorse (*Ulex europaeus*). Also species of the Hiberno-Iberian disjunction like St Dabeoc's heath (*Daboecia cantabrica*) and strawberry tree (*Arbutus unedo*) are found here. The heath vegetations can be divided in several associations depending on differences in climate and altitude varying from strict Atlantic in the north to more or less continental in the highest parts of de Serra de Estrela (Braun-Blanquet et al 1964) [7].
In Beira baixo the boundary between the Atlantic domain and the Mediterranean region is rather sharp and can be recognised in the forest of Bu'aco near Coimbra. The coastal plain between Coimbra and Lisboa is the main centre of the west-Mediterranean forests of cork oak and Lusitanean oak (Quercion fagineo-suberis) of which characteristic species are among others Lusitanean oak or carvalho Português (*Quercus faginea*), Spanish bluebell (*Hyacinthoides hyspanica*) and some peony species (*Paeonia broteri, P. coriacea*). According to Rivas-Martínez (1974) [8] an important part of the vegetation of southern Portugal consist of the natural cork oak forest, that is found mainly in Alentejo (*Sanguisorbo-Quercetum suberis* or *Quercion suberis* according to Noirfalise 1987) [9].
The third important element of the portuguese nature is the presence of Macaronesian flora and fauna mainly on the islands of Madeira (and Desertas and Porto Santo) and the Açores, but elements of it are also found on the coastal areas of the continent. The Macaronesian flora and fauna partly originates

[4] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

[5] S. Rivas Martinéz, 'Avance sobre una Sintesis corologica de la Peninsula Ibérica'; *Anales del Instituto Biologico A.J. Cavanilles*, Tomo XXX, 1973, pp. 69-87.

[6] J. Braun-Blanquet, A.R. Pinto da Silva and A. Rozeira, 'Résultats de deux excursions geobotaniques à travers le Portugal septentrionel II'; *Agronomia Lusitana*, 1956, 18(3):167-236.

[7] J. Braun-Blanquet, A.R. Pinto da Silva and A. Rozeira, 'Résultats de trois excursions geobotaniques à travers le Portugal septentrionel'; *Agronomia Lusitana*, 1964, 18(4):229-313.

[8] S. Rivas Martinéz, 'Observaciones sobre la sintaxonomia de las bosques acidofilos Europeos, Datos sobre la Quercetalia robori petraeae en la peninsula iberica'; *Colloques Phytosociologiques III*, 1974(a), pp. 225-260.
S. Rivas Martinéz, 'La vegetación de la clase Quercetea ilicis en España y Portugal'; *Anales del Instituto Biologico A.J. Cavanilles*, Tomo XXXI, 1974(b), pp. 205-259.

[9] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

from the Tertiary and is characterised by several endemic species. The endemic flora of Macaronesia comprise about 685 species out of 3200 species (21%). Species characteristic for this flora are among others *Pinus canariensis, Adianthum reniforme, Davallia canariensis, Persea indica, Myrica faya, Smilax canariensis, Laurus azorica, Dracaena draco, Daboecia azorica* and *Spergularia azorica* (Humphries 1979) [10].

The degradation phase of the natural forests are widespread in the Mediterranean. These are low, sclerophyllous ligneous formations referred to as maquis (Rikli 1942): [11]

1. Maquis of mastic tree-buckthorn vegetations (*Pistacio-Rhamnetalia*) with mastic tree (*Pistacia lentiscus*), olive (*Olea sylvestris*), strawberry tree (*Arbutus unedo*), tree heath (*Erica arborea*) and narrow-leaved cistus (*Cistus monspeliensis*). In Portugal this vegetation shows the gradient from Mediterranean to Atlantic vegetation.
2. The garrigues (carrascal) on calcareous soils (*Ononido-Rosmarinetalia*) with kermes oak (*Quercus coccifera*), rosemary (*Rosmarinus officinalis*), prickly juniper (*Juniperus oxycedrus*) and on siliceous soils with heaths of the *Cisto-Lavanduletalia* with green heather (*Erica scoparia*), *Erica multiflora*, various cistus species and french lavender (*Lavandula stoechas*).
3. Grasslands rich in annual species (*Thero-Brachypodietalia*).

Protected areas

The protected areas in Portugal can be divided in three types:

- The National Park (Gerês) in the north of Portugal and Serra da Arrábida south of Lisboa;
- The natural parks in various parts of Portugal (Montesinho, Alvão, Serra da Estrela, Serra d'Aire e Candeeiros, Ria Formosa, Serra de S. Mamede);
- The 35 reservas naturais and Landscape Protected Areas widespread in Portugal.

The natural parks have been included in the category of protected landscape areas. The other two types are included in the map of nature protection areas.

The Tentative Ecological Main Structure in Portugal

In the network in Portugal emphasis has been laid on the three floristic elements as well as on the gradients between Atlantic and Mediterranean biogeographical zones. Large areas have been included of the important Atlantic heath zone and of the mediterranean cork oak forests (*Sanguisorbo-Quercetum suberis*). The importance of the small Macaronesian region and the lack of data on the Portuguese islands caused the inclusion of most of this region into the Network. Besides of these non-regulated rivers and all important inland wetlands have been included (Figure 11). The islands Madeira and Açores are included in the network for their total area.

The regions

During the design process of the Tentative Ecological Main Structure of Europe the coding of Portugal has been changed. In this study the old codes have been used The names of the regions accord as follows to the new coding:
Norte: C11, C12
Sur: C13, C14, C15
Ilhas: C2, C3.
The information based on the Corine Biotope data set was useful and seemed to

[10] C.J. Humphries, *Endemism and Evolution in Macaronesia*; in: Bramwell (ed.), *Plants and Islands*, London, Academic Press, 1979, pp. 171-199.

[11] M. Rikli, op.cit., 1942.

be reliable. It was confirmed by checks from literature sources, that resulted in about the same conclusions. Expert comments resulted in important but small approvement. The spatial claim of the Tentative Ecological Main Structure has been specified in Table 13.

Portugal Norte

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, heaths, scrubs and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [12] and the map of Natural Vegetation of Europe (Noirfalise 1987) [13] and the soil map of Europe have been used to trace and delineate the dominating biotopes and potential threatened sites. Extra information is received from literature and maps of protected areas of the Serviço Nacional de Parques Reservas e Conservação da Natureza.
Dunes have been included as much as possible. The Ria de Aveiro is an important area for migrating birds and has been included for that reason. The corridor zone has been expanded along the natural rivers Rio Minho and Rio Lima, that also have important estuaries for birds. These rivers are considered to be important corridors between the high mountains of Peneda-Gerês and the Atlantic ocean. The Rio Minho is included in the map from source (Spain) to its mouth. Stepping stones are situated along the Tejo and the Douro.

Table 13 **The partition of the Tentative Ecological Main Structure in Portugal. The area is given in ha and percentage of the total NUTS-area**

Regions	Norte	Sur	Ilhas
	C11, C12	C13, C14, C15	C2, C3
Region Area (ha)	4,527,952	4,352,383	320,321
Protected Area			
Nature (ha)	96,783	88,869	13,326
Nature (%)	2.1	2.0	4.2
Landscape (ha)	246,526	61,635	13,766
Landscape (%)	5.4	1.4	4.3
International (ha)	30,350	82,015	0
International (%)	0.7	1.9	0.0
Nature Expansion Area			
(ha)	582,894	491,782	39,301
(%)	12.9	11.3	12.3
Habitat Connection Area			
(ha)	977,378	783,178	267,694
(%)	21.6	18.0	83.6
Not-protected Area			
(ha)	336,367	430,146	25,535
(%)	7.4	9.9	8.0
Tentative Ecological Main Structure			
(ha)	1,657,056	1,363,829	320,321
(%)	36.6	31.3	100.0

[12] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.
[13] A. Noirfalise, op.cit., 1987.

All Parques Natural have been included as nature expansion areas. Peneda-Geres has been included as a protected area. Nature development areas have been designed onto the Parque natural de Montesinho. The soil map has been used to add Ranker soils. This area is the centre of the south European heathlands in combination with northwestern Spain. Grazing and burning is an essential part of its management.
The natural parks in the mountain ranges (Alvão, Montemuro, Estrela) have been expanded based on CORINE biotope data, available regional data and the soil map because of their importance for south Atlantic heath vegetations. The Serra da Estrela has been connected with the promontorium of Buçaco near Luso in the west and in the east with the Serra de Malcata, that is the core of the nature areas in central Portugal along the Spanish border. Together with the central Sierras in Spain this is one of the major natural zones in the Iberian peninsula and of major nature conservation interest.

The forest of Buçaco is one of the most northern sites in a series of Lusitanian oak-cork oak forests (*Quercion fagineo-suberis*) that characterise the calcareous coastal plains of Portugal. These forests have their main area in the Portugal and are found besides in the coastal plains in the north in the 'Terra quente Trasmontana' the warm soils over the mountains. The series of forests continues into the NUTS region Portugal Sur. Based on expert information this series is expanded with the Serra de Aire e Candeeiros.

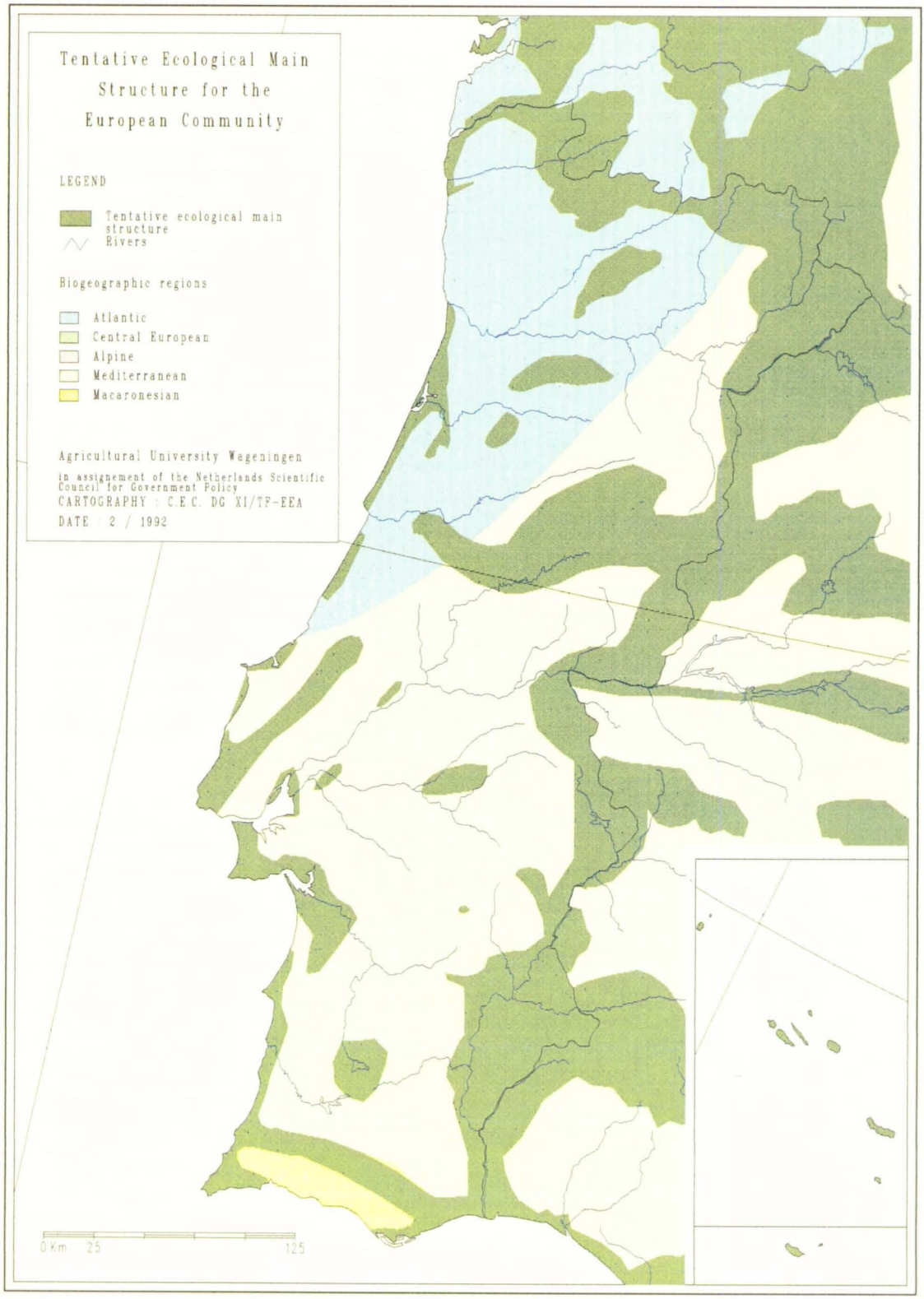
Portugal Sur

Data that have been used are CORINE biotope data on grasslands of siliceous and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, scrubs and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [14] and the map of Natural Vegetation of Europe (Noirfalise 1987) [15] and the soil map of Europe have been used to trace and delineate the dominating biotopes and potential threatened sites. Extra information is received from literature and maps of protected areas of the Serviço Nacional de Parques Reservas e Conservação da Natureza.
Between Coimbra and Lisboa important forests of Lusitanean oak (*Quercus faginea*) are situated from Buçaco in Portugal Norte onto Sintra and its surroundings. Based on expert information this series has been expanded with the Serra de Aire e Candeeiros.
The estuary of the Tejo is partly protected as a Ramsar site for its importance for migrating birds. Besides, there are alluvial forests that can be considered as important natural remnants in a regulated river. Also the estuary of the Sado has been included because of its importance for migrating birds.
The coast north of Lisboa is an important cape with endemic species showing gradients to dune areas and forests of Quercus faginea. Here protection of habitats is of utmost importance. The Serra de Caldeirão and the Serra de Monchique have been connected with the nature areas along the Guadiana. These are the most southern regions of the natural cork oak forests (*Sanguisorbo-Quercetum suberis*) and the olive-carob forests (*Oleo-Ceratonion*). Other nature expansion and nature corridor zones have been designed in the Serra de Grandola situated in area of the potential natural vegetation of the cork oak forests (*Sanguisorbo-Quercetum suberis*). This makes these areas important in the European ecological main structure. However, they are still isolated.
South of Lisboa the important national park of Serra da Arrábida is situated near Setúbal, characterised by among others Macaronesian flora, an important reason for inclusion. Also from Sines in the north to Sagres in the south the

[14] R.F.A. Grimmett and T.A. Jones, op.cit., 1089.

[15] A. Noirfalise, op.cit., 1989.

Figure 11 The Tentative Ecological Main Structure in Portugal (Continente and Ilhas)



Source: CORINE/Agricultural University, Wageningen, 1990

coast is rocky containing Macaronesian flora elements. The southern coast is an indented cliff coast with small sand beaches, salt marshes, garrigues and maquis. This diversity in biotopes and species is an important reason to include the coastal areas. The largest area of shallows is the Ria formosa near Faro. The salt marshes continue onto the Guadiana river.
Along the Guadiana a coherent structure can be designed consisting of a great diversity of biotopes and including all important nature areas that are situated here. This structure is continued into Spain along the river. It is the main structure from the Spanish Extramadura, the Sierra Morena and the Montes de Toledo towards the Atlantic coast. The Guadiana basin is very important due to its partly ichtyological fauna (mainly *Cyprinidae*). Threatened and endemic species are found here, that this river shares with the Guadalquivir. Besides it is one of the major habitats of the black stork (*Ciconia nigra*) and other threatened avifauna species.

Portugal Ilhas

Data that have been used are CORINE biotope data on grasslands on silicate soils and calcareous soils, broadleaved evergreen forests, broadleaved deciduous forests, scrubs and native coniferous forests. Data on important bird areas (Grimmett and Jones 1989) [16] and the map of Natural Vegetation of Europe (Noirfalise 1987) [17] and the soil map of Europe have been used to trace the dominating biotopes and potential threatened sites. Extra information is received from literature and maps of protected areas of the Serviço Nacional de Parques Reservas e Conservação da Natureza.
Only few data were available for the islands. Besides the area of the Portuguese islands is rather small in a European context. Because of the ecological importance and of Macaronesia and the vulnerability of island flora's in general all the islands have been included as a whole.

Consequences for agriculture and forestry

Large parts of the ecological main structure in Portugal consists of semi-natural vegetation. Large areas of these semi-natural vegetation are still in agricultural use for grazing or to be used in stables. This are natural grasslands, heaths and garigues. Continuation of this management is important to maintain biodiversity. Termination of traditional agriculture would cause a strong decline of species richness. Conifer and eucalyptus plantations do not fit into the network except for low production forests of maritime pine (*Pinus pinaster*) that can fit into the buffer zones and corridor zones.
On the islands small scale traditional agriculture can easily fit into the buffer zones and corridor zones. Also here grazing is an important way of management to maintain biodiversity.

[16] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[17] A. Noirfalise, op.cit., 1987.

United Kingdom 12

Physical Geography

The United Kingdom is situated in the Atlantic biogeographic region and consists of England, Wales, Scotland and Northern Ireland. Just off the southern coast of England the Isle of Wight and the Isles of Scilly are situated; off North Wales is Anglesey. Western Scotland is fringed by numerous islands and to the far north the important groups are the Orkneys and Shetlands (Whittow 1977) [1]. The Channel Islands and the Isle of Man are no part of the EC.
The basic geological material of the British Isles is from all main geological periods. In Great Britain the newer rocks which are less resistant to weather, and have thus been worn down to form lowland, they lie to the south and east and the British mainland can therefore be divided roughly into two main regions: Lowland Britain and Highland Britain.
In the British lowland the soft rocks of southern and eastern England have been eroded into a rich plain and calcareous and limestone hills, hardly reaching a thousand feet above sea level. The boundaries of this region run roughly from the mouth of the Tyne in the north-east of England to the mouth of the Exe in the south-west. With the exception of a few patches of poor soil or rocky land, almost the whole of the British lowland has been cultivated and farmland covers the area except for areas of urban and industrial settlements.
The coastal areas of the British lowlands differ very. Famous are the cliffs of white limestone and chalk, as the famous white cliffs of Dover, while other parts of the south and south-east coastline have beaches of sand or shingle.
The eastern coast of England between the Humber and the Thames estuary is for the most part low-lying and for hundred of years some stretches of it have been protected against the sea by embankments. Also shallows occur in this area.
Highland Britain contains all the mountainous parts of Great Britain and extensive uplands lying above 300 m. It comprises the whole of Scotland, the Lake District in north-west England, the broad central upland known as the Pennines, almost the whole of Wales and the south-western peninsula of England coinciding approximately with the counties of Devon and Cornwall.
The highest peaks are Ben Nevis (Scotland, 1470 m), Snowdon (Wales, 1187 m), Scafell Pike (England, 1070 m), Slieve Donard (Northern Ireland, 930 m).
The highlands are interspersed with valleys and plains. Geologically the mountains and hills consist mainly of outcrops of very old rocks, while the top strata in the valleys and plains are mainly more recent and similar to those in the northern and western parts of Lowland Britain.
Many parts of Highland Britain have only thin, poor soils and consist of large blanket bogs. On several places the old rock formations of Highland Britain reach the coast and form high cliffs; elsewhere the sea may penetrate in deep lochs as on many sites on the west coast of Scotland. Bold outstanding headlands are notable features in other parts of the varied coastline like the granite cliffs of Land's End, the limestone masses and slates of the Pembrokeshire coast in South Wales, the red sandstone of St Bees Head on the Cumberland coast, the vertically jointed lavas of Skye and the island of Staffa in the Inner Hebrides.
Britain has a temperate and rather uniform climate. It lies in middle latitudes on the northwestern fringe of the greater continental land mass of Eurasia, but as prevailing winds are south-westerly the climate is largely determined by that of the eastern Atlantic. Occasionally during the winter months easterly winds may bring a cold, dry, continental type of weather which, once established, may persist for many days or even weeks. In the summer the Azores

[1] J.B. Whittow, *Geology and scenery in Scotland*; Harmondsworth Middlesex England, Pelican Books, 1977.

high pressure system usually extents its influence north-eastward towards north-west Europe, and the depressions take a more northerly course, often passing entirely to the north of the British Isles.
The mean annual rainfall of the British Isles is over 1000 mm, while England has about 860 mm. The geographical distribution of annual rainfall is largely governed by topography and exposure to the Atlantic, the mountainous areas of the west and north having far more rain than the plains of the south and east. While Cambridge in the east of England has a mean yearly precipitation of 558 mm, Aberstywith on the western coast of Wales has 1051 mm. In Scotland differences are more extreme: Rattray head on the east coast has a mean yearly precipitation of 387 mm, while Achnashellach on the west coast has 2058 mm (Müller 1987) [2].

Important Habitats

Although the major part of Britain's vegetation is Atlantic, there are also mediterranean elements in the southwestern part characterised by the flora of the Hiberno-Iberian disjunction. In the north an in the mountains boreal species occur an the differences in soils complete Britain's floristic diversity. Very few really natural habitats exist in Britain. Nevertheless there are natural or semi-natural biological features of outstanding nature conservation interest. For example, the wetlands hold huge numbers of waterfowl in winter, humid deciduous woodlands in the west have a rich bryophyte flora; the wide range and extent of heathlands include types which are restricted to the UK or the UK and Ireland; extensive blanket bogs exist in northern Scotland and the unique machair habitats are found on some western Scottish coasts.
The important habitats of the UK are found especially in semi-natural landscapes, influenced by a traditional agricultural land use. In Lowland Britain the following biotopes can be seen as important habitats:

- herb-rich hay meadows of which only 3 per cent is not affected by agricultural intensification (Van Dijk 1991) [3];
- calcareous grasslands on chalk and Jurassic limestone of which 80 per cent is lost, largely by conversion to arable or improved grassland;
- heaths on acid soils, of which 40 per cent is lost, largely by conversion to arable or improved grassland, afforestation and building (Webb 1986) [4];
- old growth forests composed of native broadleaved trees of which 30 per cent – 50 per cent has disappeared by conversion to conifer plantation or to farmland;
- fens, valley and basin mires of which 50 per cent is lost through drainage operations, reclamation for agriculture and chemical enrichment of drainage water;
- raised mires, of which 60 per cent is lost through afforestation, peat-winning, reclamation for agriculture;
- hedgerows, that declined in number and in species composition (Barr et all 1991 [5], NERC 1990) [6].

In Highland Britain the important habitats consist of rough grazings, heaths but especially blanket bogs. Important habitats can also be found along the coast. Intertidal flats and saltings, shingle beaches, sand dunes, wetlands and marshes can be mentioned as important habitats of the coast. The coastal habitats are usually not included in the project, because of they are not of agricultural interest.

[2] M.J. Müller, *Handbuch ausgewählter Klimastationen der Erde*; Trier, Richter, 1987.

[3] G. van Dijk, 'Half-natuurlijke graslanden in Europa verdwijnen'; *Natuur en Milieu*, 1991, (9):8-13.

[4] N.R. Webb, *Heathlands*; London, Collins, 1986.

[5] C. Barr, D. Howard, B. Bunce, M. Gillespie, C. Hallam, *Chonges in hedgerows in Britain between 1984 and 1990*; Merlewood Research Station, Grange over Sands, Institute of Terrestrial Ecology, 1991.

[6] Natural Environmental Research Council, *Report of the Institute of Terrestrial Ecology 1989/1990*; 1990.

Human influence on the natural Environment

Based on its geologic history and with its mild climate and variation in soils, Britain has a divers pattern of natural vegetation. When the islands were first settled, oak forest probably covered the greater part of the lowland, giving place to extensive marshlands, forests of Scotch pine on higher or sandy soils and large open moorlands. In the course of the centuries the forest area has progressively been diminished. In spite of planting by estate owners in the eighteenth and nineteenth century and the establishment of large forests by the Forestry Commission in the past seventy years woodland now occupy only about 10 per cent of the country. Present afforestation affects more and more the wildlife communities of moorlands and bogs which are predominantly adapted to open habitats.

Over 80 per cent of Britain is agricultural use of which about a third is arable land and the rest pastures and meadows. In the lowland intensive agricultural practices have a major impact on wildlife. Wildlife on agricultural land tends to reflect both traditional agricultural practices of the area and its recent developments. In the lowlands, where most of the land is under crops, the wildlife is quite different from what has been there 40 years ago. Studies of the NERC (1988) [7] have shown that 95 per cent of the native flora in such areas occurs along road side verges, along streams and hedgerows, that cover less than 10 per cent of the lowland area. Between 1984 and 1990 over 20 per cent of the hedgerows have changed in structure. Nearly 10 per cent of all hedgerows has been removed (Barr et all 1991) [8]. In the other hedgerows and linear features species diversity is declining (NERC 1990) [9]. The main causes are improvements in land drainage, changes in the management of verges and hedgerows, the use of weed-killers and the replacement of animal power by mechanical farming, which has reduced reliance on permanent pastures and high-quality hay.

The uplands are less intensively managed, so more of the vegetation is semi-natural and this reflects natural communities more closely. Examples are unimproved grasslands and heather moor. Here wildlife is threatened by changes in or the lack of traditional management practices. Afforestation, hill land improvement and over-grazing are the most threatening human activities. Another threat to the mountain areas is the increasing access and in this way the increasing pressure of outdoor recreation. Still changes are smaller here than in the lowlands an mainly towards forestry (NERC 1990) [10].

The Tentative Ecological Main Structure in the United Kingdom

Loss and fragmentation of habitats have put a number of wildlife populations at risk. Species currently classed as 'endangered' or 'vulnerable' in the UK include 33 per cent of reptiles and amphibians, 24 per cent of terrestrial mammals and 8 per cent of the macrophytes. Nearly one-third of the British birds are subject of significant concern for the future of their populations, for reasons other than extreme rarity.

The nature conservation organisation in the UK is one of the oldest and strongest non-governmental conservation movements in Europe. The decline of nature has led to a new strategy for nature conservation. The Nature Conservation Council has formulated this strategy in a broad framework for the nature conservation to meet the primary objective of nature conservation up to the year 2000. This framework consists of ten themes. Three of these themes can be seen as the first steps into the direction of an ecological main structure:

[7] Natural Environmental Research Council, *Report of the Institute of Terrestrial Ecology 1987/1988*; 1988.

[8] C. Barr et all, op.cit., 1991.

[9] NERC, op.cit., 1990.

[10] ibid

In theme 1 (site of special importance to nature conservation) the conclusion has been formulated, that at least 10 per cent of the area of Britain must be protected for nature conservation if the current criteria will be applied consistently on ecological and conservation principles.
Theme 2 (conservation of nature in the wider environment) is directed to the nature conservation outside the protected areas. The recognition that the wider environment collectively represents a larger part of the total national resource of nature than the protected areas do, is the basis for this theme. Nature conservation has to develop as a land use activity, valid in its own right which requires to be integrated with other activities such a farming, forestry, amenity and recreational use.
Theme 8 (creative conservation) is directed to enlarge the resource of nature by recreating habitats and communities or reintroducing species which have been lost.
The connection of the different nature areas has not yet been a real issue in the nature conservation strategy, but there are reasons to believe, that the concept of an ecological main structure will be get entrance in the nature conservation of the UK. Great Britain is not separated from the rest of Europe because it is an island. There are many ecological relations like bird migration, vegetation gradients and floristic relations.
The ecological main structure in the United Kingdom consists of upland areas (Pennines, Snowdonia, Lake District, Scottish Highlands etc.), lowland areas and coastal areas. Along some rivers habitat connection areas have been designed for (re)habilitation of nature (Figure 12).

The regions

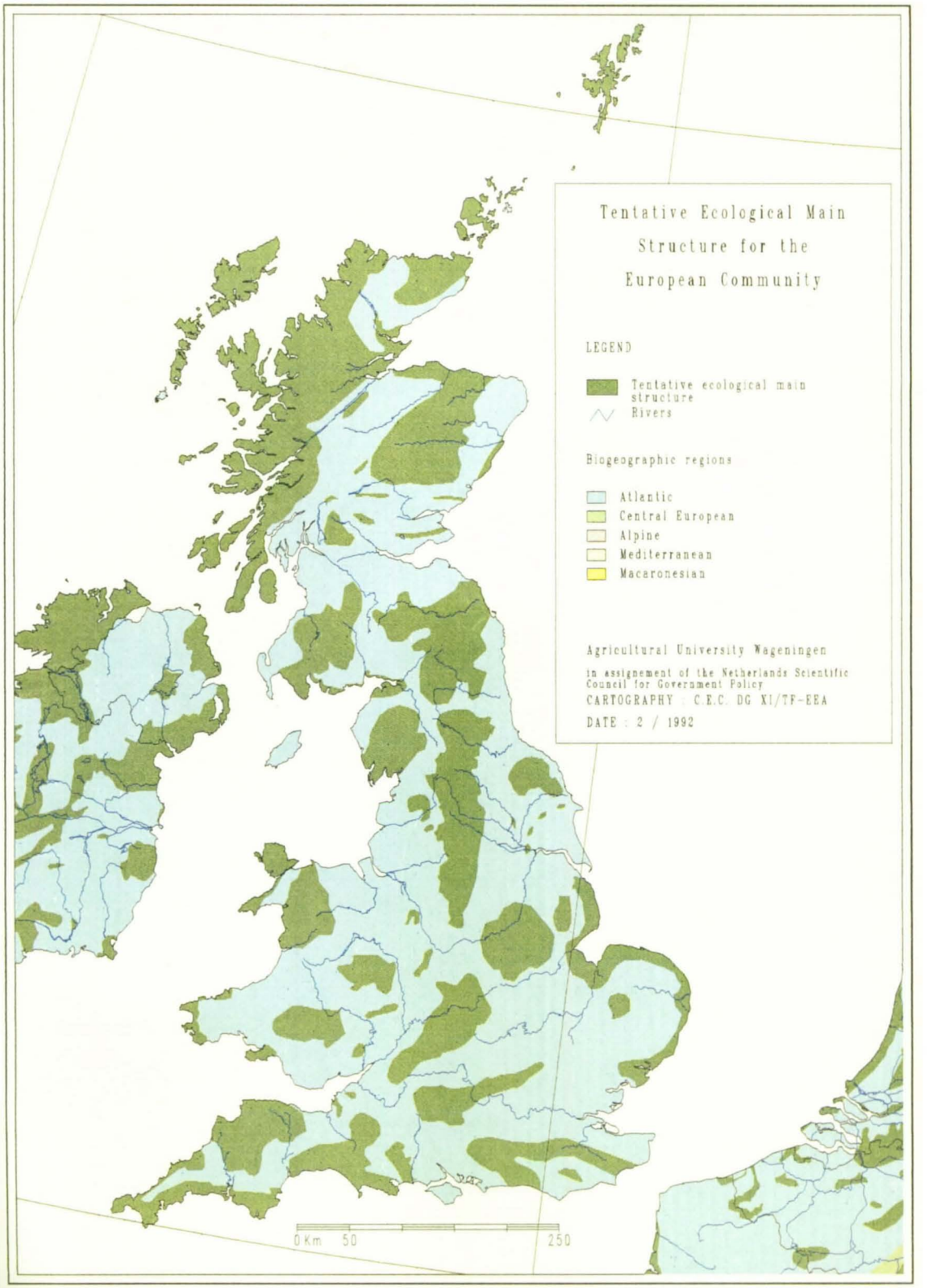
The United Kingdom is divided into 12 NUTS-regions. In Table 14 the spatial claim of the different parts of the ecological main structure has been specified.
The European ecological main structure in Wales and England has not been designed according to the procedure, described in the main report. The CORINE data of habitats were not yet completed. Consequently a selection of nature expansion areas were not possible. The procedure followed in the United Kingdom, is mainly based on national information concerning National Parks (landscape protection areas), areas of outstanding natural beauty, nature reserves and Sites of Special Scientific Interest (SSSI). Besides information concerning important bird areas has been used. The Nature expansion areas are all areas that are protected at this moment for landscape conservation. Most of the CORINE Biotope Sites that have been included in the CORINE database are situated in these areas.

North (71)

The NUTS-region North shares the borders with Scotland in the north and Yorkshire-Humberside and North West in the south. In the west and east the region is bordered by the coastlines of the Irish Sea and the North Sea respectively. The Tentative Ecological Main Structure in this region is based on national information on protected areas and the European map of the natural vegetation (Noirfalise 1987) [11]. This map has been used to compare with the protected areas and vegetation units have been used as outer boundaries for expansion.
The ecological main structure consists of four parts: the Lake District, North Pennines, Northumberland with coastal areas and the Solway coast. Below these three areas are described.

[11] A. Noirfalise, *Map of the natural vegetation of the member countries of the European Community and the Council of Europe, Scale 1:3.000.000*; Second Edition, Strassbourg, Luxembourg, Council of Europe, Commission of the European Communities, 1987.

Figure 12 The Tentative Ecological Main Structure in the United Kingdom



Source: CORINE/Agricultural University, Wageningen, 1990

Table 14 The partition of the Tentative Ecological Main Structure in the United Kingdom
The area is given in ha and percentage coverage of the total NUTS-region

Regions	71	72	73	74	75	76	77	78	79	7A	7B
Region Area (ha)	1,561,828	1,528,225	1,569,647	1,257,685	2,768,374	2,374,754	1,298,764	728,849	2,050,748	7,799,488	1,410,684
Protected Area											
Nature (ha)	74,133	24,254	6,733	82,006	99,764	28,845	0	29,734	245,436	260,875	70,534
Nature (%)	4.8	1.6	0.4	6.5	3.6	1.2	0	4.1	12.0	3.3	5.0
Landscape (ha)	550,800	339,834	56,000	176,100	763,000	669,900	188,100	231,200	496,350	1,017,300	280,726
Landscape (%)	35.3	22.2	3.6	14.0	27.6	28.2	14.5	31.7	24.2	13.0	19.9
International (ha)	28,296	300	0	79,103	39,849	3,743	0	27,931	6,899	73,160	39,500
International (%)	1.8	0.0	0.0	6.3	1.4	0.2	0	3.8	0.3	0.9	2.8
Nature Expansion Area											
(ha)	559,996	366,897	70,803	221,874	584,841	675,747	188,100	12,427	437,280	1,017,300	28,977
(%)	35.9	24.0	4.5	17.5	21.1	28.5	14.5	1.7	21.3	13.0	21.9
Habitat Connection Area											
(ha)	233,597	215,969	659,262	0	0	566,686	182,260	0	0	3,202,717	468,105
(%)	15.0	14.1	42.0	0	0	23.9	14.0	0	0	41.1	8.4
Not-protected Area											
(ha)	9,196	27,063	14,803	167,244	21,404	5,847	0	0	27,433	0	27,117
(%)	0.6	1.8	0.9	13.3	0.8	0.3	0	0	1.3	0	1.9
Tentative Ecological Main Structure											
(ha)	867,726	607,120	736,797	303,880	684,606	1,271,278	370,360	42,161	682,716	4,480,892	497,205
(%)	55.6	39.7	46.9	24.2	24.7	53.5	28.5	5.8	33.3	57.5	35.3

The Lake District is protected as National Park, however the status is not more than a protected landscape (category V of the UN-list of protected areas). The whole area has been included into the ecological main structure as nature expansion area. The Lake District consists of moorland, fells and sixteen larger lakes arranged like the spokes of a wheel in the mountain valleys. Broadleaved deciduous woodlands with pedunculate oak (*Quercus robur*), ash (*Fraxinus excelsior*), birch (*Betula pendula*), wych elm (*Ulmus glabra*), lime (*Tilia cordata*), and yew tree (*Taxus baccata*), calcareous grasslands, montane-alpine grasslands, heathlands and riverine forests along the numerous streams form the most important habitats besides the moorlands and bogs. The coastal area in the south of the Lake District is an extensive intertidal tract of sand, saltmarshes, coastal dunes an a large coastal lagoon (Hodbarrow Lagoon).
The area of Outstanding natural beauty, the Northern Pennines is a managed moorland with underlying peat. On the high parts of the Pennine the characteristic habitats are upland moorland, blanket bogs, meadows and forests.
At the border with Scotland the National Park North-Humberland is situated (cat. V in UN-list). The hills are covered with grass moorland and are partly of granite and andesite. The Somonside hills, consisting of sandstone, are covered by heathland and partly by broadleaved deciduous woodland. The valleys are cultivated land. A connection zone has been designed between the National park and the North-Humberland coast, an area of outstanding natural beauty.
On the North-Humberland coast the thrusting black basalt of the Whin Sill meets the sea in low headlands and rocky haves. This area is important for wintering birds. The islands near the coast, Lindisfarne, Farne islands, Coquet have a rocky coast with cliffs, beaches and are separated from the mainland by mudflats and saltwater marshes.
The coast of the Solway estuary consists of saltwater marshes and mudflats,raised saltmarshes, wet grasslands and arable land. The estuary is a Biosphere Reserve and the coastal area is Ramsar Site.

Yorkshire-Humberside (72)

The NUTS-region Yorkshire Humberside shares the borders with the regions North, North-West and East Midlands. In the east the region is bordered by the North Sea. The ecological main structure in this region is based on national information on protected areas and the European map of the natural vegetation (Noirfalise 1987) [12].
The Tentative Ecological Main Structure consists of the National Parks Peak District, Yorkshire Dales and North York Moors. Besides habitat connection areas have been designed following the Pennines. Along small rivers stepping stones have been designed.
The Pennines are situated in a north-south direction. It contains two National Parks (cat. V in UN-list): the Peak District in the south and the Yorkshire Dales in the north. The Peak district consists of deep dales and undulating fields characteristic of a limestone area with small forests of ash (*Fraxinus excelsior*), wych elm (*Ulmus glabra*) and maple-tree (*Acer campestre*) and field maple (*Acer campestre*), areas of peat moorland with edges of precipitous millstone grit, where heather and bracken dominate. The Yorkshire Dales are characterized by limestone cliffs, gorges, numerous waterfalls and streams. Important biotopes are relicts of ash woodlands, lakes and wetlands in the uplands and the traditional managed meadows, that are often important bird areas.
The National Park North York Moors (cat. V in UN-list) is situated at the coast with the North Sea and consists of uplands with managed heather moorland. Open heathland dominates (one third of the area). The area is threatened by the expansion of agriculture, afforestation and increasing tourism.

[12] Ibid

East Midland (73)

The NUTS-region East Midland is bordered by Yorkshire Humberside in the north, West Midland in the west and East Anglia and South England in the south. In the east the region is bordered by the North Sea coastline. The Tentative Ecological Main Structure in this region is based on national information on protected areas, areas of outstanding natural beauty and the European map of the natural vegetation (Noirfalise 1987) [13]. Besides the comments of British experts resulted in a large habitat connection area in the centre of the region. In this large area agricultural land use dominates. Partly nature (re)habilitation will be necessary, partly agricultural management can be adapted to nature conservation objectives.From the intertidal mud- and sandflats of the river Humber, consisting of saltmarshes, associated freshwater pools and sand-dune systems, to the intertidal bay of the Wash with extensive mudflats and sandbanks (Ramsar site) a wide connection area has been designed along the coast. Two small nature reserves are situated within this connection area (Gibraltar Point and Saltfleetby).
Adjacent to the large area of the Peak district in Yorkshire Humberside the south Pennines have been included within the ecological main structure. The Lincolnshire Wolds is a lowland area of outstanding natural beauty and consists of mainly agricultural land with solitary trees and small streams. Nature (re)habilitation and adaptation of the agricultural land use is needed like the creation of small scale connection elements like hedgerows and small forests.

East Anglia (74)

The NUTS-region East England borders to East Midland in the west and South-East in the south. In the north and east the region is bordered by the North Sea. The Tentative Ecological Main Structure in this region is based on national information on protected areas, areas of outstanding natural beauty, the European map of the natural vegetation (Noirfalise 1987) [14] and data on important bird areas (Grimmett and Jones 1989) [15].
The ecological main structure consists of the coastal area from the Wash to Stour and Orwell estuary and a isolated area in the centre of the agricultural land. From the intertidal bay of the Wash a large connection area has been designed to the Stour and Orwell estuaries, two estuaries with saltwater marshes and mudflats that are Sites of Special Scientific Interest (SSSI), Areas of Outstanding Natural Beauty (AONB) and reserves of the Royal Society for the Protection of Birds (RSPB). This connection area connects numerous important areas: North Norfolk coast, a complex of sand-dunes, shingle islands, spits, beaches, fresh- and saltwater lagoons, saltwater marshes, raised saltmarshes and mudflats; the Broads, a National Park, comprising a wetland complex with four large shallow lakes, surrounded by extensive areas of reed vegetation, grazing marsh and fen-meadows and a variety of typical broadland fen habitats; Minsmere-Walberswick, two large marshes with reed vegetation and fresh- and saltwater lagoons.
In the centre of the region a complex of rough grazings, heather and lichen heath sites has been included into the ecological main structure. It consists of numerous small sites with an area of nearly 6600 ha.

[13] Ibid
[14] Ibid
[15] R.F.A. Grimmett, T.A. Jones, *Important bird Areas in Europe*; Cambridge UK, ICBP Technical Publications no. 9, 1989.

South-East (75)

The NUTS-region South-East England borders East Anglia, East Midland and West Midland in the north and South-West England in the west. The east and south of the region is bordered by the English Channel and the North Sea. The Tentative Ecological Main Structure in this region is based on national information on protected areas, areas of outstanding natural beauty, the European map of the natural vegetation (Noirfalise 1987) [16] and data on important bird areas (Grimmett and Jones 1989) [17]. The CORINE biotope data have been used, but they contain no supplementary information, because all biotope sites are situated in the areas of outstanding natural beauty.
The Tentative Ecological Main Structure in South-East England consists of lowland areas with woodlands and coastal areas. On the eastern coastline starting from the Stour and Orwell Estuary a connection area has been designed along the coast, that connects different protected areas: Hamford Water, Blackwater and Colne estuaries, Foulness, Maplin Sands, Benfleet and Southend Marshes. All these areas have intertidal mudflats, saltmarshes, beaches, islands and they are surrounded by grassland and arable land. The connection area between the protected area consists in fact of the same abiotic environment.
The North Wessex Downs and Chilterns are extensive calk downlands, that ranges in south-west – north-east direction. It consists of beech forests, bluebell swathes and agricultural land (enclosed land). The natural value is related to the traditional land use: hedgerows, small forest etc. Conservation is directed to the integration of agriculture and nature conservation.

The Sussex Downs, Surrey Hills and Kent Downs are three large areas of outstanding natural beauty. These include national nature reserves and sites of special scientific interest. The characteristic habitats of these areas are: heathlands (dry and humid heaths), broadleaved deciduous woodlands, native coniferous woodlands, pastures with orchids, enclosed agricultural land. Along the coast freshwater lagoons, saltmarshes and mudflats dominate.

South-West England (76)

The NUTS-region South-West England borders West Midland and South-East England. Besides it is bordered by the coastline of the English Channel and the Atlantic ocean. The Tentative Ecological Main Structure in this region is based on national information on protected areas, areas of outstanding natural beauty, the European map of the natural vegetation (Noirfalise 1987) [18] and data on important bird areas (Grimmett and Jones 1989) [19].
The ecological main structure consists of nearly the whole coastline of the region, upland moors and lowland areas. It is the area in the United Kingdom of the Hiberno-Iberian disjunction. Mediterranean species are found here. Dartmoor, Exmoor with surrounding area consist of the two National Parks Dartmoor and Exmoor. Both are boggy plateaux divided by rivers (Dart, Exe, Avill) with divers grasslands, wooded ravines, natural broadleaved deciduous woodlands, heather, the commons. Besides in Dartmoor stone outcrops, called tors, include a special vegetation. Exmoor is one of the largest sites for the red deer in England and the Exmoor pony lives in the park A connection area has been designed between the two National Parks.
The largest part of the coastline in this region has already been designated as Area of Outstanding Natural Beauty (AONB). These areas have been included and

[16] A. Noirfalise, op.cit., 1987.
[17] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.
[18] A. Noirfalise, op.cit., 1987.
[19] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

connected within the ecological main structure. The cliffs, where waterfalls cascade to the sea contrast with the beaches, the tree-shaded areas and heath-topped plateaux. There are estuaries with mudflats and saltmarsh (Taw, Torridge, Tamar, Tavy, Lynher, Exe etc).Cranborne and West Wiltshire Downs in Dorset is an area of outstanding natural beauty. It is calcareous area with steep wooded scarps, pastures, cultivated woodland and herb-rich fens. It is the biotope of the red deer. The area is connected with the AONB Dorset, that is situated along the coast and consists of heathland, chalk downs, grasslands and along the coast cliffs dominate. The Severn Estuary is a large Ramsar site (35000 ha) with mudflats, saltwater marshes, raised saltmarsh, wet meadows, grasslands and freshwater lakes. It includes the Taff/Ely estuary, Bridgewater Bay and the islands Flat Holm and Steep Holm.

West Midlands (77)

The NUTS-region West Midland is surrounded by the neighbouring regions Wales, North West, East Midlands, South East England and South West England. The Tentative Ecological Main Structure in West Midland is based on national information concerning the areas of outstanding natural beauty. It has been compared with the European map of the natural vegetation (Noirfalise 1987) [20].
There are no National Parks and only a few national nature reserves in this region. The ecological main structure consists only of the areas of outstanding natural beauty: Cotswolds and Shropshire Hills. Some smaller areas have been included as stepping stones. The Cotswolds consists of hills that rise to a crest above the Severn Vale in a landscape with beech forests and limestone grasslands. The many drystone walls give landscape an enclosed character. The Shropshire Hills is an area of enclosed land with old dykes, grasslands and hedgerows.

North-West (78)

The NUTS-region North-West is situated along the Irish sea and borders the NUTS-regions North, Yorkshire Humberside, East and West Midland and Wales. The Tentative Ecological Main Structure is based on national information on protected areas, areas of outstanding natural beauty, the European map of the natural vegetation (Noirfalise 1987) [21] and data on important bird areas (Grimmett and Jones 1989) [22].
The Tentative Ecological Main Structure covers here only a small part of the area, because there are large urban areas (Liverpool, Manchester) and only a few nature reserves. It consists of some stepping stones along the coast and the area of outstanding natural beauty Forest of Bowland. This is an extensive upland area of acid moorland with large areas of blanket bogs. It includes several valleys with remnants of the original birch-oak forests (*Querco-Betuletum*). The coast consists of Morecambe Bay, Ribble, Alt and the Mersey estuaries have been included in the ecological main structure. They contain typical coastal habitats as mudflats, saltwater marshes, raised saltmarsh, beaches, sandy islands and wet meadows.

Wales (79)

The NUTS-region Wales has a long coastline with the Atlantic Ocean and the Irish Sea. The region borders to North-West, West Midland and South-West England. The Tentative Ecological Main Structure has been based on national

[20] A. Noirfalise, op.cit., 1987.

[21] ibid

[22] R.F.A. Grimmett and T.A. Jones, op.cit., 1989.

information on National Parks, areas of outstanding natural beauty and national nature reserves. Besides the map of the natural vegetation of Europe (Noirfalise 1987) [23] has been used to design connection areas and to extend existing protected areas.
The Tentative Ecological Main Structure consists of uplands (Snowdonia, Brecon Beacons), coastal areas and lowlands (Anglesey).
The Snowdonia National Park consists of diverse habitats: steep wooded valleys, lakes and waterfalls, wide river mouth and beaches along the coast, wet grasslands, mixed woodlands, inland cliffs and arctic-alpine grasslands.
The National Park Brecon Beacon contains four mountain massifs: Black Mountains, Brecon Beacon, Forest Fawr and the Black Mountain. Deep valleys separate these mountain massifs. Heathland, extensive wetlands, calcareous grasslands and gorges are the dominant habitats.
The National Park Pembrokeshire Coast is a rocky coast with many cliffs, beaches and sand-dunes, small islands, but also moorland. Habitats in this area show a great diversity due to pedological and climatic diversity.
The island of Anglesey is situated in the north-west of Wales and is a flat area with a long rocky coastline, important for many bird species. Broadleaved deciduous forests along the coast and meadows characterize the land area.

Scotland (7A)

The NUTS-region Scotland has a long indented coastline with numerous islands and is bordered by England in the south. It is dominated by uplands with high peaks (above 1000 m). The Tentative Ecological Main Structure in Scotland is designed by using the CORINE data of habitats and regional information concerning the natural situation in Scotland. Comparison with CORINE Biotope data and the map of natural vegetation of Europe (Noirfalise 1987) [24] afforded possibilities to design an ecological main structure. It consists of the coastal areas and most of the uplands. All the islands have been included.

The Cairngorms is a Ramsar site, 49200 ha consisting of extensive uplands with high plateaus and snow-bed habitats, lochs, marshes and bogs, moorland and streams. It includes one of the largest tracts of native Scotch Pine forests (*Pinus sylvestris*) in the UK (Rothiemurchus Pinewood). In the surrounding upland areas with arctic/subarctic flora. Along the rivers forests can be found of Birch, Common oak and Scotch Pine.
All surrounding Lochs have been included into the ecological main structure as nature expansion areas. They consists mainly of eutrophic lochs with extensive areas of rich fen vegetation. Between these connection areas have been designed resulting in a large connection area from the upland to the northern coast. Along the coast numerous sites of special scientific interest are situated (lochs and cliffs, bays).
The Caithness and Sutherland consist of a large old undisturbed peatland, covered by a mixture of rushes, sedges, rough grasses and heather. It includes numerous permanently waterlogged areas with bog mosses and the entire area is interspersed with thousands of small pools.
Via an area with lochs, marshes, wet meadows, grasslands and arable land a connection has been designed towards the coast of Caithness, that is important for many bird species.
All the Scottish Highlands have been included into the Tentative Ecological Main Structure. They are dotted by numerous important biotope sites according to CORINE data. This area includes numerous national scenic areas of which are the larger ones Wester Ross (145.000 ha) and Assynt-Coigach (90.200 ha). Both are connected through sites of special scientific interest.

[23] A. Noirfalise, op.cit., 1987.
[24] Ibid

Southwards a connection area has been designed to the national scenic areas Glen Affric, Kintail and Knoydart (67.100 ha).
Ben Nevis and Glen Coe include some of the roughest mountainous areas in Scotland: the Ben Nevis range, the Glen Coe hills and the Black Mount. This area includes two important native pinewood remnants, extensive moorland and mires. The area of Loch Lomond includes numerous SSSI with upland plant communities, mixed woodland, little modified islands habitats, fens, bogs and mires. It is situated between the Highlands with rugged mountain country and the open pasturage landscape of the south.

Northern Ireland (7B)

The NUTS-region Northern Ireland is situated on the Irish Island and borders to the Republic of Ireland. The ecological main structure has been based on the CORINE Biotope data and the European map of the natural vegetation (Noirfalise 1987) [25]. The Tentative Ecological Main Structure includes the eastern coastline and Lough Neagh and Lough Beg. A small area along the border with Ireland has also been included adjacent to the Irish ecological main structure.
Along the coast south of the islands Sheep and Rathlin a large area is designed as connection area along the coast. It includes typical coastal habitats as mudflats, sandy beaches interspersed with rocky outcrops along sandy bays and saltwater marshes. The connection area connects some areas of special scientific interest and national nature reserves.
Lough Neagh and Lough Beg are two loughs surrounded by marshes and meadows. They are Ramsar sites (39.500 ha) and of importance for bird species.
From the Lough Erne and the Lough McNean to the northwestern border with Ireland a narrow connection area has been designed. The loughs and their surroundings contain marshes, wet meadows and islands. The area includes also the Pettigoe Plateau, a blanket bog, that is threatened by afforestation peat extraction, drainage and agricultural improvement.

Consequences for agriculture and forestry

The data that had to be used to develop the Tentative Ecological Main Structure for Great Britain, existing data on nature conservation categories, imply a certain fit with present land use practice. That means, that large areas of rough grazing have been left out because of lack of data. Because nature conservation is well organised in Britain, it might be expected, that most important natural areas will have been included.
In Scotland and possibly in Northern Ireland (blanket bogs and heathlands) the area of rough grazings is underestimated. In the rough grazing area cattle breeding and sheep grazing is a normal land use category. This is not conflicting with the objectives of the Tentative Ecological Main Structure.
The southwestern part of Great Britain is characterised by rich forests, moorlands and small rivers. It also is the area with the most mild climate of Britain, expressed in flora of the Hiberno-Iberian disjunction. Therefore the connection zone and nature development zone here is relatively large. The forests here are rather natural and only low production forestry fits with the objectives of the connection areas.

[25] ibid

ANNEX III

Species list

FLORA

Abies alba	white fir
Abies cephalonica	
Acer campestris	field maple
Adianthum reniforme	
Alnus glutinosa	alder
Arbutus unedo	strawberry tree
Arenaria balearica	
Arum pictum	
Berberis vulgaris	barberry
Betula pendula	birch
Betula pubescens	downy birch
Buxus sempervirens	box
Calluna vulgaris	heather
Cardamine bulbifera	coralroot bittercress
Carpinus betulus	hornbeam
Castanea sativa	sweet chestnut
Ceratonia siliqua	St Johns bread
Cistus monspeliensis	narrow-leaved cistus
Cornus suecica	dwarf cornel
Corylus avellana	hazel
Cytisus	broom
Daboecia azorica	
Daboecia cantabrica	St Dabeoc's heath
Daphne laureola	spurge laurel
Davallia canariensis	
Dracaena draco	
Empetrum hermaphroditum	crowberry
Empetrum nigrum	crowberry
Erica arborea	tree heath
Erica cinera	bell heather
Erica lusitanica	Lusitanian heath
Erica multiflora	
Erica scoparia	green heather
Erica tetralix	cross-leaved heather
Erica vagans	Cornish heather
Fagus sylvatica	European beech
Fraxinus excelsior	ash
Genista spp.	greenweed
Genista pilosa	needlefurze
Helichrysum ambiguum	
Helleboris foetidus	stinking hellebore
Helleborus trifolius ssp lividus	
Hyacinthoides hyspanica	Spanish bluebell
Ilex aquifolium	holly
Juniperus communis	juniper
Juniperus nana	dwarf juniper
Juniperus oxycedrus	prickly juniper
Juniperus thurifera	Spanish juniper
Juniperus sabina	savin
Larix decidua	European larch
Laurus azorica	Açores laurel
Lavandula stoechas	French lavender
Luzula fortesi	woodrush
Mespilus germanica	medlar
Myrica faya	
Myrtus communis	myrthe
Olea sylvestris	olive

Paeonia broteri	peony sp.
Paeonia coriacea	peony sp.
Persea indica	
Peucedanum parisiense	milk parsley
Phragmites australis	reed
Picea abies	Norway spruce
Pinus canariensis	
Pinus cembro	arolla pine
Pinus pinaster	maritime pine
Pinus pinea	stone pine
Pinus sylvestris	Scotch pine
Pinus uncinata	mountain pine
Pistacia lentiscus	mastic tree
Pistacia terebinthus	turpentine tree
Platanus orientalis	oriental plane
Populus nigra	black poplar
Primula vulgaris	primrose
Prunus mahaleb	St. Lucie's cherry
Prunus spinosa	blackthorn
Quercus canariensis	canarian oak
Quercus coccifera	kermes oak
Quercus faginea	lusitanean oak
Quercus frainetto	frainetto oak
Quercus ilex	holm oak
Quercus macrolepis	
Quercus pubescens	white oak
Quercus pyrenaica	pyrenean oak
Quercus petraea	durmast oak
Quercus robur	pedunculate oak
Quercus rotundifolia	evergreen oak
Quercus suber	cork oak
Rhamnus species	buckthorn
Rosmarinus officinalis	rosemary
Ruscus aculeatus	butchers broom
Salix alba	white willow
Salix herbacea	least willow
Scilla non-scripta	squill
Scirpus lacustris	mat rush
Silene hifacensis	
Smilax canariensis	
Sorbus aucuparia	rowan
Spergularia azorica	
Taxus baccata	yew tree
Tilia cordata	lime
Ulex europeaus	gorse
Ulmus glabra	wych elm
Vaccinium myrtillus	bilberry
Vaccinium vitis ideae	cowberry

FAUNA

Acipenser stureo	sturgeon
Alosa alosa	shad
Alosa fallax	twaite shad
xAnas strepera	gadwall
Anguilla anguilla	eel
Anser anser	greylag goose
Anthus campestris	tawny pipit
Aquilla chrysaetos	golden eagle
Artocephalus (Callorhinus) ursinus	northern fur seal
Bos bonasus	wisent
Canis lupus	wolf
Capra ibex,	ibex
Capra pyrenaica	Spanish ibex
Capreolus capreolus	roe deer
Cervus elapus	red deer
Ciconia nigra	black stork
Dama dama	fallow deer
Falco eleonorae	Eleonora's falcon
Falco peregrinus	peregrine
Galemys pyrenaicus	Pyrenean desman
Gypaetus barbatus	lammergeier
Lagopus lagopus	Scotch ptarmigan
Lutra lutra	otter
Lynx lynx,	lynx
Lynx pardina	Spanish lynx
Milvus milvus	red kite
Milvus migrans	black kite
Monachus monachus	monk seal
Pelecanus crispus	Dalmatian pelican
Pelecanus onocrotalus	white pelican
Phoca vitulina	common seal
Phoenicopterus ruber	greater flamingo
Salmo salar	salmon
Sus scrofa	wild boar
Tetrao tetrix	black grouse
Ursus arctos	brown bear

ANNEX IV

Glossary

GLOSSARY

baldios	Common grounds in northern Portugal mainly consisting of heathland vegetation
biogeography	The study of plant distributions and animal distributions together with the geographical relationships with their environment studied over time.
biotope	Living site of a species or population. CORINE Biotope Inventory: An area of land or a body of water which forms an ecological unit of community significance for nature conservation (Moss et al 1990).
boreal	Climatic zone characterised by long, cold snowy winters and short summers.
carrascal	Low species-rich vegetation mainly consisting of scrubs, degradation phase of forests of *Quercus ilex*, *Q. suber* and *Q. faginea* (Portugal).
CORINE	COoRdination of INformation on the Environment, the EC-database on spatial environmental data
dehesa	Common grounds in Spain consisting of species-rich dry grasslands
ecosystem	The populations in a given area and their abiotic environment functioning in relation to each other
eutrophic	The state of a water body or soil when it has an excess of plant nutrients.
FAO	United Nations Food and Agriculture Organisation
garrigue	Low species-rich vegetation mainly consisting of scrubs, degradation phase of the forests of *Quercus ilex* and *Q. rotundifolia*.
GIS	Geographical Information System, computer software for mapping and map analysis.
habitat	Living site of a species or population. Habitat directive (EC): a land of water site distinguished by special geographical, abiotic and biotic features and that can be natural as well as semi-natural.
Important Bird Areas	Sites of major importance for the conservation of avifauna in Europe according to ICBP/IWRB (IBA).
ICBP	International Council for Bird Preservation
IUPN	International Union for the Protection of Nature, changed its name into IUCN in 1956
IUCN	International Union for the Conservation of Nature
IWRB	International Waterfowl and Wetlands Research Bureau
maquis	Scrubby vegetation of about 2 meters high, mainly consisting of *Cistus* spp., *Erica* spp. and *Arbutus* spp.; degradation phase of *Quercion ilicis*.
mattoral	Scrubby vegetation of about 2 meters high, mainly consisting of *Cistus* spp., *Erica* spp. and *Arbutus* spp.; degradation phase of *Quercion ilicis*.
mesotrophic	The state of a water body or soil unit whith a nutrient content that is intermediate between eutrophic and oligotrophic.
NUTS region	Nomenclature des Unites Territoriales Statistiques, Regions that are the standard administrative areas used in the EC, primarily for statistical purposes.
oligotrophic	Water or soil which contains few nutrients, these waters are characterised by a between decaying vegetation and living organisms and never loses its oxygen.
phrygana	Low species-rich vegetation mainly consisting of scrubs, degradation phase of forests of *Quercus ilex* and *Quercus frainetto*(Greece)

Ramsar sites	Areas of land brought under the international treaty on wetlands signed in Ramsar (Iran, 1971). Objective is the protection of the important wetlands in the world.
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
tomillares	Low species rich-vegetation mainly consisting of scrubs, degradation phase of forests of *Quercus ilex* and *Q. rotundifolia* dominated by thyme (Spain).
WWF	World Wide Fund for Nature

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First term of office

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4 Milieubeleid (Environmental Policy), 1974.

5 Bevolkingsprognoses (Population Forecasts), 1974.

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12 Externe adviesorganen van de centrale overheid, beschrijving, ontwikkelingen, aanbevelingen (External Advisory Bodies of the Central Government: Description, Developments, Recommendations), 1977.

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Second term of office

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21 Vernieuwing in het arbeidsbestel (Prospects for Reforming the Labour System), 1981.

22 Herwaardering van welzijnsbeleid (A Reappraisal of Welfare Policy), 1982.

23 Onder invloed van Duitsland. Een onderzoek naar gevoeligheid en kwetsbaarheid in de betrekkingen tussen Nederland en de Bondsrepubliek (The German Factor, A Survey of Sensitivity and Vulnerability in the Relationship between the Netherlands and the Federal Republic), 1982.

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Third term of office

25 Beleidsgerichte toekomstverkenning: deel 2; Een verruiming van perspectief (A Policy-oriented Survey of the Future: Part 2: Towards a Broader Perspective), 1983.

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29 Ruimte voor groei (Scope for Growth), 1987.

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31 Cultuur zonder grenzen (Culture and Diplomacy), 1987.

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35 Rechtshandhaving (Law Enforcement), 1989.

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V 7 J.J.C. Voorhoeve, Internationale Macht en Interne Autonomie International Power and Internal Autonomy) (1978)

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V17 A.J. Basoski, A. Budd, A. Kalff, L.B.M. Mennes, F. Racké en J.C. Ramaer, Exportbeleid en sectorstructuurbeleid (Export Policy and Structural Policies) Pre-adviezen bij het rapport Plaats en toekomst van de Nederlandse industrie (1980)

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V36 M.C. Brands, H.J.G. Beunders, H.H. Selier: Denkend aan Duitsland; een essay over moderne Duitse geschiedenis en enige hoofdstukken over de Nederlands-Duitse betrekkingen in de jaren zeventig (Thinking about Germany; An Essay on Modern German History, with some Chapters on Dutch-German Relations in the Seventies) (1983)

V37 L.G. Gerrichhauzen: Woningcorporaties; Een beleidsanalyse (Housing Corporations: A Policy Analysis) (1983)

V38 J. Kassies, Notities over een heroriëntatie van het kunstbeleid (Notes on a Reorientation of Policy on the Arts) (1983)

V39 Leo Jansen, Sociocratische tendenties in West-Europa (Sociocratic trends in Western Europe) (1983)

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M 2 E.H. Hollander: Kleinschalige massacommunicatie; locale omroepvormen in West-Europa (Small-scale Mass Communications: Local Broadcasting Forms in Western Europe) (1982)

M 3 L.J. Heinsman/Nederlandse Omroep Stichting: De kulturele betekennis van de instroom van buitenlandse televisieprogramma's in Nederland – Een literatuurstudie (The Cultural Significance of the Inflow of Foreign Television Programmes in the Netherlands – A Survey of the Literature) (1982)

M 4 L.P.H. Schoonderwoerd, W.P. Knulst/Sociaal en Cultureel Planbureau: Mediagebruik bij verruiming van het aanbod (Media Use and a Wider Media Range) (1982)

M 5 N. Boerma, J.J. van Cuilenburg, E. Diemer, J.J. Oostenbrink, J. van Putten: De omroep: wet en beleid; een juridisch-politicologische evaluatie van de Omroepwet (Broadcasting – Legislation and Government Policy: A Legal and Political Evaluation of the Broadcasting Act) (1982)

M 6 Intomart B.V.: Etherpiraten in Nederland (Radio Pirates in the Netherlands) (1982)

M 7 P.J. Kalff/Instituut voor Grafische Techniek TNO: Nieuwe technieken voor productie en distributie van dagbladen en tijdschriften (New Techniques for the Production and Distribution of Newspapers and Magazines) (1982)

M 8 J.J. van Cuilenburg, D. McQuail: Media en pluriformiteit; een beoordeling van de stand van zaken (The Media and Diversity: An Assessment of the State of Affairs) (1982)

M 9 K.J. Alsem, M.A. Boorman, G.J. van Helden, J.C. Hoekstra, P.S.H. Leeflang, H.H.M. Visser: De aanbodsstructuur van de periodiek verschijnende pers in Nederland (The Supply Structure of Regular Press Publications in the Netherlands) (1982)

M10 W.P. Knulst/Sociaal en Cultureel Planbureau: Mediabeleid en cultuurbeleid; Een studie over de samenhang tussen de twee beleidsvelden (Media Policy and Cultural Policy: A Study of the Interrelationship between the two Fields of Policy) (1982)

M11 A.P. Bolle: Het gebruik van glasvezelkabel in lokale telecommunicatienetten (The Use of Fibre Optic Cable in Local Telecommmunications Networks) (1982)

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M13 P.J.M. Wilms/Instituut voor Onderzoek van Overheidsuitgaven: Horen, zien en betalen; een inventariserende studie naar de toekomstige kosten en bekostigingen van de omroep (Listening, Viewing and Paying: An Inventory Study of the Future Cost and Funding of Broadcasting) (1982)

M14 W.M. de Jong: Informatietechniek in beweging, consequenties en mogelijkheden voor Nederland (Information Technology in Flux: Consequences and Possibilities for the Netherlands) (1982)

M15 J.C. van Ours: Mediaconsumptie; een analyse van het verleden, een verkenning van de toekomst (Media Consumption: An Analysis of the Past and Survey of the Future) (1982)

M16 J.G. Stappers, A.D. Reijnders, W.A.J. Möller: De werking van massamedia; een overzicht van inzichten (The operation of Mass Media: A Survey of the State of Understanding) (1983)

M17 F.J. Schrijver: De invoering van kabeltelevisie in Nederland (The Introduction of Cable in the Netherlands) (1983)

Third term of office

V40 G.J. van Driel, C. van Ravenzwaaij, J. Spronk en F.R. Veeneklaas: grenzen en mogelijkheden van het economisch stelsel in Nederland (Limits and Potentials of the Economic System in the Netherlands) (1983)

V41 Adviesorganen in de politieke besluitvorming *(Advisory Bodies in the Political Decision-Making Process)*; Report of a symposium by A.Th. van Delden and J. Kooiman (1983)

V42 E.W. van Luijk, R.J. de Bruijn: Vrijwilligerswerk tussen betaald en onbetaald werk; een verkennende studie op basis van een enquête (Volunteering between Paid and Unpaid work; an Exploratory Study Based on a Survey) (1984)

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V44 W.J. van der Weijden, H. van der Wal, H.J. de Graaf, N.A. van Brussel, W.J. ter Keurs: Bouwstenen voor een geïntegreerde landbouw (Towards an Integrated Agriculture) (1984)*

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V46 G. Meester, D. Strijker: Het Europese landbouwbeleid voorbij de scheidslijn van zelfvoorziening (The European Agricultural Policy Beyond the Point of Self-Sufficiency) (1985)

V47 J. Pelkmans: De interne EG-markt voor industriële produkten (The Internal EC-Market for Industrial Products) (1985)*

V48 J.J. Feenstra, K.J.M. Mortelmans: Gedifferentieerde integratie en Gemeenschapsrecht: institutioneel- en materieelrechtelijke aspecten (Differentiated Integration and Community Law: Institutional and Substantive Aspects) (1985)

V49 T.H.A. van der Voort, M. Beishuizen: Massamedia en basisvorming (Mass Media and the Core Curriculum) (1986)

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V52 J. Moonen: Toepassing van computersystemen in het onderwijs (The Use of Computer Systems in Education) (1986)

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V57 R.M.A. Jansweijer: Private leefvormen, publieke gevolgen (Private Households, Public Consequences) (1987)

V58 De ongelijke verdeling van gezondheid (The Unequal Distribution of Health) Verslag van een conferentie op 16-17 maart 1987 (1987)

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V60 H.G. Eijgenhuijsen, J. Koelewijn, H. Visser: Investeringen en de financiële infrastructuur (Investments and the Financial Infrastructure) (1987)

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Fourth term of office

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V66 P. de Grauwe, A. Knoester, A. Kolodziejak, A. Muijzers, F. van der Ploeg, C.J. Rijnvos: De Europese monetaire integratie: vier visies (European Monetary Integration: Four Visions) (1989)

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